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Dr. Adams obtained his master’s degree in pharmacology from Michigan State University and his doctorate in education from the University of South Florida. Dr. Adams was on the faculty of Lansing Community College and St. Petersburg College, and was Dean of Health Professions at Pasco-Hernando State College for over 19 years. He is currently Adjunct Professor of Anatomy and Physiology at Hillsborough Community College.

I dedicate this book to nursing educators, who contribute every day to making the world a better and more caring place.

—MPA

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To my daughter, Joy, an extraordinary and resilient woman who continues to change the world for the better, and in memory of my son, Keith, and my husband, Mike.

—CQU

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To my husband, Lee, and my parents, Jane and Ellis, who have given me the foundation to reach for my dreams, and to my amazing children Andrew, Sarah, and Emily, who have made me stronger, better, and more fulfilled than I could have ever imagined. I love you to the moon and back.

—RES
Thank You

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Our heartfelt thanks go out to our colleagues from schools of nursing across the country who have given their time generously to help create this exciting new edition of our pharmacology textbook. These individuals helped us plan and shape our book and resources by reviewing chapters, art, design, and more. *Pharmacology: Connections to Nursing Practice* has reaped the benefit of your collective knowledge and experience as nurses and teachers, and we have improved the materials due to your efforts, suggestions, objections, endorsements, and inspiration. Among those who gave their time generously to help us are the following:

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Preface

Pharmacology is one of the most challenging and dynamic subjects for professional nurses. Each month new drugs are being introduced, and new indications for existing medications are continually being developed. Some medications that were considered preferred drugs only a decade ago are now rarely prescribed. Current knowledge of drug actions, mechanisms, interactions, and legislation is mandatory for nurses to provide safe and effective patient care in all healthcare settings. Pharmacotherapeutics remains a critical and ever-changing component of patient care.

The subtitle of this text, Connections to Nursing Practice, has guided its continued development. At a fundamental level, pharmacology is a series of interrelated essential concepts. Some key concepts are shared with the natural and applied sciences. Prediction of drug action requires a thorough knowledge of anatomy, physiology, chemistry, and pathology as well as the social sciences of psychology and sociology. This interdisciplinary nature of pharmacology makes the subject difficult to learn but fascinating to study.

However, the discipline of pharmacology is far more than a collection of isolated facts. To effectively learn this discipline, the student must make connections to nursing practice and, ultimately, connections to patient care. Patients expect to receive effective and safe medication administration from a nurse who is competent in the study of pharmacology. Pharmacology: Connections to Nursing Practice identifies key pharmacologic concepts and mechanisms and clearly connects them to current nursing theory and practice for providing optimal patient care.

Pharmacology: Connections to Nursing Practice recognizes that pharmacology is not an academic discipline to be learned for its own sake but is a critical tool to prevent disease and promote healing. This connection to patients, their assessment, diagnoses, and interventions supports basic nursing practice. Like other core nursing subjects, the focus of pharmacology must be to teach and promote wellness for patients.

Structure of the Text

This text is organized according to body systems (units) and diseases (chapters). Unit 1, the first seven chapters, identifies fundamental pharmacologic principles that are applied throughout the text. Although new drugs are constantly being developed, these chapters build the structural framework for understanding the applications of all drugs. The role of complementary and alternative therapies, which are used by many patients, is included in the context of holistic care.

Unit 2 connects pharmacology, the nurse, and the patient, with an emphasis on positive patient outcomes. The four chapters in this unit recognize the essential role of nurse–patient interactions in providing optimal patient care throughout the lifespan. The fact that individuals vary in their responses to drug action is an important theme introduced in this unit.

Units 3 through 11 provide the concepts and connections that are necessary to understand the actions and adverse effects of individual drugs on different body systems. Many of the units begin with a chapter that briefly reviews relevant anatomy and physiology, which is a useful feature for the student when studying drug actions. Each chapter clearly identifies the concepts and connections necessary for safe and effective pharmacotherapy. Pharmacology is intimately related to the study of disease processes. The connections between pharmacology and pathophysiology are clearly established for each drug class in every chapter.

