

CHAPTER 6

PHARMACY AND TOXICOLOGY

As you advance in rate, you will become more and more involved in the administration of medicines. Although drugs and their dosages are prescribed by medical officers and other authorized prescribers, you, as the Hospital Corpsman, are involved in their administration. It is necessary for you to learn drug sources, composition, methods of preparation and administration, and physiologic and toxicologic action. This chapter covers pharmacology, toxicology, medication calculations, pharmaceutical preparations, and prescriptions.

PHARMACOLOGY

LEARNING OBJECTIVE: *Recall the subsiences of pharmacology, drug standards, medication administration methods, and factors that affect dosage.*

Pharmacology is the science that deals with the origin, nature, chemistry, effects, and uses of drugs. The subsiences of pharmacology and their specific areas of concentration are as follows:

- **PHARMACOGNOSY**—the branch of pharmacology that deals with biological, biochemical, and economic features of natural drugs and their constituents.
- **PHARMACY**—the branch of pharmacology that deals with the preparation, dispensing, and proper use of drugs.
- **POSOLOGY**—the science of dosages.
- **PHARMACODYNAMICS**—the study of drug action on living organisms.
- **PHARMACOTHERAPEUTICS**—the study of the uses of drugs in the treatment of disease.
- **TOXICOLOGY**—the study of poisons, their actions, their detection, and the treatment of the conditions produced by them.

The science of treating disease by any method that will relieve pain, cure disease, or prolong life is called **therapeutics**. Therapeutics does not deal solely with

giving or taking medicine. This field also includes many other methods, such as radiological treatment, diathermy, and hydrotherapy.

DRUG STANDARDS

The texts dealing with pharmaceutical preparations include the *United States Pharmacopeia and National Formulary (USP-NF)*, which provides standards for drugs of therapeutic usefulness and pharmaceutical necessity. Inclusion of drugs into this compendium is based on therapeutic effectiveness and popularity. The USP-NF provides tests for drug identity, quality, strength, and purity.

Drug Facts and Comparisons and the *Physicians' Desk Reference (PDR)* have multiple indexes of commercially available drugs. Both are used as advertising outlets for various drug manufacturers. A comprehensive description of each pharmaceutical preparation (including composition, action and use, administration and dosage, precautions and side effects, dosage forms available, and the common (generic) drug names) is provided in both publications. These two publications are used as references for in-depth information on pharmaceutical products by healthcare providers and pharmacy personnel.

Remington: The Science and Practice of Pharmacy is probably the most widely used text/reference in American pharmacies. It contains all areas relevant to the art/science of pharmacy. The *Pharmacological Basis of Therapeutics* (Goodman and Gilman) is a textbook of pharmacology, toxicology, and therapeutics. This work is known as the "blue bible" of pharmacology.

MEDICATION ADMINISTRATION

The quantity and frequency of a drug's administration to a patient depend on several factors, as does the method of that medication's administration. This section will cover some of the factors affecting dosage calculations and methods of administration.

Dosage

The amount of medication to be administered is referred to as the **dose**. The study of dosage and the criteria that influence it is called **posology**. The doses given in the *United States Pharmacopeia and National Formulary (USP-NF)* are average therapeutic doses and are known as “usual adult doses.” The following terms are used in connection with doses.

THERAPEUTIC DOSE.—Therapeutic dose is also referred to as the normal adult dose, the usual dose or average dose. It is the amount needed to produce the desired therapeutic effect. This therapeutic dose is calculated on an average adult of 24 years who weighs approximately 150 pounds.

DOSAGE RANGE.—Dosage range is a term that applies to the range between the minimum and maximum amounts of a given drug required to produce the desired effect. Many drugs (such as penicillin) require large initial doses that are later reduced to smaller amounts. Closely associated with “dosage range” are the terms **minimum dose** (the least amount of drug required to produce a therapeutic effect), **maximum dose** (the largest amount of drug that can be given without reaching the toxic effect), and **toxic dose** (the least amount of drug that will produce symptoms of poisoning).

MINIMUM LETHAL DOSE.—Minimum lethal dose is the least amount of drug that can produce death.

Factors Affecting Dosage

The two primary factors that determine or influence the dosage of a medication are the age and weight of the patient.

AGE.—Age is the most common factor that influences the amount of drug to be given. An infant requires a lower dose than an adult. Elderly patients may require a higher or lower dose than the average dose, depending upon the action of the drug and the condition of the patient.

The rule governing calculation of pediatric (child’s) doses, **Young’s Rule**, is expressed as follows:

$$\frac{\text{age in years}}{\text{age in years} + 12} \times \text{adult dose} = \text{child's dose}$$

The age in years of the child is the numerator, and the age plus 12 is the denominator. This fraction is multiplied by the normal adult dose.

Example: The adult dose of aspirin is 650 mg. What is the dose for a 3-year-old child?

$$\frac{3}{3 + 12} \times \frac{650 \text{ mg}}{15} = 130 \text{ mg}$$

WEIGHT.—In the calculation of dosages, weight has a more direct bearing on the dose than any other factor, especially in the calculation of pediatric doses. The rule governing calculation of pediatric doses based on weight is **Clark’s Rule**, expressed as follows:

$$\frac{\text{weight in pounds}}{150} \times \text{adult dose} = \text{child's dose}$$

The child’s weight in pounds is the numerator, and the average adult weight (150 pounds) is the denominator. This fraction is multiplied by the adult dose.

Example: The adult dose of aspirin is 650 mg. What is the dose for a child weighing 60 pounds?

$$\frac{60 \text{ lbs}}{150 \text{ lbs}} \times 650 \text{ mg} = 260 \text{ mg}$$

OTHER FACTORS THAT INFLUENCE DOSAGE.—Other factors that influence dosage include the following:

- **Sex**—Females usually require smaller doses than males.
- **Race**—Black individuals usually require larger doses, and Asians require smaller doses than Caucasians.
- **Occupation**—Persons working in strenuous jobs may require larger doses than those who sit at a desk all day.
- **Habitual use**—Some patients must take medications continuously, causing their bodies to build up tolerance to the drug. This tolerance may require larger doses than their initial doses to obtain the same therapeutic effect.
- **Time of administration**—Therapeutic effect may be altered depending upon time of administration (e.g., before or after meals).

- **Frequency of administration**—Drugs given frequently may need a smaller dose than if administered at longer intervals.
- **Mode of administration**—Injections may require smaller doses than oral medications.

Methods of Administering Drugs

Drugs may be introduced into the body in several ways, each method serving a specific purpose.

ORAL.—Oral administration of medications is the most common method. Among the advantages of administering medication orally (as opposed to other methods) are the following:

- Oral medications are convenient.
- Oral medications are cheaper.
- Oral medications do not have to be pure or sterile.
- A wide variety of oral dosage forms is available.

Oral medication administration may be disadvantageous for the following reasons:

- Some patients may have difficulty swallowing tablets or capsules.
- Oral medications are often absorbed too slowly.
- Oral medications may be partially or completely destroyed by the digestive system.

Other methods of administration closely associated with oral administration are **sublingual** and **buccal**. Sublingual drugs are administered by placing the medication under the tongue. The medication is then rapidly absorbed directly into the blood stream. An example of a sublingual drug is nitroglycerin sublingual tablets (for relief of angina pectoris).

Buccal drugs are administered by placing the medication between the cheek and gum. Buccal drugs, like sublingual drugs, are quickly absorbed directly into the blood stream. An example of a drug that may be given buccally is the anesthetic benzocaine.

PARENTERAL.—Parenteral medications are introduced by injection. All drugs used by this route must be pure, sterile, pyrogen-free (pyrogens are products of the growth of microorganisms), and in a liquid state. There are several methods of parenteral administration, including subcutaneous, intradermal, intramuscular, intravenous, and intrathecal or intraspinal.

Subcutaneous.—The drug is injected just below the skin's cutaneous layers. **Example:** Insulin.

Intradermal.—The drug is injected within the dermis layer of the skin. **Example:** Purified protein derivative (PPD).

Intramuscular.—The drug is injected into the muscle. **Example:** Procaine penicillin G.

Intravenous.—The drug is introduced directly into the vein. **Example:** Intravenous fluids.

Intrathecal or Intraspinal.—The drug is introduced into the subarachnoid space of the spinal column. **Example:** Procaine hydrochloride.

INHALATION.—Inhalation is a means of introducing medications through the respiratory system in the form of a gas, vapor, or powder. Inhalation is divided into three major types: vaporization, gas inhalation, and nebulization.

Vaporization.—Vaporization is the process by which a drug is changed from a liquid or solid to a gas or vapor by the use of heat (such as in steam inhalation).

Gas Inhalation.—Gas inhalation is almost entirely restricted to anesthesia.

Nebulization.—Nebulization is the process by which a drug is converted into a fine spray by the use of compressed gas.

TOPICAL.—Topical drugs are applied to a surface area of the body. Topically applied drugs serve two purposes:

- **Local effect:** The drug is intended to relieve itching, burning, or other skin conditions without being absorbed into the bloodstream.
- **Systemic effect:** The drug is absorbed through the skin into the bloodstream.

Examples of topical preparations are ointments, creams, lotions, and shampoos.

RECTAL.—Drugs are administered rectally by inserting them into the rectum. The rectal method is preferred to the oral route when there is danger of vomiting or when the patient is unconscious, uncooperative, or mentally incapable. Examples of rectal preparations are suppositories and enemas.

VAGINAL.—Drugs are inserted into the vagina to produce a local effect. Examples of vaginal preparations are suppositories, creams, and douches.

DRUG CLASSIFICATIONS

LEARNING OBJECTIVE: *Recall drug groups, the generic and trade names of drugs listed in each drug group, and recognize each drug's use.*

The definition of a drug is any chemical substance that has an effect on living tissue but is not used as a food. Drugs are administered to humans or animals as an aid in the diagnosis, treatment, or prevention of disease or other abnormal condition; for the relief of pain or suffering; and to control or improve any physiologic or pathologic condition. Drugs are classified according to set criteria and fall into three specific areas: general, chemical, and therapeutic.

- **General**—Drugs are grouped according to their source, whether animal, vegetable, or mineral in origin.
- **Chemical**—Drugs are grouped by their chemical characteristics.
- **Therapeutic (Pharmacological)**—Drugs are grouped according to their action on the body.

NOTE: Some drugs may have more than one action.

