CHAPTER 18

PHARMACY

INTRODUCTION

As the Hospital Corpsman (HM) advances in rate, there will be increased involvement in the administration of medicines. Although medications and their dosages are prescribed by Medical Officers (MO) and other authorized prescribers, the HM is involved in the administration. It is necessary for the HM to learn medication 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:

Identify the sub-sciences of pharmacology, medication standards, medication administration methods, and factors that affect dosage.

Pharmacology is the science dealing with the origin, nature, chemistry, effects, and uses of medications. The sub-sciences of pharmacology and their specific areas of concentration are:

- Pharmacognosy is the branch of pharmacology dealing with biological, biochemical, and economic features of natural medications and their constituents
- Pharmacy is the branch of pharmacology dealing with the preparation, dispensing, and proper use of medications
- Posology is the study of the dosages of medicines and medications
- Pharmacodynamics is the study of the action or effects of medications on living organisms

- Pharmacotherapeutics is the study of the uses of medications in the treatment of disease
- Toxicology is the study of poisons, their actions, their detection, and the treatment of the conditions produced by them
- Therapeutics is the science of treating disease by any method that will relieve pain, treat or cure diseases and infections, or prolong life
  - Therapeutics does not deal solely with giving or taking medicine
  - This field also includes many other methods, such as radiological treatment, diathermy, and hydrotherapy

MEDICATION STANDARDS

Texts dealing with pharmaceutical preparations include the United States Pharmacopeia and National Formulary (USP-NF), which sets standards for the quality, purity, strength, and consistency and provides standards for medications of therapeutic usefulness and pharmaceutical necessity. Inclusion of medications into this reference is based on therapeutic effectiveness and popularity. The USP-NF provides tests for medication identity, quality, strength, and purity. The U.S. Federal Food, Medication, and Cosmetics Act designates the USP–NF as the official reference for medications marketed in the United States.

Drug Facts and Comparisons is a comprehensive medication information reference that is organized by therapeutic medication class. A comprehensive description of each pharmaceutical preparation (including indications, administration and dosage, actions, contraindications, warnings and precautions, medication interactions, adverse reactions, and dosage forms available, and the generic and trade medication names) is provided.
This publication is used as a reference for in-depth information on pharmaceutical products by healthcare providers and pharmacy personnel.

Drug Information Handbook is an easy to use reference for clinicians and healthcare providers seeking quick and concise medication information. The information in this is similar to that which is contained in the Drug Facts and Comparisons.

Remington: The Science and Practice of Pharmacy is the most widely used text/reference in American pharmacies. It contains all areas relevant to the art/science of pharmacy. It 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 medication's administration to a patient depend on several factors, as does the method of that medication's administration. This section covers some 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.

DOSAGE RANGE.—It is a term applying to the range between the minimum and maximum amounts of a given medication required to produce the desired effect. Many medications (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 medication required to produce a therapeutic effect), maximum dose (the largest amount of medication that can be given without reaching the toxic effect), and toxic dose (the least amount of medication that will produce symptoms of poisoning).

THERAPEUTIC DOSE.—is 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 male of 24 years who weighs approximately 150 pounds.

MINIMUM LETHAL DOSE.—is the least amount of medication 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 medication 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 medication and the condition of the patient.

A rule governing calculation of pediatric (child's) doses, Young's Rule, is expressed as:

\[
\frac{\text{Age in years}}{\text{Age in years} + 12} \times \text{adult dose} = \text{child's dose}
\]

The age in years of the child is the numerator, and the age plus 12 is the denominator. This fraction is then 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?

\[
\frac{3}{3 + 12} \times 650 \text{ mg} = 260 \text{ mg}
\]
Weight—In the calculation of dosages, weight has a more direct bearing on the dose than any other factor. This is especially true in the calculation of pediatric doses. The doses of the majority of medications based on body weight are conveniently expressed in terms of 
mg/kg, since the doses of most medications are administered in milligram amounts. However, this is not always the case. Depending on the medication, dosage form or other factors, the dose of some medications may be expressed in different units of measure.

A useful equation for the calculation of doses based on body weight is:

\[ \text{Patient's dose (mg)} = \frac{\text{Patient's weight (kg)} \times \text{Medication dose (mg)}}{1 \text{ (kg)}} \]

If different units are given, other units may be substituted in the equation as long as the terms used are consistent.

Example: The dose of medication “A” is 22 mg/kg. How many milligrams of medication “A” are needed for a patient weighing 17 kg?

\[ x (\text{mg}) = 17 \text{ kg} \times 22 \text{ mg} \]
\[ x (\text{mg}) = 17 \times 22 \]
\[ x = 374 \text{ mg} \]

Another rule governing calculation of pediatric doses based on weight is Clark’s Rule, expressed as:

\[ \frac{\text{Weight in pounds}}{150} \times \text{adult dose} = \text{child's dose} \]

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?

\[ \frac{60}{150} \times 650 \text{ mg} = 260 \text{ mg} \]

NOTE: Young’s and Clark’s rule are not generally used because the majority of medications are now dosed based according to weight, providing a more patient specific dose.

Other Factors that Influence Dosage

- **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 medication. 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:** Medications 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 Medications

Medications may be introduced into the body in several ways, each method serving a specific purpose. The most common routes of administration are oral (enteral) and injection (parenteral).

**ORAL** is the most common method of administering medications. Among the advantages of administering medication orally (as opposed to other methods) are:
- Oral medications are convenient
- Oral medications are generally cheaper
- Oral medications do not have to be pure or sterile
- A wide variety of oral dosage forms are available

Oral medication administration may have disadvantages 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 medications 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 medication is nitroglycerin sublingual tablets (for relief of angina pectoris).

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

**PARENTERAL** medications are introduced by injection. All medications used by this route must be pure, sterile, pyrogen-free (pyrogens are products of the growth of microorganisms), and in a liquid state.