Resources for Faculty and Student Success

Resources for Faculty

Pearson is pleased to offer a suite of resources to support teaching and learning, including:

- TestGen Test Bank
- Lecture Note PowerPoints
- Instructor’s Resource Manual

Resources for Students

Online Resources for students that are available include:

- Making the Patient Connection case studies and answers
- Additional Case Studies and answers
- Answers to Patient Safety Questions
- Suggested answers to Connection Checkpoints, and more!
A Practical Approach to Learning Pharmacology

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**Updated! Prototype Approach.** The vast number of drugs that the practicing nurse must learn is staggering. To facilitate learning, this text uses a prototype approach in which the most representative medications in each classification are introduced in detail. This edition features 194 prototype drugs that include detailed information on therapeutic effects, mechanism of action, pharmacokinetics, adverse effects, contraindications, drug interactions, pregnancy category, and treatment of overdose.

**Adverse Effects:** Potentially serious adverse effects limit the use of amiodarone. Amiodarone may cause nausea, vomiting, anorexia, fatigue, dizziness, and hypotension. Visual disturbances are common in patients taking this drug for extended periods and include blurred vision due to cornea deposits, photophobia, xerostomia, cataracts, and macular degeneration. Rashes, photosensitivity, and other skin reactions occur in 10% to 15% of patients taking the drug. Certain tissues concentrate this medication; thus, adverse effects may be slow to resolve, persisting long after the drug has been discontinued. **Black Box Warning (oral form only):** Amiodarone causes a pneumonia-like syndrome in the lungs. Because the pulmonary toxicity may be fatal, baseline and periodic assessments of lung function are essential. Amiodarone has proarrhythmic action and may cause bradycardia, cardiogenic shock, or AV block. Mild liver injury is frequent with amiodarone.

**PROTOTYPE DRUG** Amiodarone (Pacerone)

- **Classification** Therapeutic: Antidysrhythmic, Class III  
  Pharmacologic: Potassium channel blocker

- **Therapeutic Effects and Uses:** Approved in 1985, amiodarone is the most frequently prescribed Class III antidysrhythmic. It is considered a broad-spectrum antidysrhythmic because it is effective in terminating both atrial and ventricular dysrhythmias. It is approved for the treatment of resistant ventricular tachycardia and recurrent fibrillation that may prove life threatening, and it has become a preferred medication for the treatment of atrial dysrhythmias in patients with HF.

- **Updated! Black Box Warnings.** The latest black box warnings issued by the U.S. Food and Drug Administration are clearly identified for all prototype medications.
Connections to Nursing Practice

Chapter 24
Central Nervous System Stimulants and Drugs for Attention-Deficit/Hyperactivity Disorder

Learning Outcomes

1. Describe the general actions and pharmacokinetic properties of central nervous system stimulants.

2. Identify the proper use and side effects of attention deficit hyperactivity disorder and narcolepsy.

3. Compare and contrast the central nervous system stimulants and describe the management of attention deficit hyperactivity disorder.

4. List the most common side effects of stimulants and describe the pharmacological management of attention deficit hyperactivity disorder.

5. For the early diagnosis of ADHD in children, identify the guidelines and management of drug and non-drug interventions, behavioral therapies, and parent and family education.

6. Apply the learning experience to care for patients receiving pharmacotherapy with central nervous system stimulants.

Table 38.1: Antipsychotic Drugs

<table>
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<tr>
<th>Drug</th>
<th>Route and Adult Dose (Maximum Dose Where Indicated)</th>
<th>Adverse Effects</th>
</tr>
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<tr>
<td>amantadine (Symmetrel)</td>
<td>PO: 100 mg bid to 750 mg/day (max: 1000 mg/day)</td>
<td>Dizziness, dry mouth, nausea, agitation, headache</td>
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<tr>
<td>haloperidol (Haldol)</td>
<td>PO: 1.0 mg to 6.0 mg/day (max: 20.0 mg/day)</td>
<td>Tardive dyskinesia, dystonia, tremor, akathisia</td>
</tr>
<tr>
<td>risperidone (Risperdal)</td>
<td>PO: 0.5 mg to 6.0 mg/day (max: 4.0 mg/day)</td>
<td>Erythromelia, prolactin levels, sedation, weight gain</td>
</tr>
</tbody>
</table>

CASE STUDY: Making the Patient Connection

Remember the patient “Jonathan Hogan” at the beginning of the chapter? Now read the remainder of the case study. Based on the information presented within this chapter, respond to the critical thinking questions that follow.

