Second Edition

Nursing Pharmacology and Therapeutics

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Notice: Our knowledge in clinical sciences is constantly changing. As new information becomes available, changes in treatment and in the use of drugs become necessary. The authors and the publisher of this volume have taken care to make certain that the doses of drugs and schedules of treatment are correct and compatible with the standards generally accepted at the time of publication. The reader is advised to consult carefully the instruction and information material included in the package insert of each drug or therapeutic agent before administration. This advice is especially important when using new or infrequently used drugs.

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Preface

Since the appearance of the first edition of *Nursing Pharmacology and Therapeutics*, we have continuously compiled material to develop this second edition. Information has been included to meet the ever increasing role of the nurse to perform a wider range of drug-related activities. These include dispensing and administering medications; assessing the patient prior to drug administration; monitoring, recording, critically evaluating, and reporting the response to drugs; providing emergency care to combat the adverse effects of drugs, substances of abuse, and poisonous chemicals; educating the patient and family about the safe, rational, and effective use and self-administration of prescription and over-the-counter drugs; and participating in the management and rehabilitation of drug- and alcohol-dependent patients and counseling them, members of their family, and significant friends.

To successfully discharge these professional responsibilities, it is not essential, reasonable, nor realistic that the nurse become an expert on every drug product encountered. The nurse should, however, have a good appreciation of all major classes of drugs and the most widely used members of each class, and understand why and how a given drug is being administered (or being withheld); what beneficial effects are anticipated; and be capable of anticipating, recognizing, and minimizing adverse effects. Full understanding of the therapeutic applications of medications and their limitations is based upon knowledge of the fundamental principles of drug action—this is *pharmacology*.

AIDS TO LEARNING

The very favorable reviews of and comments on the first edition have encouraged us to maintain our primary objective of preparing a highly readable introductory text on the contemporary concepts of pharmacology and their therapeutic applications in nursing practice. This text is intended to complement or supplement the lectures presented in a one-quarter or one-semester nursing pharmacology course, or it can be used by nursing graduates who are reading independently to maintain their knowledge of drug therapy. Essential background material is presented in physiology, biochemistry, pathophysiology, and disease—disciplines which provide the foundation of pharmacology and therapeutics.

All major therapeutic classes are included in this text, and yet it is specifically designed to be intermediate in size between a

comprehensive reference text and an outline that oversimplifies basic concepts in the interest of brevity. The apparently countless number of unfamiliar drug names generally contained in pharmacology texts might initially overwhelm and intimidate the beginning reader. More critical inspection reveals that many of these drugs are very similar to a much more limited number of standard prototype drugs in each therapeutic class. To avoid trivial detail and produce a text that is both stimulating and readable in size and style, the actions, effects, and therapeutic uses of these prototype drugs are emphasized. The distinguishing properties, dosages and routes of administration, and trade names of related drugs are summarized in tabular form in each chapter. The nurse will encounter many prescription and over-the-counter drug products that contain multiple ingredients. To assist in the identification of many of these products and their primary active ingredients, additional reference tables have been prepared in this new edition.

A very large proportion of patients take more than one medication. Both the beneficial and adverse effects of one drug can be enhanced or reduced by the prior or concurrent administration of another drug, alcohol, or food. Tables of clinically relevant drug interactions, with their potential consequences, appear in all applicable chapters. While the above-mentioned tables provide the reader with a readily accessible source of reference material, detailed information on specific drugs can be obtained by consulting the reference sources listed in Table 1–1.

To facilitate the application of the basic principles of pharmacology and therapeutics to nursing practice, the chapters in Sections II through IX conclude with a self-contained Nursing Implications and Patient Education section. These sections have been completely revised and extensively expanded to facilitate easy and rapid acquisition of information. Five new chapters have been prepared for this edition and 17 chapters have undergone major revision or the extensive addition of significant new topics or sections. All chapters have been updated to include the most recently introduced drugs and concepts.

