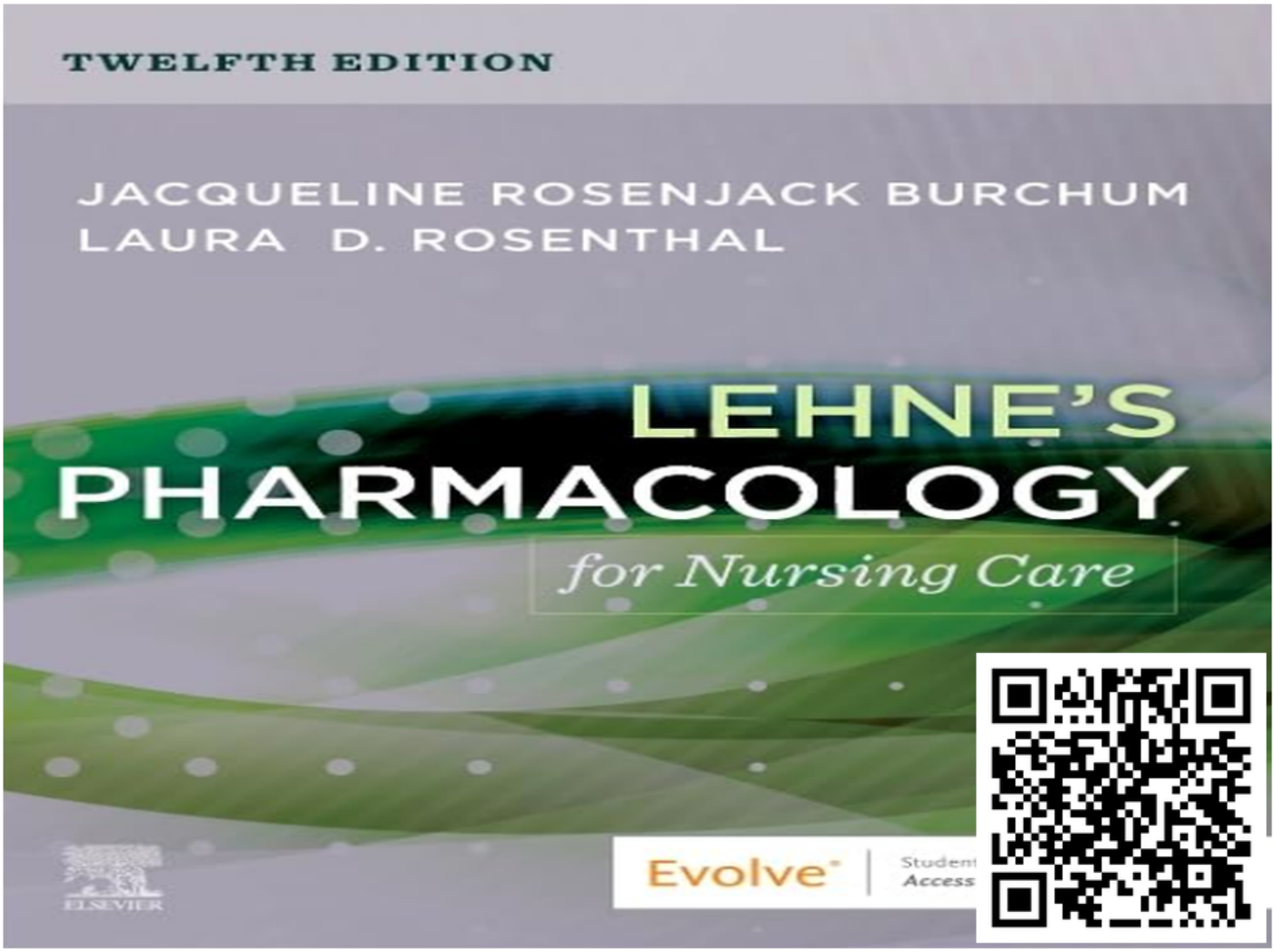

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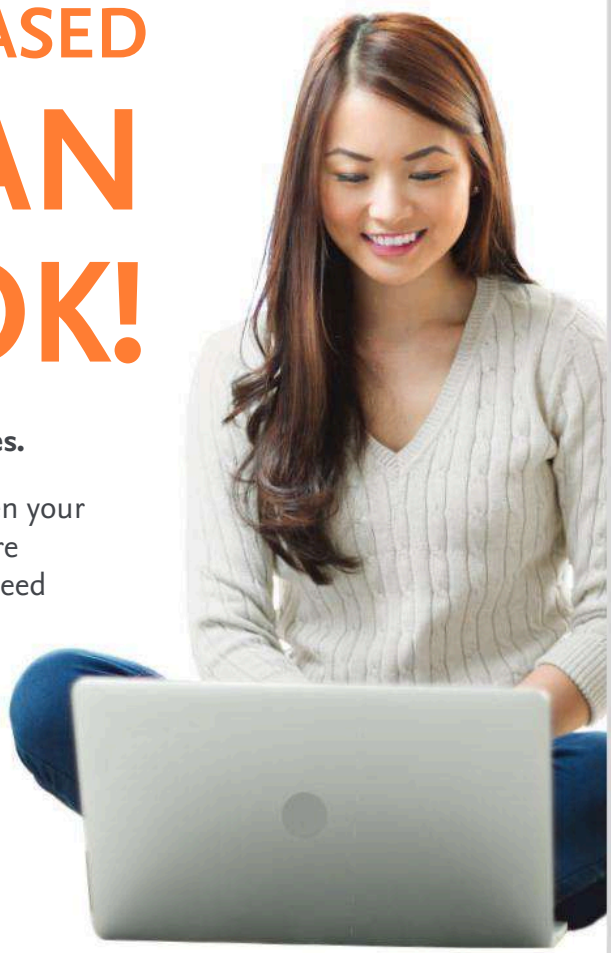

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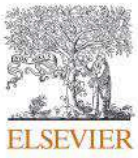

Elsevier
3251 Riverport Lane
St. Louis, Missouri 63043

LEHNE'S PHARMACOLOGY FOR NURSING CARE, TWELFTH EDITION ISBN: 978-0-443-10710-8

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Executive Content Strategist: Lee Henderson
Senior Content Development Manager: Lisa P. Newton
Publishing Services Manager: Julie Eddy
Senior Project Manager: Rachel E. McMullen
Design Direction: Brian Salisbury

Printed in Canada

Last digit is the print number: 9 8 7 6 5 4 3 2 1

To Pat and Al Rosenthal—You continue to be an inspiring couple.

LDR

To my son, Jade, my daughter-in-law, Violetta, and my husband, Tony, always. I believe I must be the most fortunate person in the world just to have you in my life.

JRB

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Preface

Pharmacology pervades all phases of nursing practice and relates directly to patient care and education. Yet despite its importance, many students—and even some teachers—are often uncomfortable with the subject because traditional texts have stressed *memorizing* rather than *understanding*. In this text, the guiding principle is to establish a basic understanding of drugs, after which secondary details can be learned as needed.

This text has two major objectives: (1) to help you, the nursing student, establish a knowledge base in the basic science of drugs; and (2) to show you how that knowledge can be applied in clinical practice. The methods by which these goals are achieved are described in the following sections.

LAYING FOUNDATIONS IN BASIC PRINCIPLES

To understand drugs, you need a solid foundation in basic pharmacologic principles. To help you establish that foundation, this text has major chapters on the following topics: basic principles that apply to all drugs (Chapters 4 through 9), basic principles of drug therapy across the lifespan (Chapters 11 through 13), basic principles of neuropharmacology (Chapter 14), basic principles of antimicrobial therapy (Chapter 88), and basic principles of cancer chemotherapy (Chapter 106).

REVIEWING PHYSIOLOGY AND PATHOPHYSIOLOGY

To understand the actions of a drug, it is useful to understand the biologic systems influenced by the drug. Accordingly, for all major drug families, relevant physiology and pathophysiology are reviewed. In almost all cases, these reviews are presented at the beginning of each chapter rather than in a systems review at the beginning of a unit. This juxtaposition of pharmacology, physiology, and pathophysiology is designed to help you understand how these topics interrelate.

TEACHING THROUGH PROTOTYPES

Within each drug family, we can usually identify a prototype—a drug that embodies the characteristics shared by all members of the group. Because other family members are similar to the prototype, to know the prototype is to know the basic properties of all family members.

The benefits of teaching through prototypes can be appreciated with an example. Let's consider the nonsteroidal anti-inflammatory drugs (NSAIDs), a family that includes aspirin, ibuprofen (Motrin), naproxen (Aleve), celecoxib (Celebrex), and more than 20 other drugs. Traditionally, information on these drugs is presented in a series of paragraphs describing each drug in turn. When attempting to study from such a list, you are likely to learn many drug names and little else; the important concept of similarity among family members is easily lost. In this text, the family prototype—aspirin—is discussed first and in depth. After this, the small ways in which individual NSAIDs differ from aspirin are pointed out. Not only is this approach more efficient than the traditional approach, but it is also more effective in that similarities among family members are emphasized.

USING CLINICAL REALITY TO PRIORITIZE CONTENT

This book contains two broad categories of information: pharmacology (the basic science about drugs) and therapeutics (the clinical use of drugs). To ensure that content is clinically relevant, we use evidence-based treatment guidelines as a basis for deciding what to stress and what to play down. Unfortunately, clinical practice is a moving target. Guidelines change when effective new drugs are introduced and when clinical trials reveal new benefits or new risks of older drugs, so we need to work hard to keep this book current. Despite our best efforts, the book and clinical reality may not always agree: Some treatments discussed here will be considered inappropriate before the 12th edition is published. Furthermore, in areas where controversy exists, the treatments discussed here may be considered inappropriate by some clinicians right now.