Jonathan Hogan has had trouble at school beginning in kindergarten and for the past year. He has been prescribed modafinil (Provigil). Jonathan Hogan’s parents have told his parents that Adderall may help Jonathan with his ADHD.

Critical Thinking Questions

1. What is ADHD and why would Jonathan be experiencing more difficulty as he becomes older?

2. How might amphetamine-sulfate and dextroamphetamine (Adderall) help Jonathan with his ADHD?

3. What caregiver education would be appropriate regarding dextroamphetamine and amphetamine sulfate (Adderall)?

4. What are other nonpharmacologic treatments for ADHD?

Answers to Critical Thinking Questions are available on the faculty resources site. Please consult with your instructor.
Liotrix (Thyrolar):

Liothyronine (Cytomel, Triostat):

Treatment of Overdose:

- Hypothyroidism
- Treatment with antithyroid drugs and decreasing thyroid hormone. It has a shorter onset, half-life, and duration of therapy for hypothyroidism. Its actions, adverse effects, and indications are different from those of levothyroxine.

• Continue periodic monitoring of TSH levels.
• Obtain baseline height, weight, and vital signs. Obtain an electrocardiogram (ECG) as needed.
• If indicated, obtain serum electrolyte levels and a complete blood count (CBC). Monitor for signs and symptoms of cardiac arrhythmias, such as palpitations, dysrhythmias. With large doses, significant loss of sodium, potassium, and chloride can cause gout in some patients due to hyperuricemia, the major risk factor for gout. Potassium levels may decrease with use of diuretics, especially furosemide, which causes an acute increase in intracellular potassium. Potassium levels may also decrease with the use of parenteral nutrition. Dizziness and fainting can result from the fall in blood pressure that occurs with use of antihypertensive medications. Antihypertensives should be used cautiously in patients with CKD. Administration of antihypertensive medications results in a significant increase in potassium levels, such as potassium supplements and angiotensin-converting enzyme (ACE) inhibitors.

Dramatic changes in thyroid status, improvement in dyslipidemias, or the effect on vascular endothelium (Hataya, Igarashi, Yamashita, & Komatsu, 2013) can cause gout in some patients due to hyperuricemia, the major risk factor for gout. Potassium levels may decrease with use of diuretics, especially furosemide, which causes an acute increase in intracellular potassium. Potassium levels may also decrease with the use of parenteral nutrition. Dizziness and fainting can result from the fall in blood pressure that occurs with use of antihypertensive medications. Antihypertensives should be used cautiously in patients with CKD. Administration of antihypertensive medications results in a significant increase in potassium levels, such as potassium supplements and angiotensin-converting enzyme (ACE) inhibitors.

Key nursing implications

- Monitor for signs and symptoms of cardiac arrhythmias, such as palpitations, dysrhythmias.
- With large doses, significant loss of sodium, potassium, and chloride can cause gout in some patients due to hyperuricemia, the major risk factor for gout. Potassium levels may decrease with use of diuretics, especially furosemide, which causes an acute increase in intracellular potassium.

Connections: Treating the Diverse Patient

Improved Kidney Function from Thyroid Hormone Replacement

Because thyroid hormones affect nearly all body systems, even slight changes in the amount of circulating hormones may have profound effects, especially in the very young and the older adult populations. Recent research suggests that thyroid hormone therapy may help preserve renal function in older patients (Lu, Guo, Liu, & Zhao, 2016). Subclinical hypothyroidism may have significant effects on chronic kidney disease. Several theories exist as to why thyroid replacement improves renal function, including improvement in cardiac status, improvement in dyslipidemias, or the effect on vascular endothelium (Hataya, Igarashi, Yamashita, & Komatsu, 2013; Rhee et al., 2016; Shin et al., 2013). Individualized treatment for subclinical hypothyroidism should be considered in older patients.

Connections: Complementary and Alternative Therapies

Probiotics for Diarrhea

- Probiotics are live microorganisms that are taken in specified amounts to confere a health benefit on the host. Most commercial probiotics are bacteria from the genera Lactobacillus and Bifidobacterium, but yeasts such as Saccharomyces is sometimes also used.