**EXAMINATIONS OF PARENTERAL SOLUTIONS**.— Parenteral solutions are examined at least three times at the activity at which they are ultimately used:
- Upon receiving the solution
- Periodically while in storage
- 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 for the following reasons:
- Deterioration from prolonged storage
- Accidental contamination occurring upon original packaging
- Defects that may develop in containers or seals

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

Subcutaneous is the medication injected just below the skin's cutaneous layers. Example: Insulin.

Intradermal is the medication injected within the dermis layer of the skin. Example: Purified Protein Derivative (PPD).

Intramuscular is the medication injected into the muscle. Example: Procaine Penicillin G.

Intravenous is the medication introduced directly into the vein. Example: Intravenous fluids.

Intravenous (I.V.) administration has certain advantages over other routes:

- I.V. administration provides the most rapid onset of action
- Medication is administered directly into the bloodstream
- Patients may not be able to take oral medications
- Some medications are not suitable for oral administration

Some dangers and disadvantages associated with intravenous administration:

- Effects of an error in dose are magnified when medications are administered by I.V. Once administered, it is difficult to stop the medication from producing all of its effects, including adverse effects
- Risk of infection is always present when the skin is punctured
- Pain, real or psychological may accompany an injection
- Medication injected intravenously must be sterile. This demands special medication dosage forms and supplies; as well as the skills to prepare and administer them

Intrathecal or Intraspinal is the medication introduced into the subarachnoid space of the spinal column. Example: Procaine hydrochloride.

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 - the process by which a medication is changed from a liquid or solid to a gas or vapor by the use of heat (such as in steam inhalation)
- Gas Inhalation - almost entirely restricted to anesthesia
- Nebulization - the process by which a medication is converted into a fine spray by the use of compressed gas

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

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

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

RECTAL.—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.—inserted into the vagina to produce a local effect. Examples of vaginal preparations are suppositories, creams, and douches.
"RIGHTS" OF MEDICATION ADMINISTRATION

To prevent medication errors, there are six important steps to follow when administering medication to a patient. Many medication errors can be linked to an inconsistency in adhering to the six “right” steps of medication administration.

Right Patient

Make sure the patient is identified. This is more than asking for the patient’s name. Sometimes the patient is confused, their level of consciousness may be altered due to medication or a procedure, or they may be unable to communicate. The HM should use two forms of patient identification. Check the patient’s arm band and verify it with the Medication Administration Record (MAR).

Right Medication

A medication order is required for every medication to be administered to a patient. Compare the order with the MAR when the order was initially ordered. After determining the information on the MAR is accurate, use the MAR to prepare the medications. When preparing medications from bottles or container, compare the label with the MAR three times: (1) before removing from the shelf or drawer, (2) as the amount of medication ordered is removed from the container, and (3) before returning the container to storage. If it is listed as a generic equivalent and the HM is unsure if it is the same as what is ordered on the MAR, they must consult a medication book or other reference to confirm that the medication to be given is the same as the one ordered. Certain medications are frequently confused with another with a similar name or appearance.

Right Dose

With the use of generic drugs increasing in hospitals, the HM may be confronted with the need to give more than one of a specific tablet or capsule, or to measure a liquid into a syringe or dose cup.

The HM must double-check measurements and make sure of the correct number of pills or capsules before taking the medication to the patient. Tablets may need to be split. If using the automated system, there should be a warning of the dosage difference. The HM must not exclusively rely on that for accuracy. Check the packaging against the MAR.

Right Route

If the medication is ordered PO, make sure it is given it PO. Don't give an injection as an IV infusion. If it’s ordered deep IM, make sure the right length and correctly gauged needle is used for accurate administration. Do not leave the medication on the bedside table; watch the patient to make sure the medication is taken correctly. Patients have been known to ingest suppositories or make other mistakes while confused or under the influence of pain medications.

Right Time

Medication doses can be spaced at specific intervals. Levels may need to be maintained in the bloodstream, certain meds may need to be given an hour or more apart from other medications, or they may need to be taken in specific relation to meals. Absorption and efficacy may be affected if medications are incorrectly administered, **If in question, review the MAR and reference books, and refer to the patient’s chart if needed in order to make sure the appropriate guidelines are being followed for the ordered medication(s)**.

There are established windows for administering oral, IM, and IV medications. These windows allow for certain flexibility, but the medication should be given within the established framework unless extenuating circumstances prevent it. In that case, the HM needs to document why the medication was given outside the parameters and notifies the MO and pharmacy to adjust the future doses.
Right Documentation

Health care providers use accurate documentation to communicate with each other. Many medication errors result from inaccurate or incomplete documentation. Before administering medications, ensure the MAR clearly reflects the patient's name, name of the medication ordered written out in full, and the medication's dosage route and frequency. After administering the medication, document which medications were given on the patient's MAR according to local policy to verify that the medication was given as ordered.

Healthcare professionals have a responsibility to make sure that patients receive the best care possible. Safe medication administration is an important part of quality care and will help minimize the occurrence of negative effects while the patient is under care.

MEDICATION CLASSIFICATIONS

LEARNING OBJECTIVE:

Identify medication groups, the generic and trade names of medications listed in each medication group, and recognize each medication's use.

The definition of a medication is any chemical substance that has an effect on living tissue but is not used as a food. Medications 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.

Medications are classified according to set criteria and fall into three specific areas: general, chemical, and therapeutic.

- **General**: Grouped according to their source whether animal, vegetable, or mineral in origin
- **Chemical**: Grouped by their chemical characteristics
- **Therapeutic (Pharmacological)**: Grouped according to their action on the body

**NOTE:**
Some medications may have more than one action and fall into more than one therapeutic class.

MEDICATION NOMENCLATURE

Medications normally have three names: chemical, generic (nonproprietary), and brand (proprietary).