NURSING IMPLICATIONS: DEMONSTRATING THE APPLICATION OF PHARMACOLOGY IN NURSING PRACTICE

The principal reason for asking you to learn pharmacology is to enhance your ability to provide patient care and education. To show you how pharmacologic knowledge can be applied to nursing practice, nursing implications are integrated into the body of each chapter. That is, as specific drugs and drug families are discussed, the nursing implications inherent in the pharmacologic information are noted side by side with the basic science.

To facilitate access to nursing content, nursing implications are also summarized at the end of most chapters. These summaries serve to reinforce the information presented in the chapter body. These summaries have been omitted in chapters that are especially brief or that address drugs that are infrequently used. Even in these chapters, however, nursing implications are incorporated into the main chapter text.

In addition, "Safety Alert" features throughout draw attention to important safety concerns related to contraindications, adverse effects, pregnancy categories, and more.

WHAT'S NEW IN THE BOOK?

Lehne's Pharmacology for Nursing Care has been revised cover to cover to ensure that the latest and most accurate information is presented. One new chapter helps to focus on an identified gap in knowledge for health care providers—transgender care. Approximately 2.6 million people in the United States identify as transgender. Historical lack of access to competent and compassionate care providers remains a barrier to transgender people receiving quality, evidence-based care. As nursing focuses on care of all individuals, it is important to include this information.

In addition, **thoroughly updated drug content** reflects the latest US Food and Drug Administration drug approvals, withdrawals, and therapeutic uses with revisions to the corresponding nursing content.

Learning Supplements for Students

- Online Evolve Resources accompany this edition and include **Downloadable Key Points, Next-Generation NCLEX® (NGN) Examination–Style Case Studies, Review Questions, Unfolding Case Studies**, and more. These resources are available at http://evolve.elsevier.com/Lehne.
- The **Study Guide**, which is keyed to the book, includes–study questions; critical thinking, prioritization, and delegation questions; case studies, and new NGN-style questions.

Teaching Supplements for Instructors

- The Instructor Resources for the 12th edition are available online and include Next-Generation NCLEX® Examination–Style Questions, TEACH® for Nurses Lesson Plans, a Test Bank, a PowerPoint Collection, and an Image Collection.

WAYS TO USE THIS TEXTBOOK

Thanks to its focus on essentials, this text is especially well suited to serve as the primary text for a course dedicated specifically to pharmacology. In addition, the focused approach makes it a valuable resource for pharmacologic instruction within an integrated curriculum and for self-directed learning by students, teachers, and practitioners.

How is this focus achieved? Four primary techniques are used: (1) teaching through prototypes, (2) using standard print for essential information and small print for secondary information, (3) limiting discussion of adverse effects and drug interactions to information that matters most, and (4) using evidence-based clinical guidelines to determine what content to stress. To reinforce the relationship between pharmacologic knowledge and nursing practice, nursing implications are integrated into each chapter. To provide rapid access to nursing content, nursing implications are summarized at the end of most chapters using a nursing process format, along with cognitive skills from the NCSBN Clinical Judgment Measurement Model. In addition, key points are listed at the end of each chapter. As in previous editions, the 12th edition emphasizes conceptual material—reducing rote memorization, promoting comprehension, and increasing reader friendliness.

Pharmacology can be an unpopular subject because of the vast and rapidly changing area of content. Often, nursing students believe that pharmacology is one of the most difficult classes to master. We hope that this book makes the subject of pharmacology easier and more enjoyable for you to understand by allowing you to focus on the most important umbrella concepts of pharmacology as they relate to nursing care and the safety of patients.

ACKNOWLEDGMENTS

We would like to acknowledge the support of our colleagues at Elsevier, including Executive Content Strategist Lee Henderson, Senior Content Development Manager Lisa P. Newton, and Senior Project Manager Rachel E. McMullen

Finally, we would like to express our gratitude to Richard A. Lehne for his dedication to this book for eight editions. We are honored to be able to continue his work.

Jacqueline Rosenjack Burchum
Laura D. Rosenthal

Contents

UNIT I

INTRODUCTION

CHAPTER 1

Orientation to Pharmacology

By now, you've been hitting the science books for many years and have probably asked yourself, "What's the purpose of all these prerequisite science courses?" In the past, your question may have lacked a satisfying answer. Happily, now you have one: Those courses have provided an excellent background for your studies in pharmacology!

Pharmacology is a science that draws on information from multiple disciplines, such as anatomy, physiology, chemistry, microbiology, and psychology. Consequently, before you could study pharmacology, you had to become familiar with these other sciences. Now that you've established the requisite knowledge base, you're finally ready to learn about drugs.

FOUR BASIC TERMS

Before you begin, it is important to define four basic terms: *drug, pharmacology, clinical pharmacology*, and *therapeutics*. As we consider these terms, I will indicate the kinds of information that we will and will not discuss in this text.

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Drug

A drug is defined as *any chemical that can affect living processes*. By this definition, virtually all chemicals can be considered drugs because, when exposure is sufficiently high, all chemicals will have some effect on life. Clearly, it is beyond the scope of this text to address all compounds that fit the definition of a drug. Accordingly, rather than discussing all drugs, we will focus primarily on drugs as medications that have therapeutic applications.

Pharmacology

Pharmacology can be defined as *the study of drugs and their interactions with living systems*. Under this definition, pharmacology encompasses the study of the physical and chemical properties of drugs, as well as their biochemical and physiologic effects. In addition, pharmacology includes knowledge of the history, sources, and uses of drugs and knowledge of drug absorption, distribution, metabolism, and excretion. Because pharmacology encompasses such a broad spectrum of information, it would be impossible to address the entire scope of pharmacology in this text. Consequently, we limit consideration to information that is *clinically relevant* (i.e., related to therapy).

Clinical Pharmacology

Clinical pharmacology is defined as the study of drugs in humans. This discipline includes the study of drugs in patients and in healthy volunteers (during new drug development). Because clinical pharmacology encompasses all aspects of the interaction between drugs and people and because our primary interest is the use of drugs to treat patients, clinical pharmacology includes some information that is outside the scope of this text. For our purposes, we will focus our study on how medications affect the patients who will be in our care.

Therapeutics

Therapeutics, also known as pharmacotherapeutics, is defined as the use of drugs to diagnose, prevent, or treat disease or to prevent pregnancy. Alternatively, therapeutics can be defined simply as the medical use of drugs.

In this text, therapeutics is our principal concern. Accordingly, much of our discussion focuses on the basic science that underlies the clinical use of drugs. This information is intended to help you understand how drugs produce their therapeutic and adverse (undesirable) effects; the reasons for giving a particular drug to a particular patient; and the rationale underlying the selection of dosage, route, and schedule of administration. This information will also help you understand the strategies used to promote beneficial drug effects and to minimize undesired effects. Armed with this knowledge, you will be well prepared to provide drug-related patient care and education. In addition, by making drugs less mysterious, this knowledge should make working with drugs more comfortable and perhaps even more satisfying.

PROPERTIES OF AN IDEAL DRUG

If we were developing a new drug, we would want it to be the best drug possible. To approach perfection, our drug should have certain properties, such as effectiveness and safety. In the discussion that follows, we consider these two characteristics as well as others that an ideal drug might have. However, please note that the ideal medication exists in theory only: In reality, *there is no such thing as a perfect drug*. The truth of this statement will become apparent as we consider the properties that an ideal drug should have.

The Big Three: Effectiveness, Safety, and Selectivity

The three most important characteristics that any drug can have are effectiveness, safety, and selectivity.

Effectiveness

An ideal drug is effective. An effective drug is one that elicits the responses for which it is given. *Effectiveness is the most important property a drug can have*. Regardless of its other virtues, if a drug is not effective—that is, if it doesn't do what it is intended to do—there is no justification for giving it. Current U.S. law requires that all new drugs be proved effective before being released for marketing.

Safety

An ideal drug is safe. A safe drug is defined as one that cannot produce harmful effects—even if administered in very high doses and for a very long time. All drugs have the ability to cause injury, especially with high doses and prolonged use. The chances of producing harmful effects can be reduced by proper drug selection and proper dosing. Nevertheless, the risk of harmful effects can never be eliminated. The following examples illustrate this point:

- Certain anticancer drugs (e.g., cyclophosphamide, methotrexate), at usual therapeutic doses, always increase the risk for serious infection.
- Opioid analgesics (e.g., morphine, meperidine), at high therapeutic doses, can cause potentially fatal respiratory depression.
- Aspirin and related drugs, when taken long term in high therapeutic doses, can cause life-threatening gastric ulceration, perforation, and bleeding.

Clearly, drugs have both benefits and risks. This fact may explain why the Greeks used the word *pharmakon*, which can be translated as both *remedy* and *poison*.

Selectivity

An ideal drug is selective. A selective drug is defined as one that elicits *only* the response for which it is given. *There is no such thing as a wholly selective drug because all drugs cause side effects*. Common examples include the drowsiness that can be caused by many antihistamines; the peripheral edema that can be caused by calcium channel blockers; and the sexual dysfunction commonly caused by certain antidepressants.

Additional Properties of an Ideal Drug

Reversible Action

An ideal drug has effects that are reversible. In most cases, we want drug actions to subside within an appropriate time. For example, general anesthetics would be useless if patients never woke up. Likewise, it is unlikely that oral contraceptives would find wide acceptance if they caused permanent sterility. However, for a few drugs, reversibility is not desirable. For example, with antibiotics, we want the toxicity to microbes to endure.