History and Claims

- Although probiotics have been used for thousands of years, only in the past 20 years has research begun to confirm their health benefits. Probiotics are claimed to improve immune function, decrease cancer risk, lower blood cholesterol, reduce blood pressure, and prevent vaginal infections. Probiotic supplements are available in certain drinks, yogurts, and tablets. Although probiotics are safe, care must be taken not to exceed recommended doses.

Standardization

- Supplements include capsules, tablets, and granules, as well as cultured dairy products that contain the probiotic bacteria. Doses are not standardized. Tablet doses range from 50 to 500 mg, and not all dairy products contain active cultures.

Evidence

- Most of the evidence supporting the efficacy of probiotics is related to their effects on the intestinal tract. Both Lactobacillus and Bifidobacterium are normal nonpathogenic inhabitants of a healthy digestive tract. These are considered to be probiotic flora, inhibiting the growth of potentially pathogenic species such as E. coli, Candida albicans, Helicobacter pylori, and Gram-negative vaginosis. Probiotics restore the normal flora of the intestinal tract, specifically diarrea resulting from antibiotic therapy (National Center for Complementary and Integrative Health, 2019). A 2015 systematic review indicated that probiotics do in fact reduce symptoms of IBD in patients (Didari, Mozaffari, & Tahrani, 2015).

- Probiotics have also been shown to be effective at treating episodes of acute infectious diarrhea and may be considered an option for increasing eradication rates for those with H. pylori (Zhang, Rehman, Zhou, & Zhang, 2014). Although probiotics have been used for many years, they are not without risk: Infections (including sepsis, lactic acidosis, and other serious adverse effects have been noted (Donoh & Snyderman, 2015). Because of these, probiotic supplements should be used with caution in critically ill patients.
Connections: Nursing Practice Applications features concisely connect the nursing process to the major drug classes in each drug chapter and incorporate outcomes from the Quality and Safety Education for Nurses (QSEN) competencies of patient-centered care, teamwork and collaboration, patient safety, and evidence-based practice. Each nursing intervention is patient centered and includes the rationale and associated patient and family teaching. Collaboration with other disciplines, such as social support services or dietary services, is also included in the interventions. Important lifespan and diverse patient considerations are noted throughout. The Nursing Practice Applications are organized to help students learn to think like a nurse as they take students through the processes of drug administration, nursing care, and teaching that are necessary in pharmacotherapy.

Connections: Patient Safety

Incorrect Insulin Dose
A patient with diabetes has 30 units of Humulin R (regular) insulin ordered for the morning dose. There are several patients with diabetes on the unit and the nurse has given many doses of insulin that morning. The nurse prepares the insulin but draws up Humalog 30 units instead. The patient begins experiencing symptoms of hypoglycemia within 15 minutes and is treated successfully.

What errors occurred and how could they be prevented in the future?

Answers to Patient Safety questions are available on the faculty resources site. Please consult with your instructor.

Connections: Patient Safety, a QSEN competency, is a feature that presents a brief patient–nurse scenario that illustrates potential pitfalls encountered by nurses that can lead to medication errors. Most scenarios end with a question asking the student to identify what went wrong, what the nurse should do in the situation, what the nurse should question about the order, or what the nurse should do differently in order to prevent medication administration errors.

New! Connections: Using Research in Practice features illustrate connections to nursing or pharmacology research and discuss the short- and long-term directions of pharmacotherapeutics. A critical thinking question is presented at the end of each feature to challenge the student to connect scientific evidence to nursing practice.

Connections: Using Research in Practice

Early Exposure to Allergens May Reduce Asthma Risk

Allergen exposure has been noted to increase the risk for and severity of asthma in both children and adults (Custovic, 2015; Sheehan & Phipatanakul, 2016). What is not as clear is what roles the timing of initial exposure, ongoing exposure, types of allergens, or amount of exposure play in the development of protection from conditions such as asthma and anaphylaxis (Sheehan & Phipatanakul, 2016).