- **Chemical name** relates to the chemical and molecular structure. An example is 2,4,7-triamino-6-phenylpteridine. The chemical name is meaningful to the pharmaceutical chemist but is rarely used because of its complexity.
- **Generic name** is often derived from the chemical name. Every medication has only one generic name, regardless of which manufacturer markets the medication. The generic name is the common name of the medication. An example is triamterene. (Note the underlining of the chemical name above.)
- **Brand name (trade name)** is the proprietary name given by the manufacturer. Brand name is also referred to as the trade name. An example is Dyrenium®, a brand of triamterene made by SmithKline Beecham.
MEDICATION CLASSES

The types of medications outlined in this chapter and the correlating medications in common use described in appendix IV are grouped according to pharmacological classes. Only a brief summary is possible here, the HM desiring a more complete description of each medication should refer to the USP-NF, Drug Facts and Comparisons, Medication Information Handbook, or other medication reference books.

Astringents

Astringents are medications that cause shrinkage of the skin and mucous membranes. Mainly used to stop seepage, weeping, or discharge from mucous membranes.

- **Aluminum Acetate solution (Burow’s Solution, Domeboro®)** is used as a wet to dry dressing for the relief of inflammatory conditions of the skin, such as athlete’s foot, poison ivy, swelling, external otitis, bruises and insect bites.

- **Calamine, zinc oxide, glycerin, and bentonite magma in calcium hydroxide (calamine lotion)** is used to treat various skin afflictions in the same way as aluminum acetate. It is a topical astringent and protectant. It should be applied to blistered, raw, or oozing areas of the skin.

Emollients

Emollients are bland or fatty substances that may be applied to the skin to make it more pliable and soft. They may serve as vehicles for application of other medicinal substances. Emollients are available as ointments, creams, or lotions.

- **Theobroma oil (cocoa butter)** is an excellent emollient with a pleasant odor. Ideal for the treatment of chapped skin and lips, cracked nipples, or minor irritated or abraded skin areas.

- **Petrolatum (petroleum jelly)** is a good emollient that provides a highly occlusive, protective barrier. When petrolatum is used as an ointment base, it may not release some drugs.

- **Zinc Oxide** is a white petrolatum containing approximately 20% zinc oxide powder. It is used as an emollient with slightly astringent properties. Because of its opaqueness, is ideal for protecting the skin and relieving chafing.

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 exudates from the trachea, bronchi, or lungs. 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.

- **Guaiifenesin and dextromethorphan (Robitussin® DM)** In this drug combination, guaiifenesin acts as an expectorant. It may be useful in symptomatic relief of dry, nonproductive cough, and in the presence of mucous in the respiratory tract. Dextromethorphan is a synthetic non-narcotic derivative of codeine that acts as an antitussive. It is used to control non productive coughs by sooth minor throat and bronchial irritations.

- **Guaiifenesin and codeine phosphate (Robitussin® AC)** are combined to relieve the symptoms of the common cold. Guaiifenesin is an expectorant, and codeine phosphate is a narcotic antitussive. Patients should be advised that this medication contains a narcotic and, if abused, could cause dependency.
Nasal Decongestants

Nasal Decongestants reduce congestion and the swelling of mucous membranes. They are used for temporary relief of nasal congestion due to the common cold, allergies, and sinusitis, and to promote nasal or sinus drainage. They are used to relieve Eustachian tube congestion. They are often combined with antihistamines, antitussives, and expectorants to relieve the symptoms of colds, allergies, and sinusitis.

- **Pseudoephedrine Hydrochloride** *(Sudafed®)* Pseudoephedrine hydrochloride (HCL) is indicated for the symptomatic relief of nasal congestion due to the common cold, hay fever, or other upper respiratory allergies.

- **Pseudoephedrine Hydrochloride and Triprolidine Hydrochloride** *(Actifed®)* are a nasal decongestant and antihistamine combination. Pseudoephedrine HCl, a nasal decongestant, reduces congestion and swelling of mucous membranes, and triprolidine HCl, an antihistamine, promotes drying of mucous membranes. This drug combination is indicated for the symptomatic relief of colds, hay fever, etc.

- **Pseudoephedrine and Guaiifenesin** *(Mucinex D®)* Pseudoephedrine, a nasal decongestant, and guaiifenesin, an expectorant, are combined for the symptomatic relief of nasal congestion and cough due to the common cold, hay fever, or other respiratory allergies.

Antihistamines

Antihistamines are used to counteract the physical symptoms that are caused by histamines. Histamine, a substance released by most cells distributed in connective tissue 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.

- **Diphenhydramine Hydrochloride** *(Benadryl®)* Diphenhydramine HCl is given for active and prophylactic treatment of motion sickness, as a nighttime sleep aid, and for the symptomatic relief of urticaria, allergic rhinitis, and other allergic conditions.

- **Chlorpheniramine Maleate** *(Chlor-Trimeton®)* Chlorpheniramine HCl is used for the symptomatic treatment of urticaria and other allergic conditions.

- **Meclizine Hydrochloride** *(Antivert®, Bonine®)* Meclizine HCl is given to prevent and treat nausea, vomiting, and dizziness of motion sickness. It has a longer duration of action than diphenhydramine hydrochloride.

- **Dimenhydrinate** *(Dramamine®)* Similar to other antihistamines, the greatest usefulness of dimenhydrinate is the prevention and treatment of motion sickness. It may also be used to control nausea and vomiting in connection with radiation sickness.

Histamine H₂ Receptor Antagonists

Histamine H₂ Receptor Antagonists block histamines that cause an increase of gastric acid secretion in the stomach. They are effective in preventing complications of peptic ulcer disease and alleviating symptoms of this disease.

- **Cimetidine** *(Tagamet®)* Used for the short term treatment and maintenance of active duodenal and benign gastric ulcers. It may be used for other medical conditions which cause an excess amount of gastric acid to be produced.

- **Ranitidine** *(Zantac®)* Like Cimetidine, ranitidine is used for short term treatment and maintenance in active duodenal and benign gastric ulcers to promote healing of duodenal ulcers. It is used to treat gastroesophageal reflux disease (GERD).
Antacids

Antacids are 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 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 or metabolize many medications. For this reason, oral medications normally should not be taken within 2 hours of taking an antacid.