Predictability

An ideal drug has predictable effects. It would be very helpful if, before drug administration, we could know with certainty just how a given patient will respond. Unfortunately, because each patient is unique, the accuracy of predictions cannot be guaranteed. Some patients respond better to certain drugs than other patients. Some patients have severe adverse effects, whereas others do not experience problems. Accordingly, to maximize the chances of eliciting the desired responses, we must tailor therapy to the individual.

Ease of Administration

An ideal drug is easy to administer. For example, taking a tablet by mouth is much simpler than drawing medicine up in a syringe and injecting it. Ideal drug administration should also be convenient. For example, it is more convenient to give a drug once a day than several times daily.

Ease of administration has two benefits: (1) It can decrease risk of harm, and (2) it can enhance patient adherence to the medication regimen. Whenever skin integrity is broken, as is the case when drugs are given by injection, there is a risk of

infection and injection-site pain or discomfort. Furthermore, when a medication is taken once daily, patients are less likely to forget a dose or get off-schedule.

Lack of Drug Interactions

An ideal drug does not interact with other agents. When a patient is taking two or more drugs, those drugs may interact in ways that either augment or reduce drug responses. For example, respiratory depression caused by diazepam (Valium), which is normally minimal, can be greatly *intensified* by alcohol. Conversely, the antibacterial effects of tetracycline can be greatly *reduced* by taking the drug with iron or calcium supplements. Because of the potential for interaction among drugs, when a patient is taking more than one drug, the possible impact of drug interactions must be considered. Unfortunately, few medicines are devoid of significant interactions.

Low Cost

An ideal drug is affordable. The cost of drugs can be a substantial financial burden. As an example, treatment with adalimumab (Humira), a drug for rheumatoid arthritis and Crohn disease, cost more than $110,000 per year in 2022. More commonly, expense becomes a significant factor when a medication must be taken long term. For example, people with hypertension, arthritis, or diabetes may take medications every day for life. The cumulative expense of such treatment can be exorbitant—even for drugs of moderate price.

Chemical Stability

An ideal drug is chemically stable. Some drugs lose effectiveness during storage. Others that may be stable on the shelf can rapidly lose effectiveness when put into solution (e.g., in preparation for infusion). These losses in effectiveness result from chemical instability. Because of chemical instability, drugs eventually expire and must be discarded.

No Drug Is Ideal

From the preceding criteria for ideal drugs, we can see that available medications are not ideal. All drugs have the potential to produce side effects. Drug responses may be difficult to predict and may be altered by drug interactions. Drugs may be expensive, unstable, and hard to administer. Because medications are not ideal, all members of the health care team must exercise care to promote therapeutic effects and minimize drug-induced harm.

THE THERAPEUTIC OBJECTIVE

The therapeutic objective of drug therapy is to provide maximum benefit with minimal harm. If drugs were ideal, we could achieve this objective with relative ease; however, because drugs are not ideal, we must exercise skill and care if treatment is to result in more good than harm. As detailed in Chapter 2, you have a critical responsibility in achieving the therapeutic objective. To meet this responsibility, you must understand drugs. The primary purpose of this text is to help you achieve that understanding.

FACTORS THAT DETERMINE THE INTENSITY OF DRUG RESPONSES

Our ultimate concern when administering a drug is the intensity of the response. Multiple factors determine how an individual will respond to a prescribed dose of a particular drug (Fig. 1.1). By understanding these factors, you will be able to think rationally about how drugs produce their effects. As a result, you will be able to promote achievement of the therapeutic objective.

Working our way up from the bottom of Fig. 1.1, we can see that the intensity of the response is determined by the concentration of a drug at its sites of action. The drug dosage, route, and timing of administration are important determinants of drug responses. Accordingly, the prescriber will consider these variables with care. The steps leading from the prescribed dose to the intensity of the response are considered in the sections that follow.

Administration

When administration is performed correctly, the dose that was given will be the same as the dose that was prescribed. If drugs

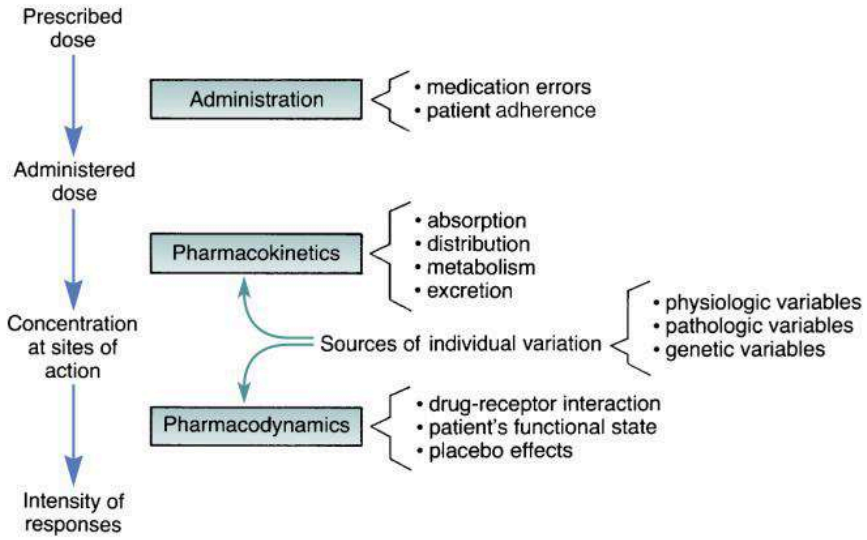

Fig. 1.1 ■ Factors that determine the intensity of drug responses.

are not taken or administered as prescribed, the result may be toxicity if the dosage is too high or treatment failure if the dosage is too low.

Sometimes patients do not take medications as prescribed. This is called *poor adherence*. To help minimize errors caused by poor adherence, you should give patients complete instructions about their medication and how to take it.

Medication errors made by hospital or clinic staff may result in a drug being administered by the wrong route, in the wrong dose, at the wrong time, or even to the wrong patient. Medication errors are discussed at length in Chapter 7.

Pharmacokinetics

Pharmacokinetic processes determine how much of an administered dose gets to its sites of action. There are four major pharmacokinetic processes: (1) drug absorption, (2) drug distribution, (3) drug metabolism, and (4) drug excretion. Collectively, these processes can be thought of as the *impact of the body on drugs*. These pharmacokinetic processes are discussed at length in Chapter 4.

Pharmacodynamics

Once a drug has reached its sites of action, pharmacodynamic processes determine the nature and intensity of the response. Pharmacodynamics can be thought of as the *impact of drugs on the body*. In most cases, the initial step leading to a response is the binding of a drug to its receptor. This drug-receptor interaction is followed by a sequence of events that ultimately results in a response. As indicated in Fig. 1.1, the patient's functional state can influence pharmacodynamic processes. For example, a patient who has developed tolerance to morphine will respond less intensely to a particular dose than will a patient who lacks tolerance. Placebo effects also help determine the responses that a drug elicits. Pharmacodynamics is discussed at length in Chapter 5.

Sources of Individual Variation

Characteristics unique to each patient can influence pharmacokinetic and pharmacodynamic processes and, by doing so, can help determine the patient's response to a drug. As indicated in Fig. 1.1, sources of individual variation include physiologic variables (e.g., age, gender, weight); pathologic variables (especially diminished function of the kidneys and liver, the major organs of drug elimination); and genetic variables. Genetic factors comprise a third variable that can affect the intensity of drug responses. Not only can they alter the metabolism of drugs, but they can also predispose the patient to unique drug reactions.

Because individuals differ from one another, no two patients will respond identically to the same drug. Accordingly, to achieve the therapeutic objective, we must tailor drug therapy to the individual. Individual variation in drug responses is the subject of Chapter 8.

KEY POINTS

- The most important properties of an ideal drug are effectiveness, safety, and selectivity.
- Other properties of an ideal drug are reversible action, predictability, ease of administration, lack of drug interactions, low cost, and chemical stability.
- No drug is an ideal drug.
- Drugs have both benefits and risks.
- The therapeutic objective of drug therapy is to provide maximum benefit with minimum harm.
- The intensity of drug response is determined by proper administration, pharmacokinetics, pharmacodynamics, and individual variation.
- Because all patients are unique, drug therapy must be tailored to each individual.

CHAPTER

2

Application of Pharmacology in Nursing Practice

Our principal goal in this chapter is to answer the question "Why should a nursing student learn pharmacology?" By addressing this question, I want to give you some extra motivation to study. Why do I think you might need some motivation? Because pharmacology can be challenging, and other topics in nursing are often more alluring. Hopefully, when you complete the chapter, you will be convinced that understanding drugs is essential for nursing practice and that putting time and effort into learning about drugs will be a good investment.

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NURSING RESPONSIBILITIES REGARDING DRUGS

Nurses administer drugs to patients in a variety of settings. In the past, a nurse's responsibility regarding medications focused on the Five Rights of Drug Administration (the Rights)—namely, give the right drug to the right patient in the right dose by the right route at the right time. More recently, various other rights—right assessment, right documentation, right evaluation, the patient's rights to education, and the patient's right of refusal—have been recommended for inclusion. Clearly, the original five Rights and their subsequent additions are important. Nevertheless, although these basics are vital, much more is required to achieve the therapeutic objective. The Rights guarantee only that a drug will be administered as prescribed, but correct administration, without additional interventions, cannot ensure that treatment will result in maximum benefit and minimum harm.