Drug Nomenclature

Drugs normally have three names: chemical, generic, and trade (brand).

- **Chemical name** relates to the chemical and molecular structure. An example is 2,4,7-triamino-6-phenylpteridine.
- **Generic name** is often derived from the chemical name. Generic name is the common name of the drug. An example is triamterene. (Note the underlining of the chemical name above.)
- **Trade name** is the proprietary name given by the manufacturer. Trade name is referred to as the brand name. An example is Dyrenium®, a brand of triamterene made by SmithKline Beecham.

Drug Groups

The types of drugs discussed in this chapter and the correlating drugs in common use described in

appendix IV are grouped according to pharmacological classes. Only a brief summary is possible here, and the Corpsman who desires a more complete description of each drug should refer to the *USP-NF, Drug Facts and Comparisons*, the *Physicians' Desk Reference*, or other drug reference books.

ASTRINGENTS.—Astringents are drugs that cause shrinkage of the skin and mucous membranes. Astringents are mainly used to stop seepage, weeping, or discharge from mucous membranes. (See appendix IV, page 1.)

EMOLLIENTS.—Emollients are bland or fatty substances that may be applied to the skin to make it more pliable and soft. They may also serve as vehicles for application of other medicinal substances. Emollients are available as ointments, creams, or lotions. (See appendix IV, page 1.)

EXPECTORANTS AND ANTITUSSIVES.—Expectorants and antitussives are commonly used in the symptomatic treatment of the common cold or bronchitis. (See appendix IV, page 1.) **Expectorants** are more accurately known as bronchomucotropic agents. These agents assist in the removal of secretions or exudate from the trachea, bronchi, or lungs. They act by liquefying viscid mucous or mucopurulent exudates. Therefore, they are used in the treatment of coughs to help expel these exudates and secretions. **Antitussives** are agents that inhibit or suppress the act of coughing. Other cold and allergy relief preparations are discussed later in this chapter.

NASAL DECONGESTANTS.—Nasal decongestants reduce congestion and the swelling of mucous membranes. They are used for the temporary relief of nasal congestion due to the common cold, nasal congestion associated with sinusitis, and to promote nasal or sinus drainage. Nasal decongestants are also used to relieve eustachian tube congestion. Nasal decongestants are often combined with antihistamines, antitussives, and expectorants to relieve the symptoms of colds, allergies, and sinusitis. Some of the more frequently used drug combinations are covered in appendix IV, page 2.

ANTI-HISTAMINES.—Antihistamines are used to counteract the physical symptoms that histamines cause. Histamine, a substance released by mast cells distributed in connective tissues usually near blood vessels, promotes some of the reactions associated with inflammation and allergies, such as asthma and hay fever. Antihistamines may cause drowsiness, so

patients should be warned against driving or operating machinery while taking this type of medication. (See appendix IV, page 2.)

HISTAMINE H₂ RECEPTOR ANTAGONISTS.—Histamine H₂ receptor antagonists block histamines that cause an increase of gastric acid secretion in the stomach. Histamine H₂ receptor antagonists are effective in preventing complications of peptic ulcer disease and alleviating symptoms of this disease. (See appendix IV, page 2.)

ANTACIDS.—Antacids are drugs used to counteract hyperacidity in the stomach. Normally, there is a certain degree of acidity in the stomach. An excess of acid can irritate the mucous membranes and is commonly known as indigestion, heartburn, or dyspepsia. In some disease states, the gastrointestinal tract may become excessively acidic (very low pH), causing diarrhea or leading to peptic ulcer formation. Antacids may interfere with the body's ability to use many drugs. For this reason, oral drugs normally should not be taken within 2 hours of taking an antacid. (See appendix IV, page 3.)

NOTE: It is important for you to be aware of the significance of the sodium content of most antacids, particularly for cardiac patients or patients on a low-sodium diet.

ANTISEPTICS, DISINFECTANTS, AND GERMICIDES.—These agents are primarily intended for the prevention of infections by destroying bacteria or preventing their growth. The differences among them are based primarily on degree of activity and how they are used. **Antiseptics** suppress the growth of microorganisms. **Germicides** kill susceptible organisms. **Disinfectants** are agents used to disinfect inanimate objects and are primarily germicidal in their action. All of these agents are for external use only, unless otherwise indicated. (See appendix IV, pages 3 and 4.)

SULFONAMIDES.—Sulfonamides were the first effective chemotherapeutic agents to be available in safe therapeutic dosage ranges. They were the mainstay of therapy of bacterial infections in humans before the introduction of the penicillins in 1941. Sulfonamides are synthetically produced and are effective against both gram-positive and gram-negative organisms. (See appendix IV, page 5.)

PENICILLINS.—Penicillin is one of the most important antibiotics. It is derived from a number of *Penicillium* molds commonly found on breads and fruits. The mechanisms of action for the penicillins is

the inhibition of cell wall synthesis during the reproductive phase of bacterial growth. It is one of the most effective and least toxic of the antimicrobial agents. (See appendix IV, page 5.)

CEPHALOSPORINS.—The cephalosporins are a group of semisynthetic derivatives of *cephalosporin C*, an antimicrobial agent of fungal origin. They are structurally and pharmacologically related to the penicillins. Because the cephalosporins are structurally similar to the penicillins, some patients allergic to penicillin may also be allergic to cephalosporin drugs. The incidence of cross-sensitivity is estimated to be 5 to 16 percent.

This family of antibiotics is generally divided into generations:

- First generation — cefazolin sodium (Ancef®), Kefzol®)
- Second generation — cefoxitin sodium (Mefoxin®)
- Third generation — cefotaxime sodium (Claforan®)

The main differences among the groups is the change in the antibacterial spectrum. The third generation agents have a much broader gram-negative spectrum than the earlier generations.

Examples of various cephalosporins are listed in appendix IV, page 6.

TETRACYCLINES.—Tetracyclines, introduced in 1948, were the first truly broad-spectrum antibiotics. They include a large group of drugs with a common basic structure and chemical activity. The most important mechanism of action of the tetracyclines is the blocking of the formation of polypeptides used in protein synthesis. Because of their broad spectrum of activity, tetracyclines are most valuable to treat mixed infection, such as chronic bronchitis and peritonitis; however, they are drugs of choice for only a few bacterial infections. Tetracycline is also used as a topical preparation to treat acne.

The tetracyclines are relatively nontoxic, the most common side effects being mild gastrointestinal disturbances. Allergic reactions and anaphylaxis are rare. Administration to children and pregnant women is not indicated because it may produce discoloration of the teeth and depress bone marrow growth. The major hazard of tetracycline therapy is the overgrowth of resistant organisms, especially *Candida* and staphylococci.

Tetracyclines should not be administered with milk, milk products, antacids or iron preparations; they combine with metal ions to form nonabsorbable compounds.

Examples of tetracyclines in common use are listed in appendix IV, page 6.

AMINOGLYCOSIDES.—Aminoglycosides are a group of drugs that share chemical, antimicrobial, pharmacologic, and toxic characteristics, and that are effective against most gram-positive and gram-negative organisms. Their method of action is by inhibiting protein synthesis. Aminoglycosides can cause varying degrees of ototoxicity and nephrotoxicity, depending on the particular agent and the dose. Toxicity is more prevalent in the very young or old, in the presence of renal impairment or dehydration, or with the use of diuretics. Because of their high toxicity, aminoglycosides are not recommended when the infective organism is susceptible to less toxic preparations.

Examples of several aminoglycosides are listed in appendix IV, page 7.

MACROLIDES.—Macrolide antibiotics constitute a large group of bacteriostatic agents that inhibit protein synthesis. They are effective against gram-positive cocci, *Neisseria*, *Hemophilus*, and mycobacteria. All are similar to penicillin in their antibacterial spectra, and are often used in patients who are sensitive to penicillin. (See appendix IV, pages 7 and 8.)

ANTIFUNGALS.—Antifungal agents inhibit or suppress the growth systems of fungi, dermatophytes, or *Candida*. Antifungals have not been developed to the same degree as antibacterial agents. Most fungi are completely resistant to the action of chemicals at concentrations that can be tolerated by the human cell. Since there are only a few available for internal use, most antifungal agents are topical. The antifungal agents that are available for systemic use generally produce hepatic or renal dysfunction or other serious side effects. Because of these side effects, systemic antifungals should be limited to serious or potentially fatal conditions. Therapy that includes topical preparations may be provided in conjunction with oral or parenteral antifungal agents.

Examples of several antifungal agents are listed in appendix IV, page 8.

ANTIPARASITICS.—Antiparasitics are agents that are destructive to parasites. Parasitic infections or infestations account for the largest number of chronic

disabling diseases known. They are especially prevalent in the tropics or subtropics and in lesser-developed countries where overcrowding and poor sanitation exist. Parasitic infections include protozoal infections (malaria, amebiasis, and to a lesser extent, trichomoniasis), helminthic infections (intestinal worms), and **ectoparasites**. Ectoparasites, such as head lice and crab lice, although not disabling, are considered a nuisance and can transmit disease.

Examples of antiparasitics in common use are listed in appendix IV, page 9.

LAXATIVES.—Laxatives are drugs that facilitate the passage and elimination of feces from the colon and rectum. They are indicated to treat simple constipation and to clean the intestine of any irritant or toxic substances (catharsis). Laxatives may also be used to soften painfully hard stools and to lessen straining of certain cardiac patients when defecating. They are contraindicated in certain inflammatory conditions of the bowel, bowel obstruction, and abdominal pain of unknown origin, and should not be used in the presence of nausea and vomiting. Laxatives are classified as irritant, bulk, emollient, or stool softeners. Frequent or prolonged use of any laxative may result in dependence. (See appendix IV, pages 9 and 10.)

ANTIDIARRHEALS.—Antidiarrheals are drugs that are effective in combating diarrhea. Diarrhea is defined as an abnormal frequency and liquidity of fecal discharge. This condition may result from food poisoning, parasitic infestation of the bowel, and gastrointestinal diseases. (See appendix IV, page 10.)