- **Magnesium Hydroxide** (Milk of Magnesia USP) is used for the symptomatic relief of upset stomach associated with hyperacidity, treatment and maintenance of duodenal ulcers, and used to reduce phosphate absorption in patients with chronic renal failure. It should be taken on an empty stomach with lots of fluids. It should not be used in the presence of abdominal pain, nausea, or vomiting. Prolonged use may result in kidney stones. Magnesium hydroxide also has a laxative effect.

- **Aluminum Hydroxide Gel** (Amphojel®) is used to manage peptic ulcers, gastritis, and gastric hyperacidity. The major advantage of this drug is that no systemic alkalosis is produced. It may cause constipation.

- **Alumina and Magnesia Oral Suspension** (Maalox®) Alumina and magnesia oral suspension coats the stomach lining and neutralizes gastric acid. It is less constipating than aluminum hydroxide alone.

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.

- **Phenol (carbolic acid)** Historically, one of the first antiseptic agents used. It is the standard by which all other antiseptic, disinfectant, and germicidal agents are measured in effectiveness. Because of its highly caustic nature, phenol must be handled with care. The effect of phenol is coincident with the concentration: high concentrations are germicidal and can cause tissue destruction; lower concentrations are antiseptic. Phenol is inactivated by alcohol. Because more effective and less damaging agents have been developed, phenol is no longer used extensively.

- **Povidone-iodine** (Betadine®) Numerous iodine and iodine-complex agents are available for use in disinfection. The most common of these is povidone-iodine (Betadine ®). It is used externally to destroy bacteria, fungi, viruses, protozoa, and yeasts. Povidone-iodine is relatively, nontoxic, nonirritating, and non-sensitizing to the skin. When used as an antiseptic, the complex breaks down on contact with skin or mucous membranes to release free iodine, which is slowly absorbed. Most commonly used as a preoperative skin antiseptic.

**NOTE:**
Check for iodine allergies before using this antiseptic on patients.

- **Isopropyl Alcohol** (Isopropanol) is used in a 70% solution as a skin antiseptic; it is volatile and also has a drying effect on the skin.

Antiseptics, Disinfectants, and Germicides

Antiseptics, Disinfectants, and Germicides 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.
- **Hexachlorophene** (PhisoHex®) Synthetic preparation is a bacteriostatic cleansing agent effective against gram-positive organisms. The presence of pus or serum decreases its effectiveness. It is a neurotoxin agent and must not be used on premature infants, denuded skin, burns, or mucous membranes. It is used as an antiseptic scrub by physicians, dentists, food handlers, and others. Residual amounts can be removed with alcohol.

- **Glutaraldehyde** (Cidex®) is effective against vegetative gram-positive, gram-negative, and acid-fast bacteria, bacterial spores, some fungi, and viruses. It is used in an aqueous solution for sterilization of fiber optics, plastics, rubber, and other materials that are not resistant to heat.

- **Hydrogen Peroxide** is a germicide and routinely used to cleanse pus-producing wounds and in the treatment of necrotizing ulcerative gingivitis (NUG) also known as trench mouth. It is an oxidizing agent that is destructive to certain pathogenic organisms, but it is mild enough to be used on living tissue. It is for external use only and is normally available in 3% solution.

- **Silver Nitrate** The soluble salts of silver nitrate ionize in water to produce highly concentrated antiseptic and antiseptic solutions. In a solid form, it is most commonly used to cauterize mucous membranes and to treat aphthous ulcers. The most common side effect of silver nitrate is the skin turns black where the silver nitrate comes in contact with it. The black area on the skin is not harmful and will resolve slowly. Silver nitrate in liquid form is used as eye drops to prevent gonorrhea ophthalmia in newborns. Liquid silver nitrate is also used as a wet dressing.

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**CAUTION:**

When using silver nitrate as a wet dressing, use precautions to keep the dressing from drying out.

If the wet dressing dries out, the silver nitrate will precipitate and be absorbed into the skin, which will turn a slate gray.

This condition is known as argyria.

There is no known reversal for this condition.

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**Sulfonamides**

Sulfonamides were the first effective chemotherapeutic agents to be available in safe therapeutic dosage ranges. Prior to the introduction of penicillins in 1941, sulfonamides were the main therapy for bacterial infections in humans. Sulfonamides are synthetically produced and are effective against both gram-positive and gram-negative organisms.

- **Sulfisoxazole** (Gantrisin®) is a systemic sulfonamide that is a bacteriostatic and is indicated to treat urinary tract infections and acute otitis media.

- **Trimethoprim and Sulfamethoxazole** (Bactrim®, Septra®) The combination of trimethoprim and sulfamethoxazole is an anti-infective used to treat urinary tract infection and otitis media.

- **Sulfacetamide Sodium** (Sodium Sulfamyd®, Bleph-10) Sulfacetamide sodium is an ophthalmic bacteriostatic for the treatment of conjunctivitis, corneal ulcer, and other superficial ocular infections. It is available in solutions of various strengths and in ointment form.

- **Silver Sulfadiazine** (Silvadene® Cream) is a topical antimicrobial agent used to treat second and third degree burns to prevent wound sepsis. It is water soluble and easily washed off the skin.
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 mechanism of action 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.

- **Penicillin G, Acute** is indicated for susceptible infection such as meningococcal meningitis, anthrax, and gonorrhea. Penicillin G is for parenteral (IV) use only.

- **Penicillin G, Benazathine (Bicillin® LA)** is indicated for conditions such as syphilis and upper respiratory tract infections caused by streptococcal (Group A) bacteria. This drug is injected into a large muscle.

- **Penicillin G Procaine, Aqueous (Wyocillin®)** is indicated for conditions such as uncomplicated pneumonia, middle ear and sinus infections, NUG and pharyngitis, and scarlet fever. Penicillin G procaine is for parenteral use only, and it has longer duration of action than most of the other penicillins.