Limitations of the Five Rights

The limitations of the Rights can be illustrated with this analogy: The nurse who sees nursing's responsibility as being complete after correct drug administration would be like a major league baseball pitcher who believes that his responsibility is over once he throws the ball toward the batter. As the pitcher must be ready to respond to the consequences of the interaction between ball and bat, you must be ready to respond to the consequences of the interaction between drug and patient. Put another way, although both the nurse and the pitcher have a clear obligation to deliver their objects in the most appropri-

ate fashion, proper delivery is only the beginning of their responsibilities: *Important events will take place after the object is delivered, and these must be responded to.* Like the pitcher, the nurse can respond rapidly and effectively only by anticipating what the possible reactions to the drug might be.

To anticipate possible reactions, both the nurse and the pitcher require certain kinds of knowledge. Just as the pitcher must understand the abilities of the opposing batter, you must understand the patient and the disorder for which the patient is being treated. As the pitcher must know the most appropriate pitch (e.g., fastball, slider) to deliver in specific circumstances, you must know what medications are appropriate for the patient and must check to ensure that the ordered medication is an appropriate one. Conversely, as the pitcher must know what pitches *not* to throw at a particular batter, you must know what drugs *not* to administer to the patient. As the pitcher must know the most likely outcome after the ball and bat interact, you must know the probable consequences of the interaction between drug and patient.

Although this analogy is not perfect (the nurse and patient are on the same team, whereas the pitcher and batter are not), it does help us appreciate that the nurse's responsibility extends well beyond the Rights. Consequently, in addition to the limited information needed to administer drugs in accordance with the Rights, you must acquire a broad base of pharmacologic knowledge to contribute fully to achieving the therapeutic objective.

The Nurse as Patient Advocate

Nurses, together with health care providers and pharmacists, participate in a system of checks and balances designed to promote beneficial effects and minimize harm. Nurses are especially important in this system because it is the nurse who follows the patient's status the most closely. As a result, you are likely to be the first member of the healthcare team to observe and evaluate drug responses and to intervene if required. To observe and evaluate drug responses, and to intervene rapidly and appropriately, you must know *in advance* the responses that a medication is likely to elicit. The better your knowledge of pharmacology, the better you will be able to *anticipate* drug responses and not simply react to them after the fact.

Within our system of checks and balances, the nurse has an important role as a patient advocate. It is your responsibility to detect mistakes made by pharmacists and prescribers. For example, the prescriber may overlook potential drug interactions, be unaware of alterations in the patient's status that would prohibit use of a particular drug, or select the correct drug but order an inappropriate dosage or route of administration. Because the nurse actually administers the drugs, the nurse is the last person to check medications before they are given. Consequently, *you are the patient's last line of defense against medication errors.* It is ethically and legally unacceptable for you to administer a drug that is harmful to the patient—even though the medication has been prescribed by a licensed prescriber and dispensed by a licensed pharmacist.

The two major areas in which you can apply pharmacologic knowledge are patient care and patient education. The application of pharmacology in patient care and patient education is considered in the following two sections.

APPLICATION OF PHARMACOLOGY IN PATIENT CARE

In discussing the applications of pharmacology in patient care, we focus on eight aspects of drug therapy: (1) preadministration assessment, (2) dosage and administration, (3) promoting therapeutic effects, (4) minimizing adverse effects, (5) minimizing adverse interactions, (6) making "as needed" (PRN) decisions, (7) evaluating responses to medication, and (8) managing toxicity.

Preadministration Assessment

All drug therapy begins with an assessment of the patient. Assessment has three basic goals: (1) to collect baseline data needed to evaluate therapeutic and adverse (i.e., undesired) responses, (2) to identify high-risk patients, and (3) to assess the patient's capacity for self-care. The first two goals are highly specific for each drug. Accordingly, we cannot achieve these goals without understanding pharmacology. The third goal applies generally to all drugs, and thus it does not usually require specific knowledge of the drug you are about to give.

Collecting Baseline Data

Baseline data are needed to evaluate both therapeutic and adverse drug responses. Without these data, we would have no way of determining the effectiveness of our drug. For example, if we plan to give a drug to lower blood pressure, we must know the patient's blood pressure before treatment. Similarly, if we are planning to give a drug that can damage the liver, we need to assess baseline liver function to evaluate this potential toxicity. Obviously, to collect appropriate baseline data, we must first know the effects that a drug is likely to produce.

Identifying High-Risk Patients

Multiple factors can predispose an individual to adverse reactions from specific drugs. Important predisposing factors are pathophysiology (especially liver and kidney impairment), genetic factors, drug allergies, and life span considerations, such as pregnancy or very young or advanced age.

Patients with a penicillin allergy provide a dramatic example of those at risk because giving penicillin to such a patient can be fatal. Accordingly, whenever treatment with penicillin is under consideration, we must determine whether the patient has had an allergic reaction to a penicillin in the past and note the type of reaction. If there is a history of true penicillin allergy, an alternative antibiotic should be prescribed.

From the preceding example, we can see that, when planning drug therapy, we must identify patients who are at high risk for reacting adversely. To identify such patients, we use three principal tools: the patient history, physical examination, and laboratory data. Of course, if identification is to be successful, you must know what to look for (i.e., you must know the factors that can increase the risk of severe reactions to the drug in question). Once the high-risk patient has been identified, we can take steps to reduce the risk.

Dosage and Administration

Earlier, we noted the Rights of Drug Administration and agreed on their importance. Although you can implement

the Rights without a detailed knowledge of pharmacology, having this knowledge can help reduce your contribution to medication errors. The following examples illustrate this point:

- Certain drugs have more than one indication, and dosage may differ depending on which indication the drug is used for. For example, aspirin is given in low doses to relieve pain and in high doses to suppress inflammation. If you do not know about these differences, you might administer too much aspirin to the patient with pain or too little to the patient with inflammation.
- Many drugs can be administered by more than one route, and dosage may differ depending on the route selected. For example, morphine may be administered by mouth or injection. Oral doses are generally much larger than injected doses. Accordingly, if a large dose intended for oral use were to be mistakenly administered by injection, the resulting overdose could prove fatal. The nurse who understands the pharmacology of morphine is unlikely to make this error.
- Certain intravenous (IV) agents can cause severe local injury if the drug extravasates (seeps into the tissues surrounding the IV line). The infusion must be monitored closely, and if extravasation occurs, corrective steps must be taken immediately. The nurse who does not understand the dangers of these drugs will be unprepared to work with them safely.

The following guidelines can help ensure correct administration:

- Read the medication order carefully. If the order is unclear, verify it with the prescriber.
- Verify the identity of the patient by comparing the name on the wristband with the name on the drug order or medication administration record or by scanning the wristband electronically.
- Read the medication label carefully. Verify the identity of the drug, the amount of drug (per tablet, volume of liquid, etc.), and its suitability for administration by the intended route.
- Verify dosage calculations.
- Implement any special handling the drug may require.
- Do not administer any drug if you do not understand the reason for its use.

Measures to minimize medication errors are discussed further in Chapter 7.

Promoting Therapeutic Effects

Drug therapy can often be enhanced by nonpharmacologic measures. Examples include (1) enhancing drug therapy of asthma through breathing exercises, biofeedback, and emotional support; (2) enhancing drug therapy of arthritis through exercise, physical therapy, and rest; and (3) enhancing drug therapy of hypertension through weight reduction, smoking cessation, and sodium restriction.

Short-term interventions are also helpful. For instance, mild to moderate pain may be experienced more intensely by the patient who lies slumped down in an uncomfortable bed compared with the patient who is carefully positioned for maximum comfort. Similarly, the pediatric patient with mild to moderate pain who is in a nonstimulating environment may experience the pain more acutely than the patient for whom toys, games, or videos provide distraction.

As a nurse, you will have many opportunities to seek out creative solutions to promote therapeutic effects. You may provide these supportive measures directly or by coordinating the activities of other health care providers. Be sure to include these interventions in your patient education to empower patients and their families in optimal self-care.

Minimizing Adverse Effects

All drugs have the potential to produce undesired effects. Common examples include gastric erosion caused by aspirin, sedation caused by older antihistamines, hypoglycemia caused by insulin, and excessive fluid loss caused by diuretics. When drugs are used properly, the incidence and severity of such events can be reduced. Measures to reduce adverse events include identifying high-risk patients, ensuring proper administration, and teaching patients to avoid activities that might precipitate an adverse event.

When untoward effects cannot be avoided, discomfort and injury can often be minimized by appropriate intervention. For example, timely administration of glucose will prevent brain damage from insulin-induced hypoglycemia. To help reduce adverse effects, you must know the following about the drugs you administer:

- The major adverse effects the drug can produce
- When these reactions are likely to occur
- Early signs that an adverse reaction is developing
- Interventions that can minimize discomfort and harm

Minimizing Adverse Interactions

When a patient is taking two or more drugs, those drugs may interact with one another to diminish therapeutic effects or intensify adverse effects. For example, the ability of oral contraceptives to protect against pregnancy can be reduced by concurrent therapy with carbamazepine (an antiseizure drug), and the risk of thromboembolism from oral contraceptives can be increased by smoking cigarettes.

As a nurse, you can help reduce the incidence and intensity of adverse interactions in several ways. These include taking a thorough drug history, advising the patient to avoid over-the-counter (OTC) drugs that can interact with the prescribed medication, monitoring for adverse interactions *known* to occur between the drugs the patient is taking, and being alert to the possibility of *as-yet-unknown* interactions.

Making PRN Decisions

PRN stands for pro re nata, a Latin phrase meaning as needed. A PRN medication order is one in which the nurse has discretion regarding when to give a drug and, in some situations, how much of the drug to give. PRN orders are common for drugs that promote sleep, relieve pain, and reduce anxiety. To implement a PRN order rationally, you must know the reason the drug is prescribed and be able to assess the patient's

medication needs. Clearly, the better your knowledge of pharmacology, the better your PRN decisions are likely to be.