Lynch et al. (2014) noted that cumulative exposure to allergens in the first 3 years of life seemed to decrease the risk of recurrent wheezing and allergies and that such early exposure may be beneficial. A subsequent study also noted that
and routine laboratory monitoring is not required because following orthopedic surgery and the treatment of DVT or pulmonary embolism. Other approved indications

Enoxaparin (Lovenox):

Approved in 2001, fondaparinux -

- The therapeutic applications of CCBs are the result of physiologic effects on the heart and vascular Channel Blockade

- The faculty resources site. Please consult with your instructor.

- Connections: Lifespan Considerations features clearly identify important considerations to ensure safe and effective pharmacotherapy in the older adult and pediatric populations.

CONNECTION Checkpoint  38.1

Coagulation occurs by intrinsic and extrinsic pathways. From what you learned in Chapter 28, which pathway is activated when blood leaks from a vessel? Which is more complex and takes several minutes? Which results in the formation of fibrin? Answers to Connection Checkpoint questions are available on the faculty resources site. Please consult with your instructor.

- Connection Checkpoints ask the student to recall past concepts from previous chapters that are related to current study. Unique to this text, these reinforce material learned in previous chapters that has direct application to the current chapter.

PharmFACT

In the United States, over 13 million units of whole blood and red blood cells are donated each year. About 36,000 units of red blood cells are needed every day (American Red Cross, n.d.).

CONNECTIONS: Community-Oriented Practice

Calcium Channel Blockers and Effects on Minerals

Patients may be concerned about taking calcium supplements for osteoporosis prevention while taking CCBs. Calcium and magnesium supplements may actually help maintain a normal blood pressure or a lower high blood pressure, and as long as normal doses are taken, do not appear to affect the antihypertensive effects of CCBs. More recent research suggests that CCBs may affect the body’s mineral content (Suliburska, Bogdanski, Szulinska, & Pupak-Musialik, 2014). CCBs, along with other antihypertensive drugs such as beta blockers and angiotensin-converting enzyme (ACE) inhibitors, were found to decrease serum zinc levels. Because depletion of some minerals such as zinc may have long-term effects on glucose and lipid metabolism, adequate mineral intake through diet or supplementation should be considered when a patient is taking CCBs or other antihypertensives.

- Connections: Community-Oriented Practice features provide important information that nurses need to convey to their patients to ensure that they receive effective pharmacotherapy after leaving the hospital or clinical setting.
Nursing Responsibilities:

- Notify the prescriber prior to administration if the patient has a history of leukemia, multiple myeloma, or other myeloid malignancies.
- Monitor for and immediately report signs and symptoms of fluid overload, hypokalemia, and cardiac dysrhythmias.
- Monitor patients with preexisting fluid retention conditions carefully, such as HF, pleural effusion, or ascites, for worsening of symptoms.
- This drug has a black box warning for possible anaphylaxis. Promptly report any signs and symptoms of allergic reaction to the provider and discontinue the drug.

Lifespan and Diversity Considerations:

- Tachycardia, cardiomegaly, papilledema, conjunctival redness, and bone changes may occur more frequently in children taking oprelvekin than in adults. Carefully monitor heart rate and heart sounds, changes in visual acuity or eye pain, and for complaints of bone pain or changes in gait. Further cardiac testing (e.g., echocardiography) and frequent eye exams may be warranted.

Patient and Family Education:

- Do not take any other prescription or nonprescription drugs, dietary supplements, or herbal products without the approval of the healthcare provider.

Learning Through Visuals

Updated and Expanded! Pharmacotherapy Illustrated features visually present the mechanism of action for many of the prototype drugs, showing students specifically how drugs counteract the effects of disease.
Understanding the Chapter

The most comprehensive chapter review in its class! Understanding the Chapter begins with a Key Concepts Summary, which quickly identifies the numbered key concepts from the chapter.

Making the Patient Connection reconnects the student to the patient presented in the scenario at the chapter opening. The student learns additional details about the patient’s health history and participates in critical thinking questions about the scenario. This allows application of knowledge obtained in the chapter.

CASE STUDY: Making the Patient Connection

Remember the patient “Jonathon Hogan” at the beginning of the chapter? Now read the remainder of the case study. Based on the information presented within this chapter, respond to the critical thinking questions that follow.