- **Penicillin V Potassium (Pen-Vee K®, Betapen-VK®, V-Cillin K®)** is used to treat conditions such as upper respiratory tract infection, otitis media, sinusitis, bacterial endocarditis, and mild staphylococcal infection of skin and soft tissue. Penicillin V has the same spectra of activity of penicillin G and is usually the drug of choice for uncomplicated group-A beta-hemolytic streptococcal infections. It is available as oral tablets or powder for reconstitution for oral suspension.

- **Dicloxacillin Sodium (Dynopen®)** is used to treat infections caused by penicillin G-resistant staphylococci. It may be used to initiate therapy in any patient in whom a staphylococcal infection is suspected.

- **Ampicillin (Polycillin®)** is used to treat conditions such as shigella, salmonella, escherichia coli, and gonorrhea.

- **Amoxicillin (Amoxil®)** The spectrum of amoxicillin is essentially identical to ampicillin, except that amoxicillin is more effective against shigella. Amoxicillin also has the advantage of more complete absorption than ampicillin.

- **Amoxicillin and Clavulanate potassium (Augmentin®)** is used to treat many different infections caused by bacteria, such as sinusitis, pneumonia, ear infections, bronchitis, urinary tract infections, and infections of the skin.

Cephalosporins

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

This family of antibiotics is generally divided into three generations: first, second, and third generation. The main differences among the groups are the change in the antibacterial spectrum. The third generation agents have a much broader gram-negative spectrum than the earlier generations.

- **Cefazolin Sodium (Ancef®, Kefzol®)** is used to treat a wide range of medical conditions, such as lower respiratory tract infections (pneumonia and lung abscess), septicemia, and bone and joint infections. It is used preoperatively to reduce the chance of certain infections following surgical procedures (such as vaginal hysterectomy, gastrointestinal surgery, and transurethral prostatectomy).

- **Cephalexin (Keflex®)** is indicated for the treatment of infection of the respiratory tract, otitis media, skin and skin structures, and genitourinary system.
• Cefprozil (Cefzil®) is used to treat pharyngitis, tonsillitis, otitis media, bronchitis, and mixed infections of the skin and skin structure. Mixed infections are infections that include both aerobic and anaerobic pathogenic organisms. This medication is used preoperatively to prevent the incidence of certain postoperative infections.

Tetracyclines

Tetracyclines introduced in 1948, were the first truly broad-spectrum antibiotics. They include a large group of medications 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, they are most valuable to treat mixed infection, such as chronic bronchitis and peritonitis; however, they are medications 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 non-absorbable compounds.

• Tetracycline hydrochloride (Achromycin®, Sumycin®) is used to treat infections caused by rickettsiae (such as Rocky Mountain spotted fever and typhus fever), agents of lymphogranulommas venereum and granuloma inguinale, and the spirochetal agent of relapsing fever. Tetracycline hydrochloride is indicated for severe acne as an adjunctive therapy. Food and some dairy products may interfere with absorption; antacids containing aluminum, calcium, or magnesium impair absorption of the antibiotic as well. This medication should be given 1 hour before or 2 hours after meals.

• Doxycycline Hyclate (Vibramycin®) is active against a wide range of gram-positive and gram-negative microorganisms and has a low affinity for binding with calcium. In addition to the conditions listed under tetracycline, doxycycline is indicated for the treatment of uncomplicated chlamydial infections and uncomplicated gonococcal infections. Doxycycline can be used for malaria prophylaxis.

• Minocycline Hydrochloride (Minocin®) is indicated for the same conditions as tetracycline hydrochloride and doxycycline hyclate.

Aminoglycoside

Aminoglycosides are a group of medications 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.

- **Gentamicin sulfate** (Garamycin®) is used to treat serious systemic infections of susceptible gram-negative organisms. While the patient is on gentamicin sulfate, it is necessary to monitor renal and hepatic function to determine if toxic levels have been reached. It is available as a topical preparation for the treatment of burns and infected wounds, and as an ophthalmic preparation for eye infections.

- **Tobramycin sulfate** (Nebcin®) is used to treat serious infections such as septicemia, meningitis, and infections of the eye.

- **Neomycin sulfate** (Mycifradin®) is used as a topical preparation to treat skin infections, burn wounds, ulcers, and dermatoses. It is given orally to reduce intestinal flora prior to surgery involving the bowel or anus.

- **Clindamycin hydrochlorids** (Cleocin®) is used to treat susceptible anaerobic organisms. The use of clindamycin hydrochloride has often been associated with severe colitis and profuse diarrhea; if this condition occurs, the drug should be discontinued. A topical preparation is available for the treatment of acne.

- **Vancomycin hydrochloride** (Vancocin®) is indicated in potentially life-threatening infections not treatable with other effective, less toxic antimicrobials, including the penicillins and cephalosporins. Potentially life-threatening infections that vancomycin may be used for include endocarditis, osteomyelitis, pneumonia, and septicemia.

- **Azithromycin** (Zithromax®) is used for the treatment of community-acquired pneumonia, otitis media, infections of the skin structure, sexually transmitted diseases, chancroid, and bacterial sinusitis. It can be given as a one dose treatment, oral or parenteral, or over several days.

### Macrolides

Antibiotics constituting 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.

- **Erythromycin** (E-Mycin®, Ilotycin®) is one of the drugs of choice when penicillin is contraindicated. This medication is indicated to treat medical conditions such as gonorrhea; uncomplicated urethral, endocervical, and anal infections; early syphilis; and cases of severe or prolonged diarrhea associated with campylobacter enteritis and enterocolitis. It is prescribed, as a prophylactic agent, prior to colorectal surgery. Erythromycin is available in enteric-coated tablets, as an ophthalmic ointment, and as a topic preparation for the adjunctive treatment of acne. Erythromycin can make the skin more sensitive to sunlight and sunburn may result.