The entire text has been critically reviewed and refined for clarity. Each chapter opens with a listing of its major sections and an overview of its contents. In this revision, key terms are now boldfaced and defined in an end-of-text glossary. The nurse will commonly encounter Latin abbreviations on the medication order—called a *prescription* in an ambulatory setting and a *physician's order* in the hospital. These abbreviations, used throughout the text in tables of representative drugs, are used to designate dosage and routes of administration. Tables containing common abbreviations, and equivalent weights and measures have been relocated to the inside front cover for ease of reference.

ACKNOWLEDGMENTS

We wish to express our warmest thanks to Jeffrey Longcope, John Robert Hirschfeld, and the staff of Appleton & Lange for their assistance and support in the production of this book.

This book is dedicated with love to my wife Gloria and to Marc and Melissa Gerald; and to the O'Bannon daughters Kata O'Bannon, Kim Archer, and Kolleen Squires.

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Freda V. O'Bannon

Organization of Contents

The 62 chapters in the text, divided among nine sections, permit the instructor considerable flexibility in the selection of topics and the order in which subjects are presented or assigned for reading. The contents of the text, and the most significant revisions incorporated in this second edition, are summarized as follows:

Chapters 1 and 2 in Section I introduce the general principles of drug action that establish an essential foundation for the study of pharmacology and therapeutics. These revised chapters more extensively emphasize pharmacokinetics and the time course for the accumulation and elimination of drugs; principles upon which contemporary dosing schedules are based. The concept and significance of drug half-life is introduced in this section and incorporated in tables and text throughout the remainder of the volume.

Chapter 3, examining the administration of drugs, has been completely rewritten and now includes extensive materials on the different dosage forms and other drug delivery systems; precautions associated with the administration of drugs to pediatric, pregnant, and geriatric patients; and the legal aspects of drug administration.

With the increasing emphasis on the self-care movement, a newly written Chapter 4 provides information regarding precautions associated with administering drugs to patient populations at greater risk, which the nurse can convey to the patient. This chapter also examines in detail those factors that contribute to patient compliance to the prescribed therapeutic regimen.

Drugs affecting the autonomic nervous system and skeletal muscle relaxation are discussed in Section II. Autonomic drugs are placed early in the text because many therapeutic agents have desirable or undesirable effects on autonomic function. Because of its inherent complexity, some instructors may prefer postponing this material to a later date in the syllabus.

The pharmacology and therapeutics of a wide range of central nervous system drug classes are considered in Section III. Local anesthetics, nonnarcotic analgesics, and anti-inflammatory drugs do not primarily act by altering central functions, but therapeutic considerations influenced their inclusion in this section. Because many central drugs are subject to misuse and abuse, the nurse must be prepared to deal effectively with a wide range of problems associated with the nonmedical use of these drugs. Discussion of drug misuse and abuse has been relocated to an earlier chapter in this second edition (Chap. 12).

Specific information on the abuse potential of clinically employed drugs, alcohol, marihuana, and psychotomimetics is retained in their respective chapters.

A new chapter (Chap. 23) on antimigraine drugs has been included. Representative examples of new additions to this section include more extensive consideration of the benzodiazepines, prostaglandins, the opioid receptors, and the biochemical basis of Parkinson's disease.

Drugs used to treat cardiovascular disorders, to promote urine formation, and to alter blood coagulation appear in Section IV. The electrophysiological basis of the cardiac cycle, cardiac arrhythmias, and the actions of antiarrhythmic drugs (Chaps. 27 and 29) have been rewritten and reorganized to provide additional clarity and information on these intrinsically complex but highly significant drugs. Therapeutic considerations associated with the treatment of hypertension are much more extensively considered in Chapter 30 and calcium channel blockers are examined in Chapter 32.