DIURETICS.—The kidney is the primary organ that excretes water-soluble substances (urine) from the body. Diuretics are agents that increase the rate of urine formation. These agents are useful in treating hypertension and edematous conditions, such as congestive heart failure and acute pulmonary edema. However, loss body fluids due to use of diuretics can seriously deplete electrolytes from the system, and care should be taken to monitor and replenish lost sodium and potassium through diet and supplement therapy. (See appendix IV, page 10 and 11)

NON-NARCOTIC ANALGESICS, ANTI-PYRETICS, AND ANTI-INFLAMMATORY AGENTS.—**Non-narcotic analgesics** are drugs that relieve pain without producing unconsciousness or impairing mental capacities. **Antipyretics** relieve or reduce fevers. **Anti-inflammatory agents** counteract or suppress inflammation or the inflammatory process. Many of the drugs discussed in appendix IV, page 11, were developed with two or more of these properties.

CENTRAL NERVOUS SYSTEM STIMULANTS.—Certain drugs stimulate the activity of various portions of the central nervous system (CNS). The *Manual of the Medical Department* (MANMED) is explicit as to the usage of these drugs in the Navy. Primary indications for this class of drugs are narcolepsy, hyperkinesia, and attention deficit disorders in children. Central nervous system stimulants are generally contraindicated in patients with hypertension, arteriosclerosis, symptomatic cardiovascular disorders, agitated states, glaucoma, or history of drug abuse. (See appendix IV, page 12.)

CENTRAL NERVOUS SYSTEM DEPRESSANTS.—Central nervous system (CNS) depressants range in depressive action from mild sedation to deep coma, differing mainly in rapidity, degree, and duration of action. Any of these CNS depressants may, in sufficient doses, cause respiratory depression. Alcohol use while taking CNS depressants should be avoided. Many of the central nervous system depressants are controlled medications. Refer to the MANMED for control, custody, and accountability guidelines for controlled substances.

Barbiturates comprise a widely used group of CNS depressants. They are used mainly as sedative-hypnotics, anticonvulsants, anesthetics for short anesthesia, and may be used in combination with analgesics to enhance their analgesic effect.

NOTE: Barbiturates may be habit forming.

See appendix IV, page 12, for examples of central nervous system depressants.

OPIUM AND OPIUM ALKALOIDS.—The activity of opium is primarily due to its morphine content. The major medical use of opium has been for its antiperistaltic activity, particularly in diarrhea. Opium alkaloids, e.g., morphine and codeine, have replaced opium in medical use. Members of this drug group are used as analgesics, cough sedatives, and for certain types of diarrhea. (See appendix IV, pages 12 and 13.)

NOTE: Warn patients taking opium or opium alkaloids that drowsiness, dizziness, and blurring of vision may occur. For this reason, they should not drive or perform other tasks that require alertness. Also, caution patients against consuming alcohol and other CNS depressants. Patients should notify their physician immediately if shortness of breath or difficulty in breathing occurs.

PSYCHOTHERAPEUTIC AGENTS.—Tranquilizers and mood modifiers are the two primary groups of psychotherapeutic agents. Psychotherapeutic agents are classified as **major tranquilizers**, **minor tranquilizers**, and **mood modifiers**. The mood modifiers have replaced amphetamines as treatment of choice for depressive states. (See appendix IV, pages 13 and 14.)

SKELETAL MUSCLE RELAXANTS.—Skeletal muscle relaxants are used in connection with the treatment of muscle spasm due to various conditions. They may also be used to produce muscular relaxation during surgical anesthesia. Skeletal muscle relaxants may cause drowsiness and impair performance of tasks that require alertness. (See appendix IV, page 14.)

CARDIOVASCULAR AGENTS.—Cardiovascular agents affect the action of the circulatory system. Most of these agents are highly specialized. (See appendix IV, pages 14 and 15.)

VASOCONSTRICTORS.—Vasoconstrictors produce constriction of the blood vessels with consequent rise in blood pressure. (See appendix IV, page 15.)

ANTICOAGULANTS.—Anticoagulants delay or prevent blood coagulation. Before an anticoagulant agent is prescribed and its dosage determined, laboratory testing of the patient's blood-clotting capabilities should be performed.

Examples of commonly used anticoagulants are listed in appendix IV, page 15.

VITAMINS.—Vitamins are unrelated organic substances that occur in many foods and are necessary for the normal metabolic functioning of the body. Vitamins may be **water-soluble** or **fat-soluble**. The majority of vitamins are water-soluble. Water-soluble vitamins are excreted in the urine and are not stored in the body in appreciable quantities. The fat-soluble vitamins (A, D, E, and K) are soluble in fat solvents and are absorbed along with dietary fats. Fat-soluble vitamins are not normally excreted in the urine and tend to be stored in the body in moderate amounts.

See appendix IV, page 16, for a listing of several of the major vitamins and their respective properties.

GENERAL AND LOCAL ANESTHETICS.—Generally speaking, anesthesia means “without feeling.” Consequently, we apply the word to drugs that produce insensibility to pain. The field of anesthesia is a highly specialized one.

General anesthetics are usually gas or vapor and are administered by inhalation. Anesthesiology is a highly specialized field, and the administration of a general anesthetic should never be undertaken without the supervision of a medical officer. There may be times, however, when you, as a Hospital Corpsman, are called upon to assist by administering general anesthesia. You should, therefore, acquaint yourself with the most commonly used general anesthetics and their respective properties.

Local anesthetics produce loss of sensation to pain in a specific area or locality of the body, without loss of consciousness or mental capacity. The majority of these drugs are administered parenterally or topically.

See appendix IV, pages 17 and 18, for a listing of several of the most commonly used anesthetics.

OXYTOCICS.—Oxytocics are drugs that produce a rhythmic contraction of the uterus. Their action is selective for the uterus, although other smooth muscles are affected. (See appendix IV, page 18.)

Biological Agents

Biological agents are prepared from living organisms or their products. The chief purpose served by these preparations in the Navy is the immunization of personnel against infectious disease. They may, however, be used in the treatment of disease or act in a diagnostic capacity. Dosage and routes of administration are described in BUMEDINST 6320.1.

Biologicals include serums, viruses, toxins, antitoxins, antigens, and bacterial vaccines.

Manufacturers of these products must be licensed by the Secretary of the Treasury. Their products are monitored by the U.S. Public Health Service.

The label that must be placed on each package will bear the name, address, and license number of the manufacturer. It will also list the name of the product, lot number, date of manufacture (or expiration), period of potency, and the minimum potency (or the fact that there is no standard of potency).

FACTORS TO BE REMEMBERED CONCERNING BIOLOGICALS.—Most immunizing agents that are used in routine procedures may be obtained through normal supply channels. (Yellow fever vaccine must be ordered from activities that have been designated as supply points for this biological.) Biologicals must be stored in a cool, dry, and

preferably dark place. (Yellow fever vaccine must be maintained in a frozen state until prepared for use.) All biological products should be examined periodically, and a thorough examination for deterioration will be held immediately preceding their use.

EXAMINATIONS OF PARENTERAL SOLUTIONS.—Solutions are examined at least three times at the activity at which they are ultimately used:

1. Upon receiving the solution.
2. Periodically while in storage.
3. Immediately preceding use. Parenteral solutions, unless the label states otherwise, must be free of turbidity or undissolved material. All solutions should be inverted and gently swirled to bring any sediment or particulate matter into view. A well-illuminated black or white background will facilitate this examination.

Parenteral solutions may be unfit for use because of

- deterioration from prolonged storage,
- accidental contamination occurring upon original packaging, or
- defects that may develop in containers or seals.

There is no set rule that can be applicable in regards to any of these factors. Therefore, to ensure suitability for use, a regimented program of inspection is necessary.

IMMUNIZING AGENTS.—Following is a descriptive list of the most common immunizing agents used by the U.S. armed forces to inoculate military personnel against disease.

Diphtheria Antitoxin.—Diphtheria antitoxin is a transparent or slightly opalescent liquid, nearly colorless, and has a very slight odor due to its preservative. It is a sterile solution of antitoxic substances obtained from the blood serum or plasma of a healthy horse immunized against diphtheria toxin.

Tetanus Antitoxin.—Tetanus antitoxin is a sterile solution of antitoxic substances that are usually obtained from the blood serum or plasma of a healthy horse that has been immunized against tetanus toxin or toxoid. Tetanus antitoxin contains not more than 0.4 percent cresol or 0.5 percent phenol as a preservative. It is slightly opalescent with a yellow, brown, or greenish color, depending upon the manufacturer. There will be a slight odor of the preservative used.

Tetanus Toxoid.—Tetanus toxoid is a sterile solution of the growth of the tetanus bacillus,

Clostridium tetani, which has been treated with formaldehyde. It is a brownish yellow or slightly turbid liquid, usually having the distinctive odor of formaldehyde.

Alum Precipitated Diphtheria and Tetanus Toxoids and Pertussis Vaccines Combined (DPT).— This is a markedly turbid, whitish liquid. It is nearly odorless or may have a slight odor of the preservative. It is a sterile suspension of the precipitate obtained by treating the mixture of diphtheria toxoid, tetanus toxoid, and pertussis vaccine with alum and combining in such proportions as to ensure an immunizing dose of each in the total dosage as listed on the label.

Cholera Vaccine.—Cholera vaccine is a suspension of killed cholera, *Vibrio comma*, in a suitable diluent, usually normal saline. The vaccine presents a turbid appearance, and there may be a slight odor due to the preservative. On storage, autolysis may occur so that the vaccine may become almost as clear as water.

Poliovirus Vaccine.—There are two kinds of polio vaccine: Inactivated poliovirus vaccine (IPV), which is the shot recommended in the United States today, and a live, oral polio vaccine (OPV), which consists of drops that are swallowed. Until recently, OPV was recommended for most children in the United States. OPV helped us rid the country of polio, and it is still used in many parts of the world.

Both vaccines give immunity to polio, but OPV is better at keeping the disease from spreading to other people. However, for a few people (about one in 2.4 million), OPV actually causes polio. Since the risk of getting polio in the United States is now extremely low, experts believe that using oral polio vaccine is no longer worth the slight risk, except in limited circumstances.

Inactivated poliovirus vaccine (IPV) must be stored between 2°C and 8°C (24°F and 46°F). The vaccine is clear and colorless, and it should be administered intramuscularly or subcutaneously.

ORAL POLIOVIRUS VACCINE MUST NEVER BE ADMINISTERED PARENTERALLY. To maintain potency, OPV must be stored in the freezer compartment of the refrigerator. It should be noted that certain forms of this vaccine will remain fluid at temperatures above -14°C. If frozen, after thawing, agitate the vaccine to ensure homogeneity of its contents before use. Once the temperature rises above 0°C, the vaccine **MUST BE USED WITHIN 7 DAYS**. During this period, it must be stored below 10°C.