Evaluating Responses to Medication

Evaluation is one of the most important aspects of drug therapy. After all, this is the process that tells us whether a drug is producing a benefit or is causing harm. Because the nurse follows the patient's status most closely, the nurse is in the best position to evaluate therapeutic responses.

To make an evaluation, you must know the rationale for treatment and the nature and time course of the intended response. When desired responses do *not* occur, it may be essential to identify the reason quickly so that timely implementation of alternative therapy may be ordered.

When evaluating responses to a drug that has more than one application, you can do so only if you know the specific indication for which the drug is being used. For example, nifedipine is given for both hypertension and angina pectoris. When the drug is used for hypertension, you should monitor for a reduction in blood pressure. In contrast, when this drug is used for angina, you should monitor for a reduction in chest pain. Clearly, if you are to make the proper evaluation, you must understand the reason for drug use.

Managing Toxicity

Some adverse drug reactions are extremely dangerous. To minimize harm, you must know the early signs of toxicity and the procedure for toxicity management. If toxicity is not identified early and responded to quickly, irreversible injury or death can result.

APPLICATION OF PHARMACOLOGY IN PATIENT EDUCATION

Very often, the nurse is responsible for educating patients about medications. In your role as a patient educator, you must give the patient the following drug information:

- Drug name and therapeutic category (e.g., penicillin is an antibiotic)
- Dosage
- Dosing schedule
- Route and technique of administration
- Expected therapeutic response, and when it should develop
- Nondrug measures to enhance therapeutic responses
- Duration of treatment
- Method of drug storage
- Symptoms of major adverse effects, and measures to minimize discomfort and harm
- Major adverse drug-drug and drug-food interactions
- Whom to contact in the event of therapeutic failure, severe adverse reactions, or severe adverse interactions

To communicate this information effectively and accurately, you must first understand it. That is, to be a good drug educator, you must know pharmacology.

In the following discussion, we consider the relationship between patient education and the following aspects of drug therapy: dosage and administration, promoting therapeutic effects, minimizing adverse effects, and minimizing adverse interactions.

Dosage and Administration

Drug Name

Patients should know the name of the medication they are taking. If the drug has been prescribed by brand name, the patient should be given its generic name too. This information will reduce the risk for overdose that can result when a patient fails to realize that two drugs with different names actually contain the same medicine.

Dosage and Schedule of Administration

Patients must be told how much of a drug to take and when to take it. For some medications, dosage must be adjusted by the patient. Insulin is a good example. For insulin therapy to be most beneficial, the patient may need to adjust doses to accommodate changes in diet and subsequent glucose levels.

With PRN medications, the schedule of administration is not fixed. Rather, these drugs are taken as needed. For example, some people with asthma experience exercise-induced bronchospasm. To minimize such attacks, they can take medication before anticipated exertion. It is your responsibility to teach patients when PRN drugs should be taken.

The patient should also know what to do if a dose is missed. For example, with certain oral contraceptives, if one dose is missed, the omitted dose should be taken together with the next scheduled dose. However, if three or more doses are missed, a new cycle of administration must be initiated.

Patient Adherence

Adherence—also known as compliance or concordance—may be defined as the extent to which a patient's behavior coincides with medical advice. If we are to achieve the therapeutic objective, adherence to the prescribed drug regimen is essential. Drugs that are self-administered in the wrong dose, by the wrong route, or at the wrong time cannot produce maximum benefit and may even prove harmful. Obviously, successful therapy requires active and informed participation by the patient. By educating patients about the drugs they are taking, you can help elicit the required participation.

Some patients have difficulty remembering whether they have taken their medication. Possible causes include mental illness, advanced age, and complex regimens. To facilitate adherence for these patients, one solution is to provide the patient with a pill organizer that has separate compartments for each day of the week, and then to teach the patient or family member to load the compartments weekly. To determine whether a dose of medication has been taken, patients and their families can simply check the day of the week in the pill organizer to see whether the drugs have been removed.

Technique of Administration

Patients must be taught how to administer their drugs. This is especially important for routes that may be unfamiliar (e.g., sublingual for nitroglycerin) and for techniques that can be difficult (e.g., subcutaneous injection of insulin). Patients taking oral medications may require special instructions. For example, some oral preparations must not be chewed or crushed; some should be taken with fluids; and some should be taken with meals, whereas others should be taken on an empty stomach. Careful attention must be paid to the patient who, because

of disability (e.g., visual or intellectual impairment, limited manual dexterity), may find self-medication difficult.

Duration of Drug Use

Just as patients must know when to take their medicine, they must know when to stop. In some cases (e.g., treatment of acute pain), patients should discontinue drug use as soon as symptoms subside. In other cases (e.g., treatment of hypertension), patients should know that therapy will probably continue lifelong. For some conditions (e.g., gastric ulcers), medication may be prescribed for a specific time interval, after which the patient should return for reevaluation.

Drug Storage

Certain medications are chemically unstable and deteriorate rapidly if stored improperly. To ensure that patients take the drug prescribed rather than some altered version, those who are using unstable drugs must be taught how to store them correctly (e.g., under refrigeration, in a lightproof container). All drugs should be stored where children cannot reach them.

Promoting Therapeutic Effects

To participate fully in achieving the therapeutic objective, patients must know the nature and time course of expected beneficial effects. With this knowledge, patients can help evaluate the success or failure of treatment. By recognizing treatment failure, the informed patient will know to return to the health care provider for changes in therapy.

With some drugs, such as those used to treat depression and schizophrenia, beneficial effects may take several weeks to become maximally effective. Awareness that treatment may not produce immediate results allows the patient to have realistic expectations and helps reduce anxiety about therapeutic failure.

As noted, nondrug measures can complement drug therapy. For example, although drugs are useful in managing high cholesterol, exercise and diet are also important. Teaching the patient about nondrug measures can greatly increase the chances of success.

Minimizing Adverse Effects

Knowledge of adverse drug effects will enable the patient to avoid some adverse effects and minimize others through early detection. The following examples underscore the value of educating patients about the undesired effects of drugs:

- Insulin overdose can cause blood glucose levels to drop precipitously. Early signs of hypoglycemia include shakiness, perspiration, and anxiety. The patient who has been taught to recognize these early signs can respond by ingesting glucose or other fast-acting carbohydrate-rich foods, thereby restoring blood sugar to a safe level. In contrast, the patient who fails to recognize evolving hypoglycemia and does not ingest glucose or similar substances may become comatose and may even die.
- Many anticancer drugs predispose patients to acquiring serious infections. The patient who is aware of this possibility can take steps to avoid contagion by avoiding contact with people who have an infection and by avoiding foods likely to contain pathogens. In addition, the informed patient is in a position to notify the health care prescriber at the first sign that an infection is developing, thereby allowing early treatment. In contrast, the patient who has not received adequate education is at increased risk for illness or death from an untreated infectious disease.
- Some side effects, although benign, can be disturbing if they occur without warning. For example, rifampin (a drug for tuberculosis) imparts a harmless red-orange color to urine, sweat, saliva, and tears. Your patient will appreciate knowing about this in advance.

Minimizing Adverse Interactions

Patient education can help avoid hazardous drug-drug and drug-food interactions. For example, phenelzine (an antidepressant) can cause dangerous elevations in blood pressure if taken in combination with certain drugs (e.g., amphetamines) or certain foods (e.g., sauerkraut, aged or smoked meats, most cheeses). Accordingly, it is essential that patients taking phenelzine are given specific and emphatic instructions regarding the drugs and foods they must avoid. For patients taking multiple drugs, the opportunity for drug interactions is increased. For these patients, providing a link to a reliable medication interaction checker will be helpful.

APPLICATION OF THE NURSING PROCESS AND CLINICAL JUDGMENT MEASUREMENT MODEL IN DRUG THERAPY

The nursing process is a conceptual framework that nurses use to guide health care delivery. The Clinical Judgment Measurement Model (CJMM), formerly known as the Clinical Judgment Model, is a framework for assessing the soundness of clinical decision-making. In this section, we compare the nursing process and the CJMM and examine how they can be applied to drug therapy.

Review of the Nursing Process

The nursing process is a method of problem-solving that has been used to guide nursing care for more than half a decade. In its simplest form, the nursing process can be viewed as a cyclic procedure that has five basic steps: (1) assessment, (2) analysis, (3) planning, (4) implementation, and (5) evaluation (Fig. 2.1).

Assess

Assessment consists of collecting data about the patient. These data are used to identify actual and potential health problems. The database established during assessment provides a foundation for subsequent steps in the process. Important methods of data collection are the patient interview, medical and drug-use histories, the physical examination, observation of the patient, and findings of screening or diagnostic studies (e.g., laboratory and radiologic test results).

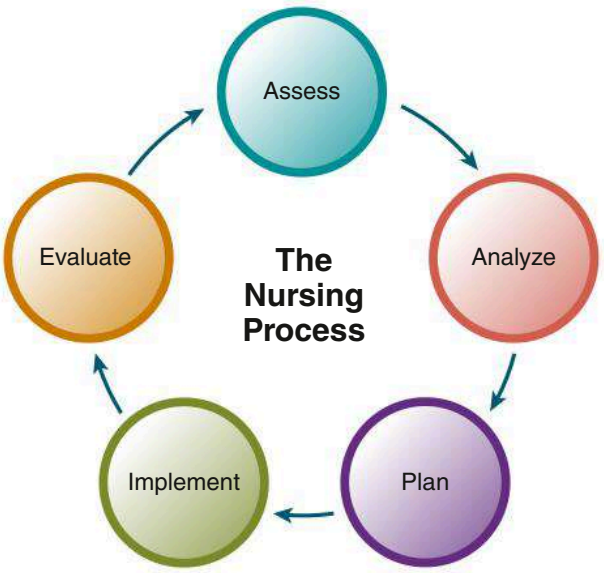

Fig. 2.1 ■ The nursing process.