Section V considers natural and synthetic hormones and their antagonists used for the treatment of endocrine and nonendocrine disorders, as contraceptive agents, and to modify the motility of the pregnant uterus. Diabetes, its treatment and control with insulin and other drugs, has been extensively expanded in Chapter 38. A section on drug alteration of sexual function has been added in Chapter 39. The treatment of sexually transmitted diseases is the subject of the newly prepared Chapter 50, which is contained in Section VI. This section addresses chemotherapeutic agents used for the management and cure of diseases caused by bacteria, fungi, viruses, protozoa, worms, and malignant cells.

Drugs used for allergies and asthma appear in Section VII, as does the newly written Chapter 58 on treatment of the common cold. Section VIII examines drugs affecting disorders of the gastrointestinal tract, particularly peptic ulcer disease (Chap. 59), and an expanded section on the H_2-receptor antagonists, and drugs affecting bowel function (Chap. 60); this latter chapter also includes a new section on antiemetic drugs.

The ninth and last section includes a chapter (Chap. 61) covering 18 important new drugs not readily placed within the boundaries of earlier chapters. Chapter (Chap. 62) examines the problem of acute chemical poisoning and its emergency treatment.

Notes to Instructors

After the completion of Chapters 1 and 2, Sections II through IX and the sequence of chapters within each section are largely self-contained, and may be completed in any order. To preclude excessive redundancy, chapters throughout the text are cross-referenced. We suggest that prior to reading Sections II through VI, students first review the material contained in the respective section introductions; namely Chapters 5, 11, 27, 35, and 43. These chapters provide the basic terminology and sufficient physiologic and pharmacologic background to enable the reader to more readily comprehend the succeeding chapters in each section. Some instructors might prefer to summarize the general principles of neuropharmacology (Chap. 5) and then proceed directly to Sections III and/or IV.

A newly developed Instructor's Guide, which has been prepared specifically for use with this volume of *Nursing Pharmacology and Therapeutics, Second Edition* should be consulted for further recommendations.

We welcome your comments, criticisms, and suggestions.

Contents

SECTION I

General Principles of Pharmacology

1 Introduction to Drugs

Information about drugs is of interest to all members of society regardless of their academic major, profession, or vocation. Rarely does a week pass without media reports of adverse drug reactions, medication complications arising from the use of oral contraceptives, antidiabetic or antianxiety drugs, the potential toxicity associated with food additives, marihuana or pesticides, and the experimental use of hallucinogens by governmental agencies, or a purported AIDS cure.

NEED FOR DRUG INFORMATION

When engaging in medication related activities, the nurse should utilize the nursing process: assessment, planning, implementation (administration), evaluation, and education.

Regardless of where a nurse practices, accurate drug information is not only of general interest but is essential. Functioning autonomously—although most often in cooperation and collaboration with physicians and pharmacists—the nurse may at times be professionally engaged in, and may assume responsibility for, one or more of the following drug related activities:

- *Obtaining a drug history*, including prescription and nonprescription drugs, taken on a regular basis or when needed, and "recreational" drugs taken for nonmedical purposes. Assess both the intended effects of the medications and any other reactions. Any side effects or adverse reactions should be accurately described and recorded; minor, discomforting side effects should be differentiated from those that are potentially severe, such as allergic reactions.
- *Assessing the patient to receive medications* to determine whether special precautions are indicated based upon age, sex, pre-existing diseases or impairments of physio-

logic functions, and possible adverse drug–drug or drug–nutrition interactions.