Yellow Fever Vaccine.—This vaccine is a dull, light orange, flaky or crust-like desiccated mass that requires rehydration immediately before use. It must be stored at or below 0°C until rehydration is effected with sterile sodium chloride injection USP.

Plague Vaccine.—The vaccine for plague is a sterile suspension of killed plague bacilli in an isotonic solution. The strain of bacilli used has been selected for its high antigenic efficiency. The vaccine is a turbid, whitish liquid with little or no odor. The presence of any precipitate is reason to suspect contamination.

Influenza Virus Vaccine.—The influenza virus vaccine is prepared from the allantoic fluid of incubated fertile hen eggs. It is a slightly hazy fluid, the result of minute amounts of egg protein. Its color varies from gray to very faint red, depending upon the method of manufacture.

The duration of immunity is probably no longer than a few months, which necessitates repeating the inoculation before the expected seasonal occurrence.

Do not inoculate individuals who are known to be sensitive to eggs or egg products, or personnel suffering from upper respiratory infections.

Dried Smallpox Vaccine.—This vaccine is prepared directly from calf lymph, purified, concentrated, stabilized, and dried by lyophilization. Dried smallpox vaccine is much more stable than the conventional liquid. When stored at or below 25°C, it retains its full potency for 18 months. When reconstituted and stored below 4°C (preferably 0°C), it retains its full potency for 3 months.

Smallpox is no longer considered to be a threat to world health, and immunizations against it are no longer required. However, a general knowledge of the disease and its prevention is important.

Anthrax Vaccine.—The anthrax vaccine for humans licensed for use in the United States is a cell-free filtrate vaccine (using dead as opposed to live bacteria). Inspect the vaccine visually for particulate matter and discoloration before administration. Anthrax vaccine should be stored between 2°C and 8°C (refrigerator temperature); it must not be frozen. Do not use the vaccine if the expiration date listed on the package has expired.

The vaccine should be administered only to healthy men and women from 18 to 65 years of age. It should **NOT** be administered to pregnant women.

The immunization consists of three subcutaneous injections given 2 weeks apart, followed by three additional subcutaneous injections given at 6, 12, and 18 months. Annual booster injections of the vaccine are required to maintain immunity.

TOXICOLOGY

LEARNING OBJECTIVE: *Identify how poisons are introduced into the body and the factors that affect their toxicity.*

Toxicology is the science of poisons, their actions, their detection, and the treatment of the conditions produced by them. A **poison** is a substance that, when inhaled, swallowed, absorbed, applied to the skin, or injected into the body in relatively small amounts, may cause damage to structures or disturbances of function. Poisons act by changing the normal metabolism of cells or by actually destroying them.

The effects of poisons may be local or remote, and in some instances, poisons can produce both effects. A **local effect** is produced when a poison only affects the area in which it is applied. A **remote effect** is produced when a poison affects parts of the body that are remote to the site of application or point of introduction. Poisons sometimes show no effect—or only a slight effect—until several doses have been taken. Then, suddenly, an effect is produced that nearly equals that produced by taking the whole amount at one time. This is known as a **cumulative effect**.

The toxicity of poisons depends upon their method of introduction into the body and how fast they are absorbed by the body. For example, snake venom taken into the mouth or into the stomach during first aid treatment of snakebite is not ordinarily harmful, but snake venom injected parenterally is extremely poisonous.

Various conditions affect an individual's reaction and susceptibility to poisons. For instance, some individuals by nature are unusually sensitive to certain poisons (such as venom from bee stings), while others possess a natural tolerance. Additionally, the age of the victim can affect the severity of the poisoning. Young children, for example, are normally more susceptible to poisons than adults. Habitual use of certain poisons, such as narcotics, may cause individuals to become accustomed to a poison's effects, even though the amount taken by these

individuals would ordinarily be considered lethal. This habitual use of poisons, however, may result in a sudden hypersensitivity that could be deadly. The actions of poisons may also be considerably modified by disease, some diseases increasing and others lessening the action of poisons.

Poisons are eliminated from the body by way of the kidneys, liver, gastrointestinal tract, and skin. Poisons are eliminated either unchanged or in the form of other compounds. These compounds are the result of chemical changes made in various body organs and tissues.

For a more in-depth understanding of the various types of poisoning and their emergency treatment procedures, see chapter 5, "Poisoning, Drug Abuse, and Hazardous Material Exposure."

PHARMACY

LEARNING OBJECTIVE: *Recall the various pharmaceutical weight and measurement systems, and determine medication dosage by using the conversion process or the percentage and ratio calculations.*

As you progress in your career as a Hospital Corpsman, you will be assigned duties in specialized departments throughout the hospital and especially aboard ship. Not only will your responsibilities increase, but your training will become more and more diversified.

One of the departments to which you may be assigned is the pharmacy, where you will assist in preparing and dispensing medicines. This section will give you a basic introduction to the field of pharmacy and help prepare you for these responsibilities.

METROLOGY AND CALCULATION

Metrology, called the arithmetic of pharmacy, is the science of weights and measures and its application to drugs, their dosage, preparation, compounding, and dispensing.

It is absolutely vital for Hospital Corpsmen to thoroughly understand the principles and applications of metrology in pharmacy. Errors in this area endanger the health—even the life—of the patient.

The Metric System

The metric system is the official system of weights and measures used by Navy Pharmacy Departments for weighing and calculating pharmaceutical preparations. The metric system is becoming the accepted system throughout the world. Hospital Corpsmen need to be concerned primarily with the divisions of weight, volume, and linear measurement of the metric system. Each of these divisions has a primary or basic unit and is listed below:

- Basic unit of weight is the **gram**, abbreviated “g”
- Basic unit of volume is the **liter**, abbreviated “l”
- Basic linear unit is the **meter**, abbreviated “m”

By using the prefixes **deka**, **hecto**, and **kilo** for multiples of, respectively, ten, one hundred, and one thousand basic units, and the prefixes **micro**, **milli**, **centi**, and **deci** for one-ten thousandth, one- thousandth, one-hundredth, and one-tenth, respectively, you have the basic structure of the metric system. By applying the appropriate basic unit to the scale of figure 6-1, you can readily determine its proper terms. For example, using the gram as the basic unit of weight, we can readily see that 10 g equals 1 dekagram, 100 g equals 1 hectogram, and 1000 g is referred to as a kilogram. Conversely, going down the scale, 0.1 g is referred to as a decigram, 0.01 g is called a centigram, and 0.001 g is a milligram.

The Apothecary System

Although fast becoming obsolete, the apothecary system for weighing and calculating pharmaceutical

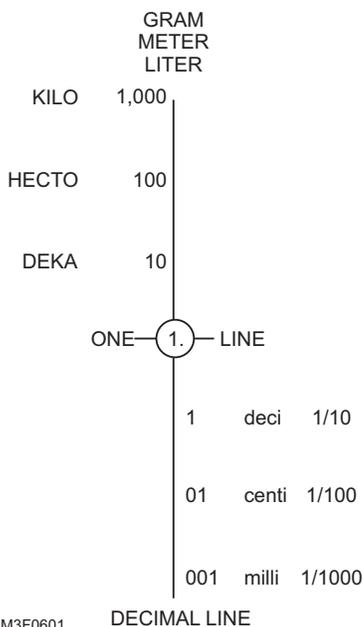


Figure 6-1.—Graph comparing the metric system with the decimal equivalent.

preparations is still used and must be taken into consideration. It has two divisions of measurement: weight and volume. In this system, the basic unit of weight is the **grain** (abbreviated “gr”), and the basic unit of volume is the **minim** (abbreviated “m”).

The Avoirdupois System

The avoirdupois system is a system used in the United States for ordinary commodities. The basic units of the avoirdupois system are dram (27.344 grains), ounce (16 drams), and pound (16 ounces).

Table of Weights and Measures

See table 6-1, a table of weights and measures; study it thoroughly.

Converting Weights and Measures

Occasionally, there are times when it will be necessary to convert weights and measures from one system to another, either metric to apothecary or vice versa. Since patients can hardly be expected to be familiar with either system, always translate the dosage directions on the prescription into a household equivalent that they can understand. Household measurements are standardized, on the assumption that the utensils are common enough to be found in any home. Table 6-2 is a table of household measures, with their metric and apothecary equivalents.

CAUTION: For the conversion of specific quantities in a prescription or in converting a pharmaceutical formula from one system to another, exact equivalents must be used.

CONVERSION

As stated earlier, in the practice of pharmacy it may be necessary to convert from one system to another to dispense in their proper amounts the substances that have been ordered. Although the denominations of the metric system are not the same as the common systems, the Bureau of International Standards has established conversion standards that will satisfy the degree of accuracy required in almost any practical situation. Ordinary pharmaceutical procedures generally require something between two- and three-figure accuracy, and the following tables of conversion (tables 6-3 and 6-4) are more than sufficient for practical use. Naturally, if potent agents are involved, you must use a more precise conversion factor for purposes of calculation.