Analyze

In this step, the nurse analyzes information in the database to determine actual and potential health problems. These problems may be physiologic, psychological, or sociologic.

Plan

In the planning step, the nurse identifies specific interventions directed at solving or preventing the problems identified in the analysis phase. These interventions form a component of the nursing care plan, a broader individualized plan of care for which the nurse defines goals, sets priorities, identifies nursing interventions, and establishes criteria for evaluating success. The planning phase is an ongoing process that must be modified as new data are gathered and the patient's situation changes.

Implement

Implementation is the process of executing the plan. Some interventions are collaborative, whereas others are independent. Collaborative interventions require a health care provider's order, whereas independent interventions do not. In addition to carrying out interventions, implementation involves coordinating the actions of other members of the health care team.

Evaluate

Evaluation is performed to determine the degree to which treatment has succeeded. By evaluating the outcomes of treatment, nurses identify those interventions that should be continued, those that should be discontinued, and potential new interventions that may be implemented. Evaluation is accomplished by analyzing the data collected after implementation. This step completes the initial cycle of the nursing process and provides the basis for beginning the cycle anew.

Review of the Clinical Judgment Measurement Model

The CJMM was developed by the National State Boards of Nursing (NCSBN) as a framework for constructing questions for the Next Generation NCLEX (NGN) nursing licensure exam. It consists of six cognitive skills used in clinical decision-making. These are (1) recognize cues, (2) analyze cues, (3) prioritize hypotheses, (4) generate solutions, (5) take action, and (6) evaluate outcomes.

TABLE 2.1 ■ Relationship Between the Nursing Process and the Clinical Judgment Measurement Model

Nursing Process	Clinical Judgment Measurement Model
Assess	Recognize Cues
Analyze	Analyze Cues
	Prioritize Hypotheses
Plan	Generate Solutions
Implement	Take Action
Evaluate	Evaluate Outcomes

Recognize Cues

The nurse collects subjective and objective data about the patient. The main sources of information include the patient's health history, assessment, and the results of any laboratory or other studies. The nurse then examines the collected data to distinguish which findings are relevant given the patient's situation.

Analyze Cues

In this step, the nurse analyses the relevant data as it applies to the patient's situation or presenting concerns. The analysis is used to identify the patient's probable needs and problems.

Prioritize Hypotheses

After the hypotheses (probable needs and problems) are identified, they are prioritized. Considerations in prioritization include the urgency with which a problem needs to be addressed and whether the problem has actually occurred or is at risk of occurring. Decisions related to prioritization are often decided on an individual basis.

Generate Solutions

In this step, the nurse first establishes desired patient outcomes. Then the nurse identifies interventions that can be used to achieve those outcomes.

Take Action

Next, the nurse implements the solutions generated in the previous step. Because we cannot manage all problems simultaneously, actions are prioritized to address the most urgent problems first. Less severe problems are relegated to lower positions when prioritizing care.

Evaluate Outcomes

The final step determines whether the actions taken were effective. This is done by evaluating patient outcomes and comparing them with the desired outcomes that were established when solutions were generated.

Although it is a six-step model, the CJMM aligns well with the nursing process (Table 2.1).

Applying the Nursing Process and Clinical Judgment Measurement Model in Drug Therapy

Having reviewed the nursing process and CJMM, we can now discuss the process as it pertains to drug therapy. Recall that the overall objective of drug therapy is to produce maximum benefit with minimum harm. In addition, keep in mind that this is somewhat modified because the process is being applied to drug therapy rather than to a patient with individualized needs.

In the discussion that follows, the headings reflect the phase of the nursing process followed by associated the CJMM skill (i.e., nursing process/CJMM).

Assess/Recognize Cues

A preadministration assessment establishes the baseline data needed to tailor drug therapy to the individual. By identifying the variables that can affect an individual's response to a drug, we can adapt treatment so as to maximize benefits and minimize harm. Preadministration assessment has two basic goals:

- Collection of baseline data needed to evaluate therapeutic effects
- Collection of baseline data needed to evaluate adverse effects

These goals are specific to the particular drug being used. Accordingly, to achieve these goals, you must know the pharmacology of the drug under consideration.

Important methods of data collection include interviewing the patient and family, observing the patient, performing a physical examination, checking the results of laboratory and radiologic tests, and taking the patient's medical and drug histories. The drug history should include prescription drugs, OTC drugs, herbal remedies, and drugs taken for nonmedical or recreational purposes (e.g., alcohol, nicotine, caffeine, and illegal drugs). Prior adverse drug reactions should be noted, including drug allergies and idiosyncratic reactions (i.e., reactions unique to the individual).

Baseline Data Needed to Evaluate Therapeutic Effects. Drugs are administered to achieve a desired response. To know whether we have produced that response, we need to establish baseline measurements of the parameter that therapy is directed at changing. For example, if we are giving a drug to lower blood pressure, we need to know what the patient's blood pressure was before treatment. Without this information, we have no basis for determining the effectiveness of our drug.

Baseline Data Needed to Evaluate Adverse Effects. All drugs have the ability to produce undesired effects. In most cases, the adverse effects that a particular drug can produce are known. In many cases, the development of an adverse effect will be completely obvious in the absence of any baseline data. For example, we do not need special baseline data to know that hair loss after cancer chemotherapy was caused by the drug. However, in other cases, baseline data are needed to determine whether an adverse effect has occurred. For example, some drugs can impair liver function. To know whether a drug has compromised liver function, we need to know the state of liver function before drug use. Without this information, we cannot tell from later measurements whether liver dysfunction was preexisting or caused by the drug.

Analyze/Analyze Cues and Prioritize Hypotheses

With respect to drug therapy, three important objectives for this step are:

- Identify high-risk patients
- Determine the patient's capacity for self-care
- Judge the appropriateness of the prescribed regimen.

Identify High-Risk Patients. Because of individual characteristics, a particular patient may be at high risk for experiencing an adverse response to a particular drug. Just which individual characteristics will predispose a patient to an adverse reaction depends on the drug under consideration. For example, if a drug is eliminated from the body primarily by renal excretion, an individual with impaired kidney function will be at risk for having this drug accumulate to a toxic level. Similarly, if a drug is eliminated by the liver, an individual with impaired liver function will be at risk for having that drug accumulate to a toxic level.

Multiple factors can increase the patient's risk for adverse reactions to a particular drug. Impaired liver and kidney function were just mentioned. Other factors include age, body composition, pregnancy, diet, genetic heritage, other drugs being used, and practically any pathophysiologic condition. These factors are discussed at length in Chapters 8 and 9.

When identifying factors that put the patient at risk, you should distinguish between factors that put the patient at extremely high risk versus factors that put the patient at moderate or low risk. The terms *contraindication* and *precaution* are used for this distinction. A *contraindication* is defined as a condition that prohibits the use of a particular drug under all but the most critical of circumstances. For example, a previous severe allergic reaction to penicillin would be a contraindication to using penicillin again—unless the patient has a life-threatening infection that cannot be effectively treated with another antibiotic. In this situation, in which the patient *will* die if the drug *is not* administered yet the patient *may* die if the drug *is* administered, the health care provider may decide to give the penicillin along with other drugs and measures to decrease the severity of the allergic reaction. By contrast, a *precaution* can be defined as a condition that significantly increases the risk for an adverse reaction to a particular drug but not to a degree that is life-threatening. For example, sedating antihistamines pose a risk to elderly patients who are at risk of falling, which would constitute a precaution against using this drug in older adults. That is, the drug may be used, but greater than normal caution must be exercised. Preferably, an alternative nonsedating antihistamine would be selected.

Determine the Patient's Capacity for Self-Care. If drug therapy is to succeed, the outpatient must be willing and able to self-administer medication as prescribed. Accordingly, the patient's capacity for self-care must be determined. If the assessment reveals that the patient is incapable of self-medication, alternative care must be arranged.

Multiple factors can affect the capacity for self-care and the probability of adhering to the prescribed regimen. Patients with reduced visual acuity or limited manual dexterity may be unable to self-medicate, especially if the technique for administration is complex. Patients with limited intellectual ability may be incapable of understanding or remembering what they are supposed to do. Patients with severe mental illness (e.g., depression, schizophrenia) may lack the understanding

or motivation needed to self-medicate. Some patients may lack the money to pay for drugs. Others may fail to take medications as prescribed because of individual or cultural attitudes toward drugs. For example, a common cause for failed self-medication is a belief that the drug was simply not needed in the dosage prescribed. A thorough assessment will identify these factors, thereby enabling you to account for them when developing the patient care plan.

Judge the Appropriateness of the Prescribed Regimen. As the last link in the patient's chain of defense against inappropriate drug therapy, you must analyze the cues to determine whether the proposed treatment has a reasonable likelihood of being effective and safe. This judgment is made by considering the medical diagnosis, the known actions of the prescribed drug, the patient's prior responses to the drug, and the presence of contraindications to the drug. You should question the drug's appropriateness if (1) the drug has no actions that are known to benefit individuals with the patient's medical diagnosis, (2) the patient failed to respond to the drug in the past, (3) the patient had a serious adverse reaction to the drug in the past, or (4) the patient has a condition or is using a drug that contraindicates the prescribed drug. If any of these conditions apply, you should consult with the prescriber to determine whether the drug should be given.