- *Administering medications* to the patient in a hospital, an outpatient medical facility, or at home.
- *Monitoring, recording, evaluating, and reporting the patient's response to drugs.* When necessary, the nurse should be prepared to withhold medication or consult with the physician regarding changes in dosage or choice of drugs to prevent or reduce the severity of an adverse drug reaction or to maximize the benefits of the medication administered. For example, the nurse would not administer digitalis when the patient has a slow pulse rate nor inject insulin to the diabetic experiencing a hypoglycemic reaction. The nurse may recommend that the physician reduce the dosage of a barbiturate used to produce nighttime sedation when a previously active patient is lethargic during the day. Upon reviewing the results of laboratory tests, the nurse should bring to the attention of the physician any results that may indicate a need to re-evaluate the medication order; for example, that a potassium supplement be initiated or that an alternative antibiotic be utilized when the culture reveals pathogen resistance to the drug employed.
- *Providing emergency treatment* to an individual experiencing a severe drug-induced allergic reaction or respiratory depression and coma caused by an overdose of a narcotic or other central nervous system depressant, or calming a patient experiencing a phencyclidine (PCP)-induced panic reaction.
- *Educating the patient, family, and significant friends* about the possible dangers associated with indiscriminate self-medication, particularly during pregnancy; the benefits versus the risks of nonprescription drugs, including vitamins, laxatives, and antacids; the inadvisability of taking certain drugs or foods in conjunction with prescribed medications, such as alcoholic beverages with barbiturates or antihistamines; the potential temporary impairment of mental and physical function after initiating therapy with antipsychotic drugs; the practical ways of minimizing undesirable minor but highly distressful drug-induced side effects, such as dry mouth or nausea; the side effects signaling the onset of a severe adverse drug reaction that should be brought without delay to the physician's attention; the proper storage of drugs to prevent loss of potency or accidental ingestion by children; the expected effect(s) produced by the drug; and how and when to take the drug.
- *Counseling individuals* enrolled in a drug or alcohol rehabilitation program, or providing support to the patient or to their families.
- *Discharge teaching* about home medication regimens to promote the safe and effective use of drugs and reduce noncompliance.

NURSING PROCESS

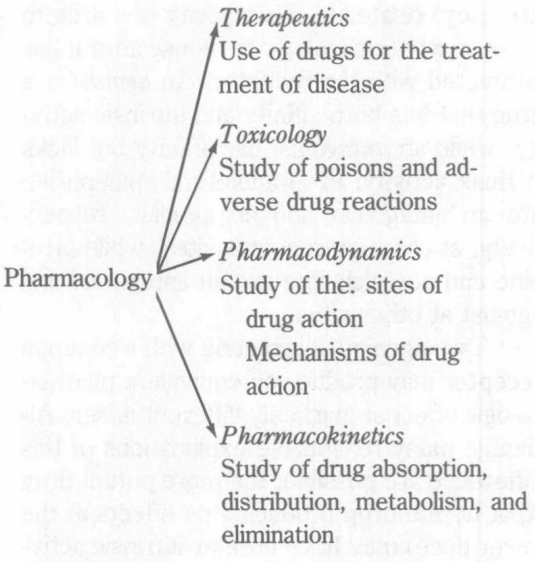
The *nursing process* is a systematic five-step problem-solving procedure used in nursing practice, and includes: (1) data gathering; (2) problem identification, or formulating the nursing diagnosis; (3) planning the intervention; (4) implementing the intervention; and (5) evaluating and modifying the intervention, as needed.

Consider, for example, the application of the nursing process when administering a drug for relief of pain. (1) *Data gathering* includes a general patient history, past drug history, and when applicable, the effectiveness of drugs in relieving pain; observation of behavior indicating the patient may be experiencing pain; and questioning the patient about perception of pain. (2) Based on the data collected, the *problem is identified* and a

nursing diagnosis is made: the need for an alteration in comfort, or more specifically, the relief of pain. (3) *Intervention* is then planned; providing comfort measures and the administration of a pain-relieving drug. (4) *Implementation* involves providing comfort measures and drug administration. (5) After administration of medication, the intervention is *evaluated* for the effectiveness of the pain relief obtained; if the pain is not satisfactorily relieved, the pain-relieving plan should be modified.

In this chapter we will examine the meaning of the terms *pharmacology, therapeutics, toxicology,* and *pharmacokinetics;* we will also consider the general effects produced by drugs, the mechanisms responsible for these effects, and how drugs are used for the treatment of disease.