### Antifungals

Agents that 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. 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.
• **Nystatin (Mycostatin®)** is primarily used to treat candidal infections. It is fungicidal and fungistatic against a wide variety of yeasts and yeast-like fungi, and is most often used to treat candidiasis. It is can be used concurrently with tetracycline to suppress the overgrowth of *Candida* in the bowel.

• **Grisocoum (Gris-PEG%, Fulvicin%)** is a fungistatic agent given orally to treat fungal infections of the nails, hair, and skin. It is generally reserved for chronic infections that have not responded to topical therapy alone. Because treatment may last for several months, the patient should be instructed to follow the treatment regimen even though symptoms may abate. Inclusion of topical therapy is a must for effective elimination of the infection.

• **Miconazole nitrate (Monistat®, Micatin®)** is a synthetic antifungal that inhibits the growth of common dermatophytes. It is indicated to treat cutaneous fungal infections and vulvovaginal candidiasis.

• **Undecylenic acid (Desenex®)** is used primarily to treat and prevent tinea pedis and is often compounded with zinc to act as an astringent. It is available in ointment, dusting powder, solution, and spray.

• **Tolnaftate (Tinaclin®, Aftate®)** was the first fungicide synthesized. It is indicated for the topical treatment of tinea pedis, tinea corporis, tinea capitis, and tinea versicolor.

• **Clotrimazole (Lotrimin®, Mycelex®)** is a broad-spectrum antifungal that inhibits the growth of pathogenic dermatophytes, yeast, and other types of fungus growth, including *Candida albicans*. It is indicated for the treatment of tinea pedis, tinea cruris, tinea corporis, and candidiasis.

**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.

• **Permethrin (Elimite®/Nix)** is a pediculicide used to treat *Pediculosis capitis* (head lice) and *Phthirius pubis* (crab lice). It is indicated for scabies. Use with caution, especially in infants, children, and pregnant women, since it penetrates human skin and has the potential for systemic poisoning. This drug is irritating to the eyes and should be discontinued immediately if local irritation occurs. It is applied only once per treatment, and must be removed by water after the appropriate contact time has elapsed.

• **Metronidazole (Flagyl®)** is effective in treating amebiasis. It is also used as a trichomonoacide. Patients should be warned about combining Flagyl and alcohol, as it can produce violent side effects.

• **Mebendazole (Vermox®)** is regarded as the drug of choice for pinworm and roundworm infestations.

• **Pyrantel pamoate (Antiminth®)** is effective in treating infestations of hookworm, roundworm, pinworm, and whipworm.

• **Thiabendazole (Mintezol®)** is a vermicide used to destroy pinworms, roundworms, threadworms, hookworms, and whipworms. It is not indicated as a prophylactic agent.

**Antimalarial Preparations**

Antimalarial preparations are medications that are used to treat or prevent malaria. Malaria is a mosquito-borne disease caused by a parasite. People with malaria often experience fever, chills, and flu-like illness. Left untreated, they may develop severe complications and die.
• Chloroquine phosphate (Aralen®) is the drug of choice in treating acute malarial attacks. It is used in the prevention and suppression of malaria in endemic areas.

• Primaquine phosphate is the drug of choice for the prevention or relapse of malaria caused by *P. vivax* and *P. ovale*. It is contraindicated in G-6-PD-deficient personnel, as it may result in hemolytic anemia.

**Laxatives**

Laxatives are medications 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). They may 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. They are classified as irritant, bulk, emollient, or stool softeners. Frequent or prolonged use of any laxative may result in dependence.

• **Mineral oil** is an emollient laxative used to lubricate the fecal mass. It is often used in combination with an irritant agent such as phenolphthalein (Ex-Lax). It can also be used for bowel irrigation.

• **Lactulose** (Enulose®) is used for the treatment of chronic constipation. Diarrhea may be a sign of overuse or overdosing. It may be mixed with fruit juice, milk, or citrus flavored beverages.

• **Bisacodyl** (Dulcolax®) is a relatively nontoxic irritant cathartic that reflexively stimulates the colon on contact. It usually produces soft, formed stools in 6 to 12 hours and is normally taken at bedtime. It is often used as a preparatory agent prior to some surgeries and radiological examinations.

• **Magnesium citrate** (Citrate of magnesia) is a saline irritant laxative that also inhibits the absorption of water from the intestine. It is preferred by radiology departments for use prior to special x-rays.

• **Psyllium hydrophilic mucilloid** (Metamucil®) is a bulk laxative that works by absorbing water. The effect occurs within 12 to 72 hours. It is provided as a dry powder that is stirred into water or fruit juice. This laxative should be drunk immediately after mixing, while the material is in suspension.

• **Ducosate calcium** (Surfak®) is a stool softener that promotes water retention in the fecal mass.

**Diuretics**

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 of 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.

• **Hydrochlorothiazide** (Esidrix®, Oretic®) is used for edema associated with congestive heart failure and other edematous conditions. It is also used to manage hypertension as the sole agent or in combination with other antihypertensive agents.

• **Chlorthalidone** (Hygroton®) is used in the same manner as hydrochlorothiazide.

• **Furosemide** (Lasix®) a potent diuretic is used to treat edema associated with congestive heart failure, cirrhosis of the liver and renal disease. It is particularly useful when greater diuretic potential is desired, and may be used alone or in combination with other antihypertensive agents to treat hypertension.
• Acetazolamide (Diamox®) is used for the treatment of various forms of glaucoma. It can also be used to treat edema in patients with congestive heart failure and acute mountain sickness.

• Triamterene and hydrochlorothiazide (Dyazide®, Maxzide®) This combination of a potassium-sparing (triamterene) and potassium-depleting diuretic is often more effective than either drug alone. It is used for edema associated with congestive heart failure and other edematous conditions. It is also used in the management of hypertension.