Jonathon Hogan has had trouble at school beginning in kindergarten and for the past year. His teachers have consistently reported that he is easily distracted and wanders around the classroom even during a lesson. Getting him to do his homework after school has been a struggle. Jonathon loves art and does well with video games. Because he is a happy-go-lucky child, his parents have assumed that Jonathon’s right-brain dominance has caused trouble with left-brain logical work. With more homework now in second grade, Jonathon is struggling to keep up in school. The school nurse suspects he may have ADHD. She has recommended an appointment with Jonathon’s healthcare provider and told his parents that Adderall may help Jonathon focus on his schoolwork.

Critical Thinking Questions

1. What is ADHD and why would Jonathon be experiencing more difficulty as he becomes older?
2. How might amphetamine sulfate and dextroamphetamine (Adderall) help Jonathon with his ADHD?
3. What caregiver education would be appropriate regarding dextroamphetamine and amphetamine sulfate (Adderall)?
4. What are other nonpharmacologic treatments for ADHD?

Answers to Critical Thinking Questions are available on the faculty resources site. Please consult with your instructor.

Additional Case Study

Anna Steinmetz has graduated from nursing school and is working nights. She is having difficulty adjusting to her night schedule. Her healthcare provider suggested she utilize a medication to assist with her adjustment to shift work. She has been prescribed modafinil (Provigil).

1. What effect does modafinil (Provigil) have on the patient’s ability to maintain alertness during shift work?
2. What teaching will you provide to the patient regarding this medication?
3. The patient reports feelings of lightheadedness with position changes. What interventions will assist in maintaining patient safety?

Answers to Additional Case Study questions are available on the faculty resources site. Please consult with your instructor.

An Additional Case Study gives students another opportunity to apply their knowledge to their patient care.

Chapter Review

1. An elementary school nurse is providing education to the faculty on the use of central nervous system stimulants to treat attention-deficit/hyperactivity disorder. Of the following, which is most important for the nurse to convey to the faculty?
2. Have the child bring the drug dose in a lunch bag and come to the office to take it to avoid being teased.
3. Request that the parents leave an extra copy of the prescription at the school in case the dose runs out.

The world would be better off without me.” Which action would the nurse take for this patient?

1. Tell the patient to stop taking atomoxetine immediately and not to take it until checking with the provider.
2. Insure the patient that these are normal symptoms because the drug may take 3 or 4 weeks to work.
3. Alert the family or caregiver that immediate attention and treatment are needed for these symptoms.
References


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effective Connections features cover current topics that nurses will face in practice.

New Connections: Preparing for Advanced Practice features help students develop critical thinking and clinical decision-making skills.

New Connections: Using Research in Practice features illustrate connections to nursing or pharmacology research.

More than 30 new drugs have been added to update medications approved by the FDA since the previous edition.

Revised art program: More than 10 figures have been added or revised in this edition to enhance the clarity of difficult pharmacologic concepts.

New to the Fourth Edition

Detailed References and a Selected Bibliography provide the foundation for evidence-based nursing practice and support the currency and accuracy of the textbook content.
MyLab Nursing

MyLab Nursing is an online learning and practice environment that works with the text to help students master key concepts, prepare for the NCLEX-RN exam, and develop clinical reasoning skills. Through a new mobile experience, students can study Pharmacology: Connections to Nursing Practice anytime, anywhere. New adaptive technology with remediation personalizes learning, moving students beyond memorization to true understanding and application of the content. MyLab Nursing contains the following features:

**Dynamic Study Modules**
New adaptive learning modules with remediation that personalize the learning experience by allowing students to increase both their confidence and their performance while being assessed in real time.

**NCLEX-Style Questions**
Practice tests with more than 1000 NCLEX-style questions of various types build student confidence and prepare them for success on the NCLEX-RN exam. Questions are organized by Chapter.
Decision Making Cases
Clinical case studies that provide opportunities for students to practice analyzing information and making important decisions at key moments in patient care scenarios. These 10 unfolding case studies are designed to help prepare students for clinical practice.

Pearson eText
Enhances student learning both in and outside the classroom. Students can take notes, highlight, and bookmark important content, or engage with interactive and rich media to achieve greater conceptual understanding of the text content. Interactive features include audio clips, pop-up definitions, figures, questions and answers, the nursing process, hotspots, and video animations.
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