WHAT IS PHARMACOLOGY?



Pharmacology *is the study of drugs.* Although for the most part we will consider the term **drug** to be synonymous with medication or a chemical used for the treatment of disease, the limited boundaries imposed by this definition would soon be outgrown. The nonmedical use of heroin, alcohol, and marihuana, the treatment of accidental poisoning by insecticides, and the use of oral contraceptives to prevent pregnancy (not generally perceived to be a disease) all represent areas of interest and importance to the nurse. Let us then expand our definition and consider a drug to be any chemical, excluding food, that interacts with living organisms to produce a response. As you can observe, this definition does not distinguish between a desirable interaction that is of benefit to the patient and an undesirable or adverse interaction that harms the patient.

Therapeutics is a general term describing the *use of drugs in the treatment of disease.* This term can be modified to describe the use of drugs for specific types of diseases; for example, psychotherapeutic and chemotherapeutic agents refer to drugs used for the management of behavioral disorders and infectious diseases, respectively.

One of the most fundamental principles of pharmacology states that *all drugs are potential poisons* when taken in sufficiently high doses. Some of these toxic effects represent an intensification of the normal therapeutic effects of the drug, while other adverse effects may be unrelated to it. For example, therapeutic doses of barbiturates produce sedation and sleep, while toxic doses intensify depression of the central nervous system, producing coma. By contrast, skin rash and other allergic responses are unrelated to the therapeutic effects of barbiturates. **Toxicology** is the study of poisons and the treatment of poisoning.

The rational use of drugs for the management of disease—therapeutics—is predicated upon an understanding of **pharmacodynamics** and **pharmacokinetics.** Pharmacodynamics deals with where a drug acts in the body (system, organ, or tissue)

and how it acts, that is, the physiologic or biochemical mechanism responsible for the observed drug effects. Pharmacokinetics deals with the rate of the absorption, distribution, metabolism, and eventual elimination of drugs. Some differentiate these terms by noting that *pharmacodynamics* is what the drug does to the body, while *pharmacokinetics* is what the body does to the drug.

MECHANISMS OF DRUG ACTION

One of the most fundamental principles of pharmacology is that *no drug produces one and only one effect.* Since drugs are not completely specific in their effects, it is useful to differentiate between the primary and secondary effects of drugs. The *primary effect* of a drug is the desired therapeutic effect; it is the effect that the physician seeks to achieve when prescribing the medication or that the patient seeks to obtain when self-administering a nonprescription medicine. *Secondary effects* are all other effects produced by the drug; these may be desirable or undesirable depending upon each patient's unique medical problem and the therapeutic objectives sought.

The biological effects produced by a drug are the consequence of an interaction between that drug and some part of the living organism. These interactions may be highly specific and selective or, in other cases, relatively nonspecific. These general mechanisms are responsible for the therapeutic and toxicologic effects observed in patients.

Drug–Receptor Interactions

Some drugs that are highly potent—that is, produce their effects at very low doses—are thought to act by specifically combining with chemical groups on the surface of the cell or within the cell. These chemical groups or molecules with which the drug interacts to produce an effect are called the **pharmacologic receptors.**

Classically, drug-receptor interactions have been described as being analogous to a lock and key. Just as few keys fit a given lock, only a few drugs interact with a given receptor. Selected keys fit the lock and turn the tumblers, while others fit the keyhole but are incapable of opening the lock. In a similar manner, some drugs interact with the receptor to produce a pharmacologic response; such drugs are called **agonists.** By contrast, when an **antagonist** interacts with the receptor, no response is produced; moreover, in the presence of the antagonist drug, the response normally produced by the agonist is reduced or totally prevented (Fig. 1–1).