The analysis must identify potential adverse effects and drug interactions. This is accomplished by integrating knowledge of the drug under consideration and the data collected during the assessment. Knowledge of the drug will indicate adverse effects that practically all patients are likely to experience. Data on the individual patient will indicate additional adverse effects and interactions to which the particular patient is predisposed.

Plan/Generate Solutions

Planning consists of defining goals, establishing priorities, identifying specific interventions, and establishing criteria for evaluating success. Good planning will allow you to promote beneficial drug effects. Of equal or greater importance, good planning will allow you to anticipate adverse effects rather than react to them after the fact.

Defining Goals. When planning care and generating solutions, it is important to first identify the desired outcomes of drug therapy. In all cases, the goal of drug therapy is to produce maximum benefit with minimum harm. That is, we want to use drugs in such a way as to maximize therapeutic responses, while preventing or minimizing adverse reactions and interactions. The objective of planning is to formulate ways to achieve this goal.

Setting Priorities. Priority setting requires knowledge of the drug under consideration and the patient's unique characteristics—and even then, setting priorities can be difficult. The highest priority is given to life-threatening conditions (e.g., anaphylactic shock, ventricular fibrillation). These may be drug induced or the result of disease. High priority is also given to reactions that cause severe, acute discomfort and to reactions that can result in long-term harm.

Identifying Interventions. The heart of planning is the identification of nursing interventions. For medication purposes, these interventions can be divided into four major groups: (1) drug administration, (2) interventions to enhance therapeutic effects, (3) interventions to minimize adverse effects and interactions, and (4) patient education (which encompasses information in the first three groups).

When planning drug administration, you must consider the dosage and route of administration, as well as less obvious factors, including the timing of administration with respect to meals and with respect to the administration of other drugs. Timing with respect to side effects is also important. For example, if a drug causes sedation, it may be desirable to give the drug at bedtime, rather than in the morning; conversely, a diuretic, which increases urination, is better given earlier in the morning rather than at bedtime.

Nondrug measures can help promote therapeutic effects and should be included in the plan. For example, drug therapy for hypertension can be combined with weight loss (in overweight patients), salt restriction, and smoking cessation.

Interventions to prevent or minimize adverse effects are of obvious importance. When planning these interventions, you should distinguish between reactions that develop quickly and reactions that are delayed. A few drugs can cause severe adverse reactions (e.g., anaphylactic shock) shortly after administration. When planning to administer such a drug, you should ensure that facilities for managing possible reactions are immediately available. Delayed reactions can often be minimized, if not avoided entirely. The plan should include interventions to do so.

Well-planned patient education is central to success. Patient education is discussed at length earlier in this chapter.

Establishing Criteria for Evaluation. The need for objective criteria by which to measure desired drug responses is obvious: Without such criteria, we could not determine how well our drug achieved the therapeutic objective. As a result, we would have no rational basis for making dosage adjustments or for deciding whether a drug should be continued.

Criteria for evaluation vary depending on the drug and its purpose. For an analgesic, the criterion for evaluation is a decrease or resolution of pain. For the patient prescribed thyroid hormones for hypothyroidism, a criterion for evaluation is typically a laboratory test (e.g., thyroid stimulating hormone level and free thyroxine level within normal range). Conversely, for the patient prescribed an antihypertensive, a criterion for evaluation may be a target blood pressure goal. Often, there are several criteria for evaluating a given drug.

If the drug is to be used on an outpatient basis, follow-up visits for evaluation should be planned. It is important to educate the patient on the importance of these visits even if the patient is feeling well.

Implement/Take Action

The nurse implements the care plan and takes action by carrying out the solutions that were generated to target the patient's problems. In drug therapy, this phase has four major components: (1) drug administration, (2) patient education, (3) interventions to promote therapeutic effects, and (4) interventions to minimize adverse effects. These critical nursing activities are discussed at length in the previous section.

Evaluate/Evaluate Outcomes

Over the course of drug therapy, the patient must be evaluated for (1) therapeutic responses, (2) adverse drug reactions and interactions, (3) adherence to the prescribed regimen, and (4) satisfaction with treatment. How frequently evaluations are performed depends on the expected time course of therapeutic and adverse effects. Like assessment, evaluation is based on laboratory tests,

observation of the patient, physical examination, and patient interviews. The conclusions drawn during the evaluation provide the basis for modifying nursing interventions and the drug regimen.

Therapeutic responses are evaluated by comparing the patient's current status with the baseline data. To evaluate treatment, you must know the reason for drug use, the criteria for evaluation, and the expected time course of responses (some drugs act within minutes, whereas others may take weeks to produce beneficial effects).

The need to anticipate and evaluate adverse effects is self-evident. To make these evaluations, you must know which adverse effects are likely to occur, how they manifest, and their probable time course. The method of monitoring is determined by the expected effect. For example, if hypotension is expected, blood pressure is monitored; if constipation is expected, bowel function is monitored. Because some adverse effects can be fatal in the absence of timely detection, it is impossible to overemphasize the importance of monitoring and being prepared for rapid intervention.

Evaluation of adherence is desirable in all patients—and is especially valuable when therapeutic failure occurs or when adverse effects are unexpectedly severe. Methods of evaluating adherence include measuring plasma drug levels, interviewing the patient, and counting pills. The evaluation should determine whether the patient understands when to take the medication, what dose to take, and the technique of administration, as well as whether the patient is taking the drug(s) exactly as prescribed.

Patient satisfaction with drug therapy increases quality of life and promotes adherence. If the patient is dissatisfied, an otherwise effective regimen may not be taken as prescribed. Factors that can cause dissatisfaction include unacceptable side effects, inconvenient dosing schedule, difficulty of administration, and high cost. When evaluation reveals dissatisfaction, an attempt should be made to alter the regimen to make it more acceptable.

Use of a Modified Nursing Process and Clinical Judgment Measurement Model Format to Summarize Nursing Implications

Throughout this text, nursing information is integrated with basic science information to reinforce the relationship between pharmacologic knowledge and nursing practice. In addition to being integrated, for those chapters that focus on specific drugs (as opposed to those such as this one), nursing implications are summarized at the end of the chapters under the heading "Summary of Major Nursing Implications." The purpose of these summaries is to provide a concise and readily accessible reference on patient care and patient education related to specific drugs and drug families.

The format used for summarizing nursing implications reflects the nursing process and CJMM. Some headings have been modified to accommodate the needs of pharmacology instruction and to keep the summaries concise.

KEY POINTS

- Nursing responsibilities with regard to drugs extend far beyond the Rights of Drug Administration.
- You are the patient's last line of defense against medication errors.
- Your knowledge of pharmacology has a wide variety of practical applications in patient care and patient education.
- By applying your knowledge of pharmacology, you will make a large contribution to achieving the therapeutic objective of maximum benefit with minimum harm.
- Application of the nursing process and Clinical Judgment Measurement Model in drug therapy is directed at individualizing treatment, which is critical to achieving the therapeutic objective.
- The goal of assessment and recognizing cues is to gather data needed for the evaluation of therapeutic and adverse effects.
- The analysis and analyzing cues phase of treatment is directed at (1) identifying high-risk patients, (2) assessing the patient's capacity for self-care, and (3) judging the appropriateness of the prescribed therapy.
- Planning and generating solutions are directed at (1) defining goals, (2) establishing priorities, (3) identifying interventions, and (4) establishing criteria for evaluating success.
- Implementation and taking action center on carrying out the solutions that were generated in developing the patient's plan of care. In drug therapy, this phase has four major components: (1) drug administration, (2) patient education, (3) interventions to promote therapeutic effects, and (4) interventions to minimize adverse effects.
- In the evaluation stage, the objective is to evaluate: (1) therapeutic responses, (2) adverse reactions and interactions, (3) patient adherence, and (4) patient satisfaction with treatment.

CHAPTER

3

Drug Regulation, Development, Names, and Information

In this chapter, we complete our introduction to pharmacology by considering five diverse but important topics. These are (1) drug regulation, (2) new drug development, (3) the annoying problem of drug names, (4) over-the-counter (OTC) drugs, and (5) sources of drug information.

LANDMARK DRUG LEGISLATION

The history of drug legislation in the United States reflects an evolution in our national posture toward regulating the pharmaceutical industry. That posture has changed from one of minimal control to one of extensive control. For the most part, increased regulation has been beneficial, resulting in safer and more effective drugs.

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1900 to 1970

The first American law to regulate drugs was the *Federal Pure Food and Drug Act* of 1906. This law set standards for drug quality and purity in addition to strength. It specifically focused on product labeling and required that any variations from the standards be placed on the label.

The *Food, Drug, and Cosmetic Act*, passed in 1938, was the first legislation to address drug safety. The motivation behind the law was a tragedy in which more than 100 people died after using a new medication. The lethal preparation contained sulfanilamide, an antibiotic, plus diethylene glycol as a solubilizing agent. Tests showed that the solvent was the cause of death. (Diethylene glycol is commonly used as automotive antifreeze.) To reduce the chances of another such tragedy, Congress required that all new drugs undergo testing for safety. The results of these tests were to be reviewed by the *U.S. Food and Drug Administration* (FDA), and only those drugs judged safe would receive FDA approval for marketing.

In 1962, Congress passed the *Harris-Kefauver Amendments* to the Food, Drug, and Cosmetic Act. This bill was created in response to the thalidomide tragedy that occurred in Europe in the early 1960s. Thalidomide is a sedative now known to cause birth defects and fetal death. Because the drug was used widely by pregnant patients, thousands of infants were born with phocomelia, a rare birth defect characterized by the gross malformation or complete absence of arms or legs. This tragedy was especially poignant in that it resulted from nonessential drug use: The women who took thalidomide could have managed their conditions without it. Thalidomide was not a

problem in the United States because the drug never received approval by the FDA.