Table 6-1.—Measuring Equivalents

Systems of Weights	Systems of Volume Measures	Linear Measure
AVOIRDUPOIS		
Primary unit of weight is the grain.		
437.5 grains = 1 ounce (av. oz.)		
16.0 ounces = 1 pound (av. lb.)		
<hr/>		
APOTHECARY	APOTHECARY	
Primary unit of weight is the grain.		
20 grains (gr) = 1 scruple (℥)	60 minims (m) = 1 fluid dram (ʒ)	
3 scruples = 1 dram (ʒ)	8 fluid drams = 1 fluid ounce (ʒ)	
8 drams (480 gr) = 1 ounce (ʒ)	16 fluid ounces = 1 pint (0)	
12 ounces = 1 pound (lb)	2 pints = 1 quart (qt.)	
	4 quarts = 1 gallon (Cong. or gal.)	
<hr/>		
METRIC	METRIC	METRIC
Primary unit of weight is the gram.		
1000.000 grams = 1 kilogram (kg)	Primary unit of volume is the liter.	
100.000 grams = 1 hectogram (hg)	1000.000 liters = 1 kiloliter (kl)	
10.000 grams = 1 dekagram (dkg)	100.000 liters = 1 hectoliter (hl)	
1.000 gram = 1 gram (gm)	10.000 liters = 1 dekaliter (dkl)	
0.1 gram = 1 decigram (dg)	1.000 liter = 1 liter (l)	
0.01 gram = 1 centigram (cg)	0.1 liter = 1 deciliter (dl)	
0.001 gram = 1 milligram (mg)	0.01 liter = 1 centiliter (cl)	
	0.001 liter = 1 milliliter (ml)	
	Primary unit of linear measure is the meter.	
	1000.000 meters = 1 kilometer (km)	
	100.000 meters = 1 hectometer (hm)	
	10.000 meters = 1 dekameter (dkm)	
	1.000 meter = 1 meter (m)	
	0.1 meter = 1 decimeter (dm)	
	0.01 meter = 1 centimeter (cm)	
	0.001 meter = 1 millimeter (mm)	

NOTE: The relationship of the basic units in the Metric System should be noted. The meter, which is 1/40,000,000 of the earth's polar circumference, is the natural standard. The volume contained in 1/10 of a meter cubed is 1 liter. The weight of 1 cubic centimeter of distilled water is 1 gram. Grams of water are approximately equivalent at all temperature ranges. Current usage prefers that ml rather than cc be used since it has been found that 1000 cc do not equal exactly 1 liter.

Table 6-2.—Table of Metric Doses with Approximate Equivalents

Metric	Apothecary	Household
5 ml	1 fl dr	1 teaspoonful*
10 ml	2 fl dr	1 dessertspoonful
15 ml	4 fl dr	1 tablespoonful (½ fl oz)
30 ml	8 fl dr	2 tablespoons (1 fl oz)
60 ml	2 fl oz	1 wineglassful
120 ml	4 fl oz	1 teacupful
240 ml	8 fl oz	1 tumblerful
480 ml	16 fl oz	1 pint
960 ml	32 fl oz	1 quart
*Official U.S.P. teaspoonful is 5 ml.		

Table 6-3.—Conversion Table for Weights and Liquid Measures

Conversion Table for Weights and Liquid Measures
1 grain = 0.065 gram or 65 milligrams
1 gram = 15.432 grains
1 milliliter = 16.23 minims
1 fluid ounce = 29.57 milliliters

Table 6-4.—Examples of Weight and Liquid Conversions

Examples of Weight and Liquid Conversions	
gr to g	gr/15.432 = g
ml to fl oz	ml/29.57 = fl oz
minims to ml	minims/16.23 = ml
mg to gr	mg/65 = gr
g to gr	g x 15.432 = gr
fl oz to ml	fl oz x 29.57 = ml
ml to minims	ml x 16.23 = minims
gr to mg	gr x 65 = mg

PERCENTAGE CALCULATIONS

Percentage means “parts per hundred” or the expression of fractions with denominators of 100. Thus, a 10 percent solution may be expressed as 10%, 10/100, 0.10, or 10 parts per 100 parts.

It is often necessary for the pharmacist to compound solutions of a desired percentage strength. Percentage in that respect means **parts of active ingredient per 100 parts of total preparation.**

Following are the three basic rules to remember in solving percentage problems:

- To find the amount of the active ingredient when the percentage strength and the total quantity are known,** multiply the total weight or volume by the percent (expressed as a decimal fraction).

Example: Substance X contains 38% fat. How many grams of fat are required to prepare 120 g of substance X?

Solution: 38% is expressed as a decimal fraction (0.38) and multiplied by the amount of the finished product required.

$$\begin{array}{r}
 120 \text{ g} \\
 \times .38 \\
 \hline
 960 \\
 360 \\
 \hline
 45.60 \text{ g, the weight of fat needed.}
 \end{array}$$

2. **To find the total quantity of a mixture when the percentage strength and the amount of the active ingredient are known**, divide the weight or volume of the active ingredient by the percent (expressed as a decimal fraction).

Example: If a mixture contains 20% of substance Y, how many grams of the 20% mixture would contain 8 g of Y?

Solution: 20% is expressed as a decimal fraction (0.20). Divide the weight (8 g) by the percent, thus:

$$\begin{array}{r} \underline{40.0} \text{ g,} \\ .20 \text{) } 8.00 \\ \underline{80} \\ 00 \end{array} \quad \begin{array}{l} \text{the weight of 20\%} \\ \text{mixture that would} \\ \text{contain 8 g of} \\ \text{substance Y.} \end{array}$$

3. **To find the percentage strength when the amount of the active ingredient and the total quantity of the mixture are known**, divide the weight or volume of the active ingredient by the total weight or volume of the mixture. Then multiply the resulting answer by 100 to convert the decimal fraction to percent.

Example: Find the percentage strength of Z if 300 g of a mixture contains 90 g of substance Z.

Solution:

$$\begin{array}{r} \underline{0.3} \text{ g,} \\ 300 \text{) } 90.00 \\ \underline{90} \\ 00 \end{array} \quad \begin{array}{l} \text{is the percent of Z} \\ \text{expressed as a decimal} \\ \text{fraction} \end{array}$$

$$0.3 \times 100(\%) = \mathbf{30\%} \text{ of Z in the mixture}$$

ALTERNATE METHODS FOR SOLVING PERCENTAGE PROBLEMS

The alternate method for solving percentage problems, illustrated below, incorporates the three rules discussed above into one equation. This method is often preferred since it eliminates errors that may result from misinterpreting the values given in the problem.

$$\% \text{ strength} = \frac{\text{Amt of active ingredient} \times 100(\%)}{\text{Total amt of preparation}}$$

Example #1: Calculate the percent of A in a solution if 120 g of that solution contains 6 g of A.

Solution: Substitute the known values in the equation and use X for the percent (the unknown factor).

$$X = 6/120 \times 100(\%) = 5 (\%)$$

Therefore, **X = 5**, which is the percent strength of the solution.

Example #2: Calculate the amount of active ingredient in 300 g of a 5% mixture of active ingredient B.

Solution: Convert 5% to a decimal fraction (0.05). Substitute the known values in the equations, and use X for the amount of the unknown ingredient .

$$0.05 = X/300 \qquad \mathbf{X = 15 \text{ g}}$$

A variation of the alternate percentage equation, illustrated below, uses “parts per hundred” instead of percent, with X used as the unknown.

$$\frac{\text{Amt of active ingredient}}{\text{Amt of total preparation}} = \frac{\text{Parts of active ingredient}}{100 \text{ parts (total mixture)}}$$

Example: Ascertain the percent B in a mixture of 600 g that contains 15 g of B.

Solution:

$$\frac{15}{600} = \frac{X}{100} \qquad \qquad \qquad 600X = 1500$$

$$X = \frac{1500}{600}$$

$$X = \mathbf{2.5}, \text{ the parts of active ingredient} \\ \text{per 100 parts of total mixture, or} \\ \mathbf{2.5\%}$$

RATIO AND PROPORTION CALCULATIONS

Ratio is the relationship of one quantity to another quantity of like value. Example ratios are 5:2, 4:1. These ratios are expressed as “5 to 2” and “4 to 1,” respectively. A ratio can exist only between values of the same kind, as the ratio of percent to percent, grams to grams, dollars to dollars. In other words, the denominator must be constant.

Proportion is two equal ratios considered simultaneously. An example proportion is

$$1:3::3:9$$

This proportion is expressed as “1 is to 3 as 3 is to 9.” Since the ratios are equal, the proportion may also be written $1:3 = 3:9$

Terms of Proportion

The first and fourth terms (the terms on the ends) are called the **extremes**. The second and third terms (middle terms) are called the **means**.

In a proportion, the product of the means equals the product of the extremes; therefore, when three terms are known, the fourth (or unknown) term may be determined.

Application of Proportion

The important factor when working proportions is to put the right values in the right places within the proportion. By following a few basic rules, you can accomplish this without difficulty and solve the problem correctly.

In numbering the four positions of a proportion from left to right (i.e., first, second, third, and fourth, observe the following rules):

- Let X (the unknown value) always be in the fourth position.
- Let the unit of like value to X be the third position.
- If X is smaller than the third position, place the smaller of the two leftover values in the second position; if X is larger, place the larger of the two values in the second position.
- Place the last value in the first position. When the proportion is correctly placed, multiply the extremes and the means and determine the value of X, the unknown quantity.

Example #1: What is the percent strength of 500 ml of 70% alcohol to which 150 ml of water has been added?

Solution: When adding 150 ml to 500 ml, the total quantity will be 650 ml; consequently, our four values will be **500 ml**, **650 ml**, **70%**, and **X** (the unknown percent). Following the rules stated above, the problem will appear as follows:

$$\begin{array}{ll} 4^{\text{th}} \text{ position:} & X (\%) \\ 3^{\text{rd}} \text{ position:} & 70\% \text{ (like value to X)} \end{array}$$

When we add water to a solution, the strength is diluted; consequently, the 70% strength of this solution will be lessened when we add the extra 150 ml of water. Therefore, of the two remaining given quantities (650 ml and 500 ml), the smaller (500 ml) will be placed in the second position, leaving the quantity 650 ml to be placed in the first position:

$$\begin{array}{ll} 2^{\text{nd}} \text{ position:} & 500 \text{ ml} \\ 1^{\text{st}} \text{ position:} & 650 \text{ ml} \end{array}$$

The proportion appears as follows:

$$650 : 500 :: 70 : X$$

Multiplying the extremes and the means, we arrive at:

$$650X = 35,000, \text{ or } X = 53.8$$

When 150 ml of water is added to 500 ml of 70% alcohol, the result is 650 ml of 53.8% solution.

Example #2: When 1000 ml of 25% solution is evaporated to 400 ml, what is the percent strength?

Solution:

$$\begin{array}{ll} 4^{\text{th}} \text{ position:} & X(\%) \\ 3^{\text{rd}} \text{ position:} & 15\% \text{ (like value to X)} \end{array}$$

When we evaporate a solution, it becomes stronger. Therefore, the larger of the two remaining given values (1000 ml and 400 ml), will be placed in the second position, leaving the quantity 400 ml to be placed in the first position:

$$\begin{array}{ll} 2^{\text{nd}} \text{ position:} & 1000 \text{ ml} \\ 1^{\text{st}} \text{ position:} & 400 \text{ ml} \end{array}$$

The proportion appears as follows:

$$400 : 1000 :: 15 : X$$

Multiplying the extremes and the means, we arrive at:

$$400X = 25,000, \text{ or } X = 62.5$$

When 1000 ml of water is evaporated to 400 ml, the result is a 62.5% solution.