The terms *affinity* and *intrinsic activity* are used to describe the nature of the drug–receptor interaction. **Affinity** refers to the tendency of a drug to combine with its receptor. **Intrinsic activity** (sometimes called **efficacy**) relates to the capacity of a drug to produce a pharmacologic response after it has interacted with the receptor. An *agonist* is a drug that has both affinity and intrinsic activity, while an *antagonist* has affinity but lacks intrinsic activity. Propranolol and epinephrine are an antagonist and an agonist, respectively, at common receptor sites, while atropine and acetylcholine are an antagonist and agonist at other sites.

Two agonists interacting with a common receptor may produce an equivalent pharmacologic effect at markedly different doses. Although many reasonable explanations of this difference are possible, the more potent drug (that is, the drug producing its effects at the lower dose) may have greater intrinsic activity. (The clinical significance, or lack thereof, of differences in drug potency will be discussed later.)

Atropine and *d*-tubocurarine are antagonists of acetylcholine, and their therapeutic uses as an antiulcer and as a preoperative

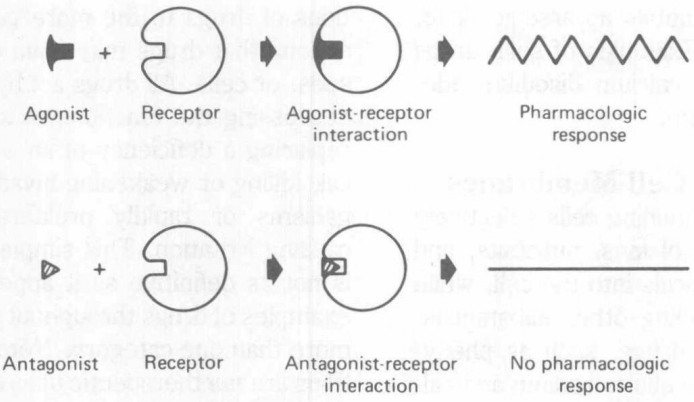


Figure 1–1. Drug–Receptor Interactions. The agonist is theorized to be capable of neatly fitting and interacting with the receptor site to produce a pharmacologic response. On the other hand, the antagonist only partially fits the receptor site; its structure is such that it is unable to cause an effect. By preventing the agonist from combining with the receptor, it prevents the agonist-induced effects.

muscle relaxant, respectively, are predicated upon antagonism of this naturally occurring agonist. Most authorities believe that the antipsychotic effects of chlorpromazine are the result of this drug's ability to block dopamine receptor sites located in the brain. Antihistamines, drugs used for the management of allergic disorders, antagonize the actions of histamine by blocking its receptors.

Drug–Enzyme Interactions

Many drugs have been shown to produce their effects by modifying the function of enzymes, the indispensable biological catalysts. Inhibitors of the enzyme acetylcholinesterase prevent the breakdown and inactivation of acetylcholine, and drugs such as physostigmine (eserine) are used for the treatment of glaucoma. Other chemicals acting by this same mechanism are employed as insecticides (parathion) and as potential chemical warfare agents (sarin). Inhibitors of the enzymes monoamine oxidase (tranylcypromine) and carbonic anhydrase (acetazolamide) are used for the treatment of depression and as diuretics for the removal of excessive body water, respectively.

Antimetabolites

By a series of specific biochemical reactions, living organisms are capable of converting simple starting materials into end products (metabolites) that are essential for their survival. **Antimetabolites** are drugs that resemble natural chemicals required for the biosynthesis of the essential metabolites. These drugs compete with the natural chemical and, when incorporated into the biosynthetic pathway in preference to the natural product, result in the formation of an end product that the living organism is incapable of utilizing to sustain life. Examples of commonly employed antimetabolites include the anticancer drug methotrexate and the sulfonamides ("sulfa drugs") used to combat bacterial infections.

Chelating Agents

The term *chelate*, derived from a Greek word meaning *crab's claw*, aptly describes the manner by which chelating agents grasp toxic metals present in the body to form drug–metal complexes that are nontoxic and readily eliminated. **Chelating agents** are used as specific antidotes for the treatment of poison-