Non-Narcotic Analgesics, Anti-pyretics, and Anti-Inflammatory Agents

Non-narcotic analgesics are medications 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 medications discussed were developed with two or more of these properties.

• Aspirin (ASA, Ecotrin®) is still the most economical analgesic, antipyretic, and anti-inflammatory agent available. Some preparations have an antacid-type buffer to assist in the reduction of gastric irritation. It is an analgesic for mild to moderate pain and an effective antipyretic. It is indicated for various inflammatory conditions, such as rheumatoid arthritis and bursitis.

• Acetaminophen (Tylenol®) is an analgesic and antipyretic used to relieve pain and fever accompanying diseases (such as the common cold and influenza). It is also used to relieve pain and discomfort of upper GI disease (ulcer and gastritis), gouty arthritis, a variety of arthritic and rheumatic conditions involving musculoskeletal pain, as well as other painful disorders. It is indicated for patients who are allergic to aspirin.

• Ibuprofen (Motrin®) is indicated for the relief of mild to moderate pain, including headaches and menstrual cramps. It is also used as an anti-inflammatory agent to treat arthritis, tendinitis, bursitis, etc. It is not recommended for use in cases of gastrointestinal bleeding or renal impairment, or during the third trimester of pregnancy.

• Indomethacin (Indocin®) is a potent anti-inflammatory agent with antipyretic and analgesic properties. With the potential for adverse reactions, indomethacin should be reserved for cases of chronic rheumatoid arthritis, osteoarthritis, and acute gout.

• Naproxen (Naprosyn®, Anaprox®) an analgesic indicated for the relief of mild to moderate pain and for the treatment of primary dysmenorrhea, rheumatoid arthritis, osteoarthritis, tendinitis, bursitis, and acute gout. The effects are similar to those of aspirin and indomethacin, but with fewer and less toxic gastrointestinal side effects; however, it is not indicated for patients with a history of gastrointestinal disease, especially those with a propensity for peptic ulcer disease.

• Meloxicam (Mobic®) is an anti-inflammatory agent used for treatment osteoarthritis, rheumatoid arthritis and juvenile rheumatoid arthritis. It is contraindicated in the 3rd trimester of pregnancy.

• Piroxicam (Feldene®) is an anti-inflammatory agent used to relieve the signs and symptoms of acute and chronic osteoarthritis and rheumatoid arthritis.

Central Nervous System Stimulants

Certain medications stimulate the activity of various portions of the central nervous system (CNS). The Manual of the Medical Department (MANMED) Chapter 21 is explicit as to the usage of these medications in the Navy. Primary indications for this class of medications are narcolepsy, hyperkinesis, 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 medication abuse.

- **Methylphenidate hydrochloride (Ritalin®)** is indicated for use in hyperkinetic children and children with attention deficit disorders. In children, this drug is used as a central nervous system depressant. Methylphenidate HCl is also indicated for narcolepsy in adults.

- **Dextroamphetamine sulfate (Dexadrine®)** is primarily indicated for narcolepsy. However, because of dextroamphetamine's anorexia effect (it diminishes appetite); it is occasionally used as an adjunct to diet therapy for obesity caused by overeating.

**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 Chapter 21 of 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.

- **Phenobarbital (Luminal®)** is a long-lasting barbiturate frequently used to treat convulsive disorders. This is the drug of choice in petit mal epilepsy, and it is used as a hypnotic or sedative.

- **Pentobarbital (Nembutal®)** is indicated for short-term treatment of insomnia. It is used as a preanesthetic medication.

- **Phenytoin sodium (Dilantin®)** is a nonbarbiturate anticonvulsant that is the drug of choice for the treatment and management of grand mal epilepsy. Because phenytoin sodium possesses no hypnotic properties, it is preferred to Phenobarbital in treating seizure disorders. However, Phenytoin sodium and Phenobarbital are frequently used in combination to more effectively manage certain types of epilepsies.

**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 medication group are used as analgesics, cough sedatives, and for certain types of diarrhea.

**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.

- **Morphine Sulfate (Roxanol®, MS Contin®)** is an opium alkaloid indicated for the relief of severe pain. It is used to preoperatively sedate patients and to treat severe pain associated with myocardial infarction. Morphine is contraindicated for patients with head injuries, acute alcoholism, and convulsive disorders.
• **Codeine Sulfate** is an opium alkaloid like morphine. However, it has only one-sixth of the analgesic power and one-fourth of the respiratory depressant effect of morphine. Codeine is used for moderate to severe pain and as an antitussive.

• **Meperidine hydrochloride (Demerol®)** is a synthetic analgesic similar to morphine. It is used for moderate to severe pain and as a preoperative medication. Meperidine HCl is not as effective as morphine in its analgesic properties.

**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.

• **Chlorpromazine hydrochloride (Thorazine®)** is indicated for alleviating manifestations of psychosis, tension, and agitation. Dosage is highly individualized depending on the severity of symptoms and degree of response. It may be used as an antiemetic.

• **Thioridazine (Mellaril®)** is used for antipsychotic purposes and is considered to be a good all around tranquilizer.

• **Prochlorperazine (Compazine®)** is most often used in the symptomatic treatment of nausea and vomiting, but it shares all the antipsychotic effects of chlorpromazine.

• **Haloperidol (Haldol®)** is indicated in treating schizophrenia with manifestations of acute manic symptoms, social withdrawal, paranoid behavior, and the manic stage of manic-depressive patients.

• **Lithium (Eskalith®, Lithonate®)** is used to treat manic episodes of manic-depressive illness. It is the drug of choice to prevent or diminish the intensity of manic episodes.

• **Amitriptyline hydrochloride (Elavil®)** is an antidepressive mood elevator with mild tranquilizing effects. It is indicated for the long-term treatment of depressive disorders.

• **Chlordiazepoxide hydrochloride (Librium®)** is an antianxiety agent for the treatment of anxiety disorders. It is not indicated for anxiety or tension associated with the stress of everyday activities. It is indicated in the abatement of acute withdrawal symptoms of alcoholism.