Ratio Solutions

Ratio solutions are usually prepared in strengths as follows: 1:10, 1:150, 1:1000, 1:25000, etc., using even numbers to simplify the calculations. When a solution is made by this method, the first term of the ratio expresses the part of the solute (the substance dissolved in a solvent), while the second term expresses the total amount of the finished product.

Rules for solving ratio-solution problems are as follows:

W/W (weight/weight) solution: Divide the total weight (grams) of solution desired by the larger number of the ratio, and the quotient will be the number of grams of the solute to be used.

Example: How many grams of KMNO_4 are needed to make 500 g of a 1:2000 solution?

Solution:

$$500 \div 2000 = 0.25 \text{ g of drug needed}$$

$$500 - 0.25 = \underline{499.75} \text{ g of solvent needed}$$

$$500.00 \text{ g total solution}$$

W/V (weight/volume) solution: Divide the total volume (in milliliters) of solution desired by the larger number of the ratio, and the quotient will be the number of grams of the solute needed.

Example: How many grams of bichloride of mercury are needed to prepare 500 ml of a 1:1000 solution?

Solution:

$$500 \div 1000 = 0.50 \text{ g of drug needed}$$

Add sufficient solvent to make 500 ml of solution.

V/V (volume/volume) Solution: Divide the total volume (in milliliters) of the solution desired by the larger number of the ratio, and the quotient will be the number of milliliters of the drug to be used.

Example: How many milliliters of HCl are needed to prepare a 1:250 solution with a total volume of 500 ml?

Solution:

$$500 \div 250 = 2.0 \text{ ml of drug needed}$$

Percentage solutions from stock and/or ratio solutions:

Example: From a 1:10 solution of silver nitrate in water, prepare 60 ml of a 1.5% solution of the same ingredients.

Solution: A 1:10 (W/V) solution contains 1 g of solute and enough solvent to total 10 ml of solution (finished product). Therefore, 1 ml of the solution would contain 0.1 g of the solute. Since it is required that 0.9 g of the solute be used to prepare 60 ml of the required strength, use 9 ml of the stock solution and enough solvent (water) to make the total volume measure 60 ml.

PHARMACEUTICAL PREPARATIONS

LEARNING OBJECTIVE: *Recall the composition and physical characteristics of commonly used pharmaceutical preparations.*

While assigned to a pharmacy or naval vessel, you may be required to make pharmaceutical preparations. The following sections will acquaint you with the composition and physical characteristics of some of these preparations.

Elixirs

Elixirs are aromatic, sweetened hydroalcoholic solutions containing medicinal substances. The color of elixirs varies according to the nature of the ingredients; some are artificially colored.

Suspensions

Suspensions are coarse dispersions comprised of finely divided insoluble material suspended in a liquid medium. To keep the insoluble material suspended, a third agent, called a suspending agent, is required. The process of mixing or combining the ingredients to form a suspension is called **reconstitution**.

Ointments

Ointments are semisolid, fatty, or oily preparations of medicinal substances. These preparations are of such a consistency as to be easily applied to the skin and gradually liquefy or melt at body temperature. Ointments vary in color according to their ingredients. The base of an ointment is generally greasy in texture,

and the medicinal substances combined with it are always intended to be very fine particles, uniformly distributed.

Suppositories

Suppositories are solid bodies intended to introduce medicinal substances into the various orifices of the body (rectum, vagina, and urethra). The ingredients are incorporated in a base that melts at body temperature.

Capsules

Capsules are gelatin shells containing solid or liquid medicinal substances to be taken orally. A common type of capsule contains medicine in the form of a dry powder that is enclosed in transparent cases made of gelatin. Capsules are sized by universally designated numbers: 5, 4, 3, 2, 1, 0, 00, 000. The number 5 has the capacity of about 65 mg of powder (such as aspirin) and the number 00 capsule contains about 975 mg of the same substance. Only sizes 3 through 00 are available through the Federal Stock System.

PHARMACEUTICAL INSTRUMENTS

LEARNING OBJECTIVE: *Identify commonly used pharmaceutical instruments and describe the purpose of each.*

In the process of preparing some pharmaceutical preparations, you may need to use specialized instruments. To acquaint you with some of the more commonly used pharmaceutical instruments, the following sections will give you a description of each instrument and explain its purpose. See figure 6-2 for an illustration of each instrument discussed.

Pharmaceutical Balances

Two types of pharmaceutical balances are in common use in the Navy: torsion balances (shown in figure 6-2) and electronic balances (not shown). These balances are classified as either “Class A” or “Class B.” Class A balances are used for weighing loads from 120 mg to 120 g. All dispensing pharmacies are required to have at least one Class A balance on hand at all times. Class B balances weigh loads of more than 648 mg, and they must be conspicuously marked

“Class B.” Class B balances are optional equipment in the pharmacy.

Ribbed Funnel

Ribbed funnels are utensils used in the filtering process. They are most commonly made of glass, but other substances (tin, copper, rubber) are occasionally used. The funnel is shaped so that the inside surface tapers at a 60° angle, ending in a tapered delivery spout. The inside surface is “ribbed” to allow air to escape from between the glass and the filtering medium (improving the filtration process).

Erlenmeyer Flask

The Erlenmeyer flask is a glass container with metric measurements inscribed on it. It is used for mixing and measuring various medicinal ingredients.

Mortar and Pestle

These two items always go together, one being useless without the other. The mortar is basically a heavy bowl, with one distinct property: the inside concavity is geometrically hemispheric. The accompanying pestle is primarily a handtool that has a tip made of identical material as the mortar, and its convexity forms a perfect hemisphere. The reason for the two opposing hemispheres is to provide an even grinding surface. Mortars and pestles are made of glass, metal, or unglazed pottery called wedgewood. Glass is used when triturating (reducing substances to fine particles or powder by rubbing or grinding) very pure products (such as eye ointments), and when the preparations contain stains.

NOTE: Metal mortars and pestles should never be used when the drugs are likely to react with the metals.

Spatula

The spatula is a knifelike utensil with a rounded, flexible, smoothly ground blade, available in various sizes. The spatula is used to “work” powders, ointments, and creams in the process of levigation (the rubbing, grinding, or reduction to a fine powder with or without the addition of a liquid) and trituration. It is also used to transfer quantities of drugs from their containers to the prescription balance. Spatulas should not be used to pry open cans or as knives for opening boxes. Once the surface is scratched or the edges bent,



PRESCRIPTION
BALANCE

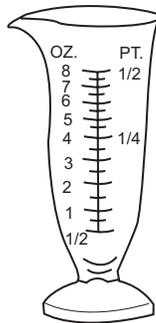


MORTAR
AND
PESTLE

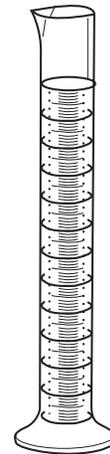


SPATULA

HM3F0802



GRADUATE
(CONICAL)



GRADUATE
(CYLINDRICAL)

Figure 6-2.—Pharmaceutical instruments.

the spatula is ruined, and it becomes useless for pharmacy work.

Graduates

Graduates are conical or cylindrical clear glass containers, graduated in specified quantities and used to measure liquids volumetrically. Measuring should always be done at eye level.

DRUG INCOMPATIBILITIES, CONTRAINDICATIONS, AND ADVERSE EFFECTS

Occasionally, the drugs we use to improve a person's condition may not work in the manner intended. The outcome may be contrary to that which was expected, and, indeed, could even cause harm to the patient. It is important to be aware of symptoms that may indicate a drug is not doing its job properly.

Incompatibilities

LEARNING OBJECTIVE: *Identify the three classifications of drug incompatibility, and recall what causes these drug incompatibilities to occur.*

There are instances when a drug used simultaneously with another drug or substance does not perform as it was intended. These drugs or substances may be incompatible together and, therefore, should not be administered at the same time. A drug incompatibility can also occur when drugs are compounded together in the pharmacy. There are three classes of drug incompatibilities: therapeutic, physical, and chemical. In the following sections, each class of drug incompatibility is discussed.

THERAPEUTIC INCOMPATIBILITIES.—Therapeutic incompatibilities occur when agents

antagonistic to one another are prescribed together. Such circumstances seldom occur, but when they do, the Hospital Corpsman should bring the perceived incompatibility to the attention of the physician. The pharmaceutical agents may have been used together for one agent to modify the activity of the other. The physician will verify the prescription as necessary.

PHYSICAL INCOMPATIBILITIES.—

Physical incompatibilities are often called pharmaceutical incompatibilities and are evidenced by the failure of the drugs to combine properly. It is virtually impossible for uniform dosages of medicine to be given from such solutions or mixtures. Ingredients such as oil and water (which are physically repellant to each other) and substances that are insoluble in the prescribed vehicle are primary examples of physical incompatibilities.

CHEMICAL INCOMPATIBILITIES.—

Chemical incompatibilities occur when prescribed agents react chemically upon combination to alter the composition of one or more of the ingredients (constituents).

MANIFESTATIONS OF INCOMPATIBILITY.—

The following list outlines the various ways incompatibility between or among drug agents may be manifested. The respective type of incompatibility is also noted.

- Insolubility of prescribed agent in vehicle (physical)
- Immiscibility of two or more liquids (physical)
- Precipitation due to change in menstrum that results in decreased solubility (called **salting out**) (physical)
- Liquification of solids mixed in a dry state (called **eutexia**) (physical)
- Cementation of insoluble ingredients in liquid mixtures (physical)
- Evolution in color (chemical)
- Reduction or explosive reaction (called **oxidation**) (chemical)
- Precipitation due to chemical reaction (chemical)
- Inactivation of sulfa drugs by procaine HCl (therapeutic)

Although it is, of course, impossible to eliminate all drug-agent incompatibilities, some combinations

may respond to one of the following corrective measures.

- Addition of an ingredient that does not alter the therapeutic value (such as the addition of an ingredient to alter solubility of an agent)
- Omission of an agent that has no therapeutic value or that may be dispensed separately
- Change of an ingredient (e.g., substitution of a soluble form of an ingredient for an equivalent insoluble form)
- Change of a solvent
- Utilization of special techniques in compounding

Contraindications

LEARNING OBJECTIVE: *Recall drug contraindications, adverse drug reactions, and interactions.*

A contraindication is any condition the patient might display that makes a particular treatment or procedure inadvisable. These conditions include, but are not limited to, the disease process and other administered medications.