Because of the European experience with thalidomide, the Harris-Kefauver Amendments sought to strengthen all aspects of drug regulation. A major provision of the bill required that drugs be proved *effective* before marketing. Remarkably, this was the first law to demand that drugs actually offer some benefit. The new act also required that all drugs that had been introduced between 1932 and 1962 undergo testing for effectiveness; any drug that failed to prove useful would be withdrawn. Lastly, the Harris-Kefauver Amendments established rigorous procedures for testing new drugs. These procedures are discussed later in this chapter under *New Drug Development*.

In 1970, Congress passed the *Controlled Substances Act* (Title II of the Comprehensive Drug Abuse Prevention and Control Act). This legislation set rules for the manufacture and distribution of drugs considered to have the potential for abuse. One provision of the law defines five categories of controlled substances, referred to as Schedules I, II, III, IV, and V. Drugs in Schedule I have no accepted medical use in the United States and are deemed to have a high potential for abuse. Examples include heroin, mescaline, and lysergic acid diethylamide (LSD). Drugs in Schedules II through V have accepted medical applications but also have a high potential for abuse. The abuse potential of these agents becomes progressively less as we proceed from Schedule II to Schedule V. The Controlled Substances Act is discussed further in Chapter 40.

1990 to Present

In 1992, FDA regulations were changed to permit *accelerated approval* of drugs for acquired immunodeficiency syndrome (AIDS) and cancer. Under these guidelines, a drug could be approved for marketing before the completion of phase III trials (discussed later in the chapter), provided that rigorous follow-up studies (phase IV trials) were performed. The rationale for this change was that (1) medications are needed, even if their benefits may be marginal, and (2) the unknown risks associated with early approval are balanced by the need for more effective drugs. Although accelerated approval seems like a good idea, in actual practice, it has two significant drawbacks. First, manufacturers often fail to conduct or complete the required follow-up studies. Second, if the follow-up studies—which are more rigorous than the original—fail to confirm a clinical benefit, the guidelines have no clear mechanism for removing the drug from the market.

The *Prescription Drug User Fee Act* (PDUFA), passed in 1992, was a response to complaints that the FDA was taking too long to review applications for new drugs. Under the Act, drug sponsors pay the FDA fees that are used to fund additional reviewers. In return, the FDA must adhere to strict review timetables. Because of the PDUFA, new drugs now reach the market much sooner than in the past.

The *Food and Drug Administration Modernization Act* (FDAMA) of 1997—an extension of the PDUFA—called for widespread changes in FDA regulations. For health professionals, four provisions of the act are of particular interest:

- The fast-track system created for AIDS drugs and cancer drugs now includes drugs for other serious and life-threatening illnesses.
- Manufacturers who plan to stop making a drug must inform patients at least 6 months in advance, thereby giving them time to find another source.
- A clinical trial database is required for drugs directed at serious or life-threatening illnesses. These data allow clinicians and patients to make informed decisions about using experimental drugs.
- Drug companies can now give prescribers journal articles and certain other information regarding off-label uses of drugs. (An *off-label use* is a use that has not been evaluated by the FDA.) Before the new act, clinicians were allowed to prescribe a drug for an off-label use, but the manufacturer was not allowed to promote the drug for that use—even if promotion was limited to providing potentially helpful information, including reprints of journal articles. In return for being allowed to give prescribers information regarding off-label uses, manufacturers must promise to do research to support the claims made in the articles.

Two laws—the *Best Pharmaceuticals for Children Act* (BPCA), passed in 2002, and the *Pediatric Research Equity Act* (PREA) of 2003—were designed to promote much-needed research on drug efficacy and safety in children. The BPCA offers a 6-month patent extension to manufacturers who evaluate a drug already on the market for its safety, efficacy, and dosage in children. The PREA gives the FDA the power, for the first time, to require drug companies to conduct pediatric clinical trials on new medications that might be used by children. (In the past, drugs were not tested in children, so there was a general lack of reliable information upon which to base therapeutic decisions.)

In 2007, Congress passed the *FDA Amendments Act* (FDAAA), the most important legislation on drug safety since the Harris-Kefauver Amendments of 1962. The FDAAA expands the mission of the FDA to include rigorous oversight of drug safety *after* a drug has been approved. (Before this act, the FDA focused on drug efficacy and safety *before* approval but had limited resources and authority to address drug safety after a drug was released for marketing.) Under the new law, the FDA has the legal authority to require postmarketing safety studies, to order changes in a drug's label to include new safety information, and to restrict distribution of a drug based on safety concerns. In addition, the FDA was required to establish an active postmarketing risk surveillance system, mandated to include 25 million patients by July 2010 and 100 million by July 2012. Because of the FDAAA, adverse effects that were not discovered before drug approval came to light much sooner than in the past, and the FDA now has the authority to take action (e.g., limit distribution of a drug) if postmarketing information shows a drug to be less safe than previously understood.

In 2009, Congress passed the *Family Smoking Prevention and Tobacco Control Act*, which, at long last, allows the FDA to regulate cigarettes, which are responsible for about one in five deaths in the United States each year. Under the act, the FDA was given the authority to strengthen advertising restrictions, including a prohibition on marketing to youth; require revised and more prominent warning labels; require

disclosure of all ingredients in tobacco products and restrict harmful additives; and monitor nicotine yields and mandate gradual reduction of nicotine to nonaddictive levels. The *Comprehensive Addiction and Recovery Act (CARA) of 2016* and the *Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment (SUPPORT) for Patients and Communities Act of 2018* were developed to combat a nationwide opioid epidemic by addressing the crisis from multiple approaches. To that end, they provide grants to support efforts directed toward prevention, treatment, and rehabilitation/recovery; opioid overdose reversal by first responders, law enforcement officers, and families; and the establishment of opioid recovery centers. Implications for nursing are significant because nurses have important roles in the expanded drug education and other prevention programs and in drug addiction treatment and recovery programs. In addition, nurses are often in roles in which they serve as first responders.

HAZARDOUS DRUG EXPOSURE

Health Care Worker Safety

Exposure to certain drugs can be dangerous for nurses and other health care workers who handle them. It is imperative to ensure your own safety as well as the safety of your patients.

The NIOSH, established in 1970, has the responsibility to promote and enhance worker safety. Thus NIOSH identifies which of the thousands of drugs are hazardous for handling and publishes guidance on the safe handling of these drugs.

Hazardous Drug Identification

In their publication *NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings, 2016* (available, with updates, online at https://www.cdc.gov/niosh/docs/2016-161), the NIOSH identifies a drug as hazardous for handling if it meets one or more of the following criteria:

- Carcinogenicity
- Teratogenicity or developmental toxicity
- Reproductive toxicity
- Organ toxicity at low doses
- Genotoxicity
- New drugs with structure and toxicity profiles similar to drugs previously determined to be hazardous

It is probably not surprising to find that antineoplastic drugs (drugs that kill cancer cells) are included in the list, but common drugs such as oral contraceptives (birth control pills) are also included. You will learn about these throughout the textbook, and the full listing is also available in the NIOSH publication.

The NIOSH provides instructions on how nurses and other health care workers can use protective equipment and environmental controls to prevent the potentially harmful effects associated with these drugs. These guidelines are provided in Table 3.1.

NEW DRUG DEVELOPMENT

The development and testing of new drugs is an expensive and lengthy process, requiring 10 to 15 years for completion. Of the thousands of compounds that undergo testing, only a few enter clinical trials, and of these, only one in five gains approval. According to an article in the March 2020 issue of the Journal of the American Medical Association (JAMA), the estimated average research and development investment to bring a new drug to market is $1335.9 million.

Rigorous procedures for testing have been established so that newly released drugs can be both safe and effective. Unfortunately, although testing can determine effectiveness, it cannot guarantee that a new drug will be safe. For example, significant adverse effects may evade detection during testing, only to become apparent after a new drug has been released for general use.

The Randomized Controlled Trial

RCTs are the most reliable way to objectively assess drug therapies. RCTs have three distinguishing features: use of controls, randomization, and blinding. All three serve to minimize the influence of personal bias on the results.

Use of Controls

When a new drug is under development, researchers want to know how it compares with a standard drug used for the same disorder or perhaps how it compares with no treatment at all. To make these comparisons, some subjects in the RCT are given the new drug and some are given either (1) a standard treatment or (2) a placebo (i.e., an inactive compound formulated to look like the experimental drug). Subjects receiving either the standard drug or the placebo are referred to as controls. Controls are important because they help us determine whether the new treatment is more (or less) effective than standard treatments or at least whether the new treatment is better (or worse) than no treatment at all. Likewise, controls allow us to compare the safety of the new drug with that of the old drug, a placebo, or both.

Randomization

In an RCT, subjects are randomly assigned to either the control group or the experimental group (i.e., the group receiving the new drug). The purpose of randomization is to prevent allocation bias, which results when subjects in the experimental group are different from those in the control group. For example, in the absence of randomization, researchers could load the experimental group with patients who have mild disease and load the control group with patients who have severe disease. In this case, any differences in outcome may well be because of the severity of the disease rather than differences in treatment. Moreover, even if researchers try to avoid bias by purposely assigning subjects who appear similar to both groups, allocation bias can result from unknown factors that can influence outcome. By assigning subjects randomly to the control and experimental groups, all factors—known and unknown, important and unimportant—should be equally represented in both groups. As a result, the influences of these factors on outcome should tend to cancel each other out, leaving differences in the treatments as the best explanation for any differences in outcome.

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