• **Hydroxyzine pamoate (Vistaril®, Atarax®)** is a rapid-acting antianxiety and antiemetic with antispasmodic and muscle relaxant effects. It is most often used in pre- and postoperative sedation and in conjunction with meperidine hydrochloride to enhance its effects and reduce nausea.

• **Diazepam (Valium®)** is useful in treating mild to moderate depression with anxiety and tension. Because of its muscle relaxant properties, it is used to treat spastic muscle conditions and convulsive seizure episodes. It is the drug of choice in status epilepticus. In the United States Military diazepam is also known as CANA (Convulsive Antidote, Nerve Agent). One CANA kit is typically issued to service members, along with three Mark I NAAK kits when operating in circumstances where chemical weapons in the form of nerve agents are considered a potential hazard.

• **Fluoxetine hydrochloride (Prozac®)** is an oral antidepressant used to treat depression. It may be useful in treating bulimia nervosa and obsessive compulsive disorders.

• **Zolpidem (Ambien®)** is a non-benzodiazepine and hypnotic indicated for the short term treatment of insomnia (difficult with sleep onset).

**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.

- Methocarbamol (Robaxin®) is used as an adjunct therapy for the relief of discomfort associated with acute, painful musculoskeletal conditions. It may have a beneficial effect in the control of neuromuscular manifestations of tetanus.
- Cyclobenzaprine (Flexeril®) is indicated as an adjunct to rest and physical therapy for relief of muscle spasm with acute painful musculoskeletal conditions.

Cardiovascular Agents

Cardiovascular agents affect the action of the circulatory system.

- Digoxin (Lanoxin®) is indicated for all degrees of congestive heart failure and for various arrhythmias. It has a direct effect on the myocardium, causing and increase in the force of contractions.
- Quinidine Sulfate is indicated for premature atrial and ventricular contractions and other arrhythmias. NOTE: Do NOT confuse this medication with quinine sulfate, an antimalarial.
- Amyl Nitrate is employed medically to treat heart diseases such as angina and is used for the prevention of erection in adult males following circumcision.
- Nitroglycerin (Nitrostat®, Nitro-Bid®) is indicated for the treatment and management of acute and chronic angina pectoris.
- Isosorbide dinitrate (Isordil®, Sorbitrate®) is similar to nitroglycerin in its antianginal action.
- Dipyridamole (Persantine®) is indicated as an adjunct to warfarin sodium (an anticoagulant) in the prevention of postoperative thromboembolic complications of cardiac valve replacement.
- Procainamide hydrochloride (Pronstyl®, Procan® SR) is indicated for the treatment of premature ventricular contractions, ventricular tachycardia, and atrial fibrillation. It may be used for cardiac arrhythmias associated with anesthesia and surgery.
- Verapamil (Isoptin®) is indicated for the treatment of angina pectoris and for the management of essential hypertension.
- Diltiazem (Cardizem®) is indicated for the treatment of angina pectoris and for the management of essential hypertension.

Vasoconstrictors

Vasoconstrictors produce constriction of the blood vessels with consequent rise in blood pressure.

- Epinephrine (Adrenaline, Chloride, Susprine) When inhaled, is used to relieve acute bronchial asthma. When injected, relieves respiratory distress in bronchial asthma attacks and relieves bronchospasms in patients with chronic bronchitis, emphysema, and other obstructive pulmonary diseases. It may be used to treat hypersensitivity reactions to drugs, serums, insect stings or other allergens. (Symptoms of these reactions may include bronchospasms; urticaria; pruritus; and swelling of the skin, lips, eyelids, tongue, and nasal mucosa; and anaphylactic shock.
- Tetrahydrozoline hydrochloride (Visine® Eye Drops) is an ophthalmic preparation for symptomatic relief of irritated eyes.
- Phenylephrine hydrochloride (Neo-Synephrine®) is used to shrink mucous membranes of the nose and to relieve local congestion.
- Oxymetazoline hydrochloride (Afrin®) is a topical vasoconstrictor used to relieve nasal congestion.
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.

- **Heparin sodium** is used in prophylaxis and treatment of venous thrombosis (and its expansion) and of pulmonary embolism.
- **Warfarin sodium (Coumadin®)** is used extensively to treat embolism in the prevention of occlusions.

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 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.

- **Vitamin A (Retinal)** is a fat-soluble vitamin is necessary for visual adaptation to darkness. Deficiencies rarely occur in well-nourished individuals, and an excess of vitamin A can be toxic. Conditions which may cause vitamin A deficiency include biliary tract or pancreatic disease, colitis, hepatic cirrhosis, and extreme dietary inadequacy (such as anorexia). Retinoic acid, a degradation product of retinol, is useful to treat acne and pseudofolliculitis barbae.
- **Vitamin B₃ (Riboflavin)** is a water-soluble vitamin functioning in the body as a coenzyme necessary in tissue respiratory processes, e.g., oxidation reduction reactions. Deficiency is associated with cheilosis, glossitis, visual disturbances, or visual fatigue.
- **Vitamin B₅ (Niacin)** is a water-soluble vitamin indicated for the correction of niacin deficiency and in the prevention and treatment of pellagra.
- **Vitamin B₆ (Pyridoxine hydrochloride)** is a water-soluble vitamin and a coenzyme in the metabolism of protein, carbohydrate, and fat. It is most often used during isoniazid (INH) therapy to prevent the development of peripheral neuritis.
- **Vitamin B₁₂ (Cyanocobalamin)** is a water-soluble vitamin that is essential to growth, cell reproduction, and blood cell formation. When vitamin B₁₂ therapy is used to treat pernicious anemia, the treatment is continued indefinitely, and folic acid is normally included in the therapy protocol.
- **Vitamin C (Ascorbic acid)** is a water-soluble vitamin necessary for the prevention and cure of scurvy. Vitamin C in high doses is believed to prevent the common cold, and to treat asthma