Adverse Drug Reactions

Adverse drug reactions may occur when a drug, administered in a dose appropriate for human prophylaxis, diagnosis, or therapy, has an unintended and noxious effect on the patient receiving it. As a Hospital Corpsman, you must be aware of the possibility of adverse effects of medications so that you can prevent an occurrence, or at least minimize the impact on the patient.

Drug Interactions

Patients may receive more than one medication at a time (as happens frequently in the case of hospitalized patients). Combining medications can cause the individual drugs to interact with each other—either positively or negatively—to produce an outcome that would not have occurred if each drug had been administered singly. Such interactions may affect the intensity of a drug's response, the duration of its effect, and side effects that may occur. As stated above, drug interactions can be positive as well as

negative, and two or more medications are often administered to achieve a greater therapeutic effect.

Information Concerning Drug Contraindications, Adverse Reactions, and Interactions

Descriptions of drug contraindications, adverse reactions, and interactions may be found in several publications, most notably the *Physicians' Desk Reference*. However, the most important location for finding this information is the manufacturer's package insert and associated literature that accompanies each drug.

PRESCRIPTIONS

LEARNING OBJECTIVE: *Recall the parts of a prescription, authorized prescribers and how prescriptions are written, filled, verified, labeled, and filed.*

The most important tool used by the pharmacy is the prescription. A prescription is a written or computerized order from a healthcare provider (prescriber) directing the pharmacy to compound and dispense a drug or medication for a patient to use.

Of special importance is your understanding and conformance to the following protocols:

- All information pertaining to a prescription is confidential and should not be divulged to any persons not specifically involved in the treatment.
- No prescription or any of its parts may be applied or transferred to any person other than the patient specified.

To fill a prescription correctly, you must thoroughly understand the prescription writing and filling process. Because regulations and policies governing pharmacies sometimes change, it is important for you to be familiar with pharmacy policies in the *Manual of the Medical Department* (MANMED), NAVMED P-117. The MANMED is the basic guide to pharmacy operations.

PARTS OF THE PRESCRIPTION

Currently, there are two standardized forms used for prescriptions: the *DoD Prescription*, DD Form

1289 (fig. 6-3) and the *Polyprescription*, NAVMED 6710/6 (fig. 6-4). Information placed on these forms must be either typewritten or legibly handwritten in ink or indelible pencil. In addition to these two forms, many of today's fixed medical facilities (e.g., naval hospitals and medical clinics) now have automated pharmacy systems that allow healthcare providers to enter prescription requests into computers in their offices instead of handwriting prescriptions. Prescriptions, written or computerized, have, for the most part, the same information requirements. The only major difference is that automated prescriptions do not require the prescriber's signature.

DD 1289 is used extensively for outpatient prescriptions. For this reason, the key parts of DD 1289 will be discussed in the following sections. See figure 6-3 for examples of specific block entries.

Patient Information Block

In the patient information block, located at the top of the DD 1289, the patient's full name and date of birth are required. At most medical facilities, however, additional patient information is added to this block. This additional information usually includes the patient's duty station; social security number with family member prefix; rate; and branch of service.

Medical Facility and Date Block

The medical facility block, located below the patient information block, should contain the name of the medical facility or ship where the prescription was written. Completion of this block is important if the source of the prescription needs to be traced.

The date block, located to the right of the medical facility block, should contain the date in which the prescription was written.

Prescription Block

The large block in the center of the DD 1289 is the prescription block. It contains four parts: the superscription, the inscription, the subscription, and the signa.

SUPERSSCRIPTION.—The superscription "Rx" means "take" or "take thou" or, in effect, "I want this patient to have the following medication."

INSCRIPTION.—The inscription is that part of the prescription that lists the names and quantities of the ingredients to be used. This part of the prescription

is of utmost importance, since the spelling of many unrelated drugs is similar. Whenever there is doubt as to the drug or the amount listed in the inscription, the individual filling the prescription should always verify the inscription with the prescriber.

NOTE: The drug should be written generically, and the dosage size or strength written metrically.

SUBSCRIPTION.—The subscription follows the inscription and is that part of the prescription that gives directions to the compounder.

DD FORM 1289	
1 NOV 71	
DOD PRESCRIPTION	
FOR (Full name, address, & phone number) (If under 12, give age)	
<i>John R. Doe, HM3, USN</i>	
<i>U.S.S. Neverforgotten (DD 178)</i>	
MEDICAL FACILITY	DATE
<i>U.S.S. Neverforgotten (DD 178)</i>	<i>23 JAN 99</i>
R_s (Superscription)	gm or ml.
(Inscription)	
<i>Tn Belladonna</i>	<i>15 ml</i>
<i>Amphogel qsad</i>	<i>120 ml</i>
(Subscription)	
<i>M & FT Solution</i>	
(Signa)	
<i>Seg: 5ml tid a.c.</i>	
MFGR: <i>Wyeth</i>	EXP DATE: <i>12/02</i>
LOT NO: <i>P39K106</i>	FILLED BY: <i>KMT</i>
R_s NUMBER <i>10072</i>	<i>Jack R. Frost</i> <i>LCDR, MD, USNR</i> SIGNATURE RANK AND DEGREE
EDITION OF 1 JAN 60 MAY BE USED FOR S/N 0102-LF-012-6201	

HM3F0603

Figure 6-3.—DOD Prescription form.

FOR (Mechanically Imprint, Type or Print Full Name, Address & Phone)

20-222-22-2222
 31AUG02
 DOE, JANE B.
 901 STAFF E-7
 20MAR70 F ACDU-N
 12 NOV 99 ◀ DATE

NOTE: CONTROLLED SUBSTANCES MUST BE PRESCRIBED ON DD FORM 1289, DOD PRESCRIPTION, AND MUST BE FILED IN A SEPARATE FILE.

MEDICAL FACILITY: *NH Bath* AGE (if under 12 years):
 INPATIENT
 OUTPATIENT

DRUG NAME	FORM	STRENGTH	NUMBER	DIRECTIONS	PRESCRIPTION NUMBER
1 <i>Amoxicillin</i>	<i>Caps</i>	<i>250mg</i>	<i>30</i>	<i>Sig: 250mg p.o. tid x10 days</i>	<i>02689</i> NDC: EXP/MPG DATE: <i>9/01</i> LOT: <i>(3) AB</i> FILLED BY: <i>Jul</i>
2 <i>Ertex L.A.</i>	<i>Caps</i>		<i>30</i>	<i>1 p.o. q 12 pm Conjuction</i>	<i>02690</i> NDC: EXP/MPG DATE: <i>7/00</i> LOT: <i>(6)</i> FILLED BY: <i>Jul</i>
3 <i>Naproxen</i>	<i>Tabl</i>	<i>250mg</i>	<i>40</i>	<i>1 p.o. BID</i>	<i>02691</i> NDC: EXP/MPG DATE: <i>12/00</i> LOT: <i>(7) 215m</i> FILLED BY: <i>Jul</i>
4					NDC: EXP/MPG DATE: LOT: FILLED BY:

SIGNATURE OF PRESCRIBER: *Walter T. Door* GRADE: *CDR* DEGREE (MD, DDS, etc.): *MC* SOCIAL SECURITY NUMBER: *555 - 55 - 5555*

POLYPRESCRIPTION NAVMED 6710/6 (5-73) S/N 0105-228-7190 **DETACH BEFORE WRITING**

HM3F0604

Figure 6-4.—Polyprescription form.

SIGNA.—The signa, not to be confused with the prescriber’s signature, is the part of the prescription that gives the directions for the patient. This portion is preceded by the abbreviation “Sig.”

Prescriber Signature Block

Finally, the prescriber signature block, located at the bottom of the form, **must** contain a legible signature of the prescriber, as well as the prescriber’s full name, rank, corps, and service, stamped, typed, or handprinted. Mimeographed, preprinted, or rubber-stamped prescriptions may be used, but signatures must be original and in the handwriting of the prescriber. Facsimiles are not acceptable.

AUTHORIZED PRESCRIBERS

According to the MANMED, the following persons are authorized to write prescriptions:

- Medical and Dental Corps Officers
- Medical Service Corps optometrists, physician assistants, and podiatrists
- Civilian physicians employed by the Navy

- Independent duty Hospital Corpsmen
- Nurse practitioners (may prescribe when authorized in writing by the commanding officer)
- Nurse anesthetists and midwives (may prescribe within the scope of their practice when authorized in writing by the CO or delegated representative)

Prescriptions written by civilian prescribers, other than those employed by the Navy, may be filled for authorized beneficiaries, provided the prescribed item is on the medical facility’s formulary (a published listing of medications) and the prescribed quantity is within limitations established by the command.

With the exception of the polyprescription, prescriptions are limited to one item per prescription. The quantity of the drug prescribed should be a reasonable amount needed by the patient. Excessive or unrealistic quantities should not be prescribed. Erasures on prescriptions are prohibited, and interlineations (information inserted between lines of writing) must be initialed.

Finally, persons authorized to prescribe cannot write prescriptions for themselves or members of their immediate families.

FILLING PRESCRIPTIONS

When you receive a prescription for filling, you should follow certain basic steps to make sure that the right patient gets the right medicine in the right amount in the right way. There are no shortcuts—in the pharmacy things are done right or not at all!

Prescription Verification

First of all, satisfy yourself that the prescription you have received is a bonafide one and that the person you have received it from is entitled to have it filled by your pharmacy. You don't need to be tedious about verification. The simplest and best way is to ask for an ID card and verify the expiration date on the ID card.

Study the prescription carefully and make sure that the drug prescribed is reasonable, that its amount or dosage is realistic in consideration of the patient's age, and that the quantity of the medication is practical. A prescription calling for 1,000 tetracycline tablets or a pint of paregoric, for example, warrants further inquiry.

If, in the process of verification, you feel that there is a discrepancy, an ambiguity, or an incompatibility, or for any reason you find it is necessary to consult the prescriber, never allow the patient to suspect that anything is amiss. You should never fill a prescription you do not completely understand or that you feel is incorrect. What appears to be an overdose may be the desired dose for a specific patient, but the prescriber will appreciate being called for verification.

When you are sure you understand the prescription and are satisfied that it is in all respects correct, you should give its filling your undivided attention. Most mistakes are made when the person filling the prescription is either interrupted while doing so or is trying to accomplish more than one task at a time.

During the process of filling a prescription, the label on the containers used in filling the prescription should be verified at least three times. Initially, the label should be read when the container is taken from the shelf. Then it should be read again when the contents are removed from the container. And finally, the container's label should be read before it is returned to the shelf. By following these three verification steps for each prescription you fill, you

will reduce the possibility of making a prescription error.

Prescription Labeling

Proper labeling of a prescription is as important as filling it correctly. It is reasonable to assume that if a great deal of accuracy is necessary to properly compound a prescription, it is just as important that the patient take the correct amount of medication in the right manner to receive its maximum benefits. Improperly written or misunderstood directions on a prescription label can be disastrous. Make sure all labels are typed clearly and their directions translated into simple layman's language. Keep in mind that the prescription label serves two purposes. First and most important, it gives the patient directions pertaining to the medication; second, in case of misuse or error, it is the quickest means by which the contents of the prescription container, the person who wrote the prescription, and the person who filled it can be traced. Consequently, the following information, illustrated in figure 6-5, should always be on the label:

- The name and phone number of the dispensing facility
- A serialized number that corresponds with the number on the prescription form, (see figure 6-3)
- The date the prescription is filled
- The patient's name
- The directions to the patient, transcribed accurately from the prescription, in clear, concise layman's language
- The prescriber's name and rate or rank
- The initials of the compounder
- Authorized refills, if any
- The expiration date, if applicable
- Name, strength, and quantity of medication dispensed

NOTE: Pharmaceutical preparations should be identified and labeled with the generic name. However, trade or brand names may be used if the trade or brand name is actually on the container.

Other information that may need to be attached to the prescription container are labels reading "Shake Well Before Using" or "For External Use Only." "Poison" labels should be omitted when a preparation

NAVAL HOSPITAL		Phone
BETHESDA, MD	20814	295-2113
(keep out of reach of children)		295-550
John R. Doe, HM2, USN		4/28/99kk
Take one (1) tablet every 12 hours if needed for cold symptoms.		
Dimetapp #30	Dr. Johnson	
No Refills		
		117765

HM3F0605

Figure 6-5.—Prescription label.

is intended for external use, as many physicians prefer the “For External Use Only” labels.

After the prescription is labeled, check the ingredients again by some systematic method to ensure accuracy.

As an added precaution and to aid expeditious identification of drugs in case of undesirable effects, note the manufacturer and the lot number of the proprietary drug dispensed on the prescription form (fig. 6-3). This procedure, however, does not apply to medications consisting of a mixture of several ingredients. The initials or the code of the person filling the prescription must also be written on the prescription form (fig. 6-3).

FILING PRESCRIPTIONS

Prescriptions that have been filled must be maintained in one of several separate files:

- **Schedule II and III narcotics**—Prescriptions containing narcotics are numbered consecutively, preceded by the letter “N,” and filed separately.
- **Alcohol**—These prescriptions are numbered consecutively, preceded by the letter “A,” and filed separately.
- **Schedule III (nonnarcotic), IV, and V drugs**—These prescriptions are part of and are numbered in the same manner as the general files; however, they are maintained separately.
- **General files**—All other prescriptions are numbered consecutively and filed together.

Currently, prescriptions are required to be kept on file for at least 2 years after the date of issue.

REGULATIONS AND RESPONSIBILITIES PERTAINING TO CONTROLLED SUBSTANCES, ALCOHOL, AND DANGEROUS DRUGS

LEARNING OBJECTIVE: *Recall Hospital Corpsman responsibilities and accountability pertaining to controlled substances; identify controlled substance schedules; and recall controlled substance security, custody, inventory, and survey procedures.*

Hospital Corpsmen who handle controlled substances and other drugs are held responsible for the proper distribution and custody of those substances and drugs. Nowhere is the demand for strict integrity more important. Misuse, abuse, loss, and theft of these substances have always, sooner or later, ended in tragedy and severe consequences. No one has ever profited by their misappropriation.

It behooves every Hospital Corpsman to thoroughly understand the responsibility concerning the custody and handling of controlled substances and other drugs and to be familiar with the regulations and laws pertaining to them.

RESPONSIBILITY

Although the MANMED specifically assigns custodial responsibility for controlled substances, alcohol, and dangerous drugs to a commissioned officer (and more specific control to the Nursing Service), you, as a Hospital Corpsman, have the responsibilities of administering and securing them properly. All controlled substances and other drugs are to be kept under lock and key. Neither keys nor drugs should ever be entrusted to a patient.

ACCOUNTABILITY

Hospital Corps personnel are held accountable for drugs entrusted to them. Great care should be exercised to prevent the loss or unauthorized use of drugs. No drug should be administered without proper authority. In addition, U.S. Navy Regulations forbid the introduction, possession, use, sale, or other transfer of marijuana, narcotic substances, or other controlled substances.

CONTROLLED SUBSTANCE SCHEDULES

Controlled substances and drugs require special handling and security measures. The Controlled Substance Act of 1970 established five schedules (categories) related to a drug's potential for abuse, medical usefulness, and degree of dependency, if abused.

Controlled substances may migrate between schedules, and new products may be added. These changes will be promulgated by the Navy Materiel Support Command in the Medical and Dental Materiel Bulletin.

Schedule I

Schedule I substances have high abuse potential and no accepted medical use (e.g., heroin, marijuana, LSD).

Schedule II

Schedule II substances have high abuse potential and severe psychological and/or physical dependence liability. Examples of schedule II substances include narcotics, amphetamines, and barbiturates. Prescriptions for schedule II substances can never be ordered with refills and must be filled within 7 days of the date originally written.

Schedule III

Schedule III substances have less abuse potential than schedule II substances and moderate dependence liability. Examples of schedule III substances include nonbarbiturate sedatives, nonamphetamine stimulants, and medications that contain a limited quantity of certain narcotics. Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within 6 months.

Schedule IV

Schedule IV substances have less abuse potential than schedule III substances and limited dependence liability. Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within a 6-month period.

Schedule V

Schedule V substances have limited abuse potential. Schedule V substances are primarily

antitussives or antidiarrheals that contain small amounts of narcotics (codeine). Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within 6 months.

DANGEROUS DRUGS

Poisonous drugs, chemicals, and similar substances are classified as dangerous drugs. Because these substances are powerful, their containers should have a distinctive color, size, or shape, and the container should be placed in a special storage area so they are not mistaken for other drugs. In addition, the following safeguards should be enforced:

- Label all containers of dangerous substances appropriately.
- Store caustic acids (such as glacial acetic, sulfuric, nitric, concentrated hydrochloric, or oxalic acids) in appropriate containers, and do not issue to wards or outpatients.
- Account for and issue methyl alcohol (methanol) to be used by medical activities in the same manner as other controlled substances. Methanol should not be stored, used, or dispensed by the pharmacy, ward, or outpatient treatment facility.

SECURITY AND CUSTODY OF CONTROLLED SUBSTANCES

Schedule I and II controlled substances and ethyl alcohol require vault or safe storage and inventory by the Controlled Substance Inventory Board (discussed in more detail in the section entitled "Inventory of Controlled Substances"). Working stock may be kept in a locked area within the pharmacy. A copy of the safe combination must be kept in a sealed envelope deposited with the CO or representative.

Schedule III, IV, and V controlled substances require locked cabinet security for storage of bulk drugs. A minimum amount of working stock may be dispersed among other pharmacy stock, provided the pharmacy stock itself is secure. Otherwise, all stock in this category must be kept in locked cabinets.

Custodial responsibility for controlled substances, ethyl alcohol, and dangerous drugs at naval hospitals is entrusted to a commissioned officer or a civilian pharmacist who is appointed in writing by the CO. At remote branch clinics that do not have a commissioned officer or a civilian pharmacist, the CO will designate

in writing a member of the branch clinic as custodian. On board large naval vessels, the CO will appoint an officer of the Medical Department or another officer in writing as the bulk custodian. This officer will be responsible for, and maintain custody of, all bulk controlled substances. On board smaller naval vessels, access to controlled substances is limited to the bulk custodian and the senior medical department representative (SMDR). Only individuals whose official duties require access to such spaces are provided the safe combinations.

INVENTORY OF CONTROLLED SUBSTANCES

Monthly (or more frequently, if necessary), the Controlled Substances Inventory Board takes an unannounced inventory of controlled substances.

NOTE: An exception to this frequency may be made for ships with an Independent Duty Corpsman. On these ships, the inventory may be conducted on a quarterly basis if there have been no transactions of controlled substances (including filled prescriptions or receipts of items requisitioned from supply).

The CO appoints the members of the board in writing. The board consists of three members, at least two of whom are commissioned officers. After the board conducts the inventory, it submits a report to the CO. The officer having custodial responsibility cannot be a member of the board. On small ships and installations, the SMDR may be a board member. For further guidance on controlled substance inventory procedures, refer to NAVMEDCOMINST 6710.9, *Guidelines for Controlled Substances Inventory*.

SURVEY OF CONTROLLED SUBSTANCES

Schedule I and II controlled substances, ethyl alcohol, and locally controlled drugs that have become outdated, deteriorated to the point of not being usable, are of questionable purity or potency, or have had their identity compromised, must be reported to the CO. If destruction is indicated and directed by the CO, destruction must be accomplished in the presence of a member of the Controlled Substance Inventory Board. A certification of destruction form contains the complete nomenclature and quantity of the substances to be destroyed together with the method of destruction to be used. After certification is completed, approved by the CO, and signed by the members witnessing the destruction, the certification of destruction is retained and filed as required by current instructions. The destroyed substances should then be removed from the stock records and the controlled substance log.

SUMMARY

Inpatients and the majority of outpatients will receive pharmaceutical products as part of their treatment. As a healthcare provider who may administer these products or fill prescriptions, it is crucial for you to have a good foundation of knowledge in pharmacology, toxicology, and the proper handling of prescriptions and controlled substances. This chapter touched on each of these topics to assist you in your duties. However, you should consult the recommended publications, such as the *Manual of the Medical Department*, *Drug Facts and Comparisons*, and the *Physicians' Desk Reference*, to provide you with the guidance and knowledge you will need to provide the best possible care for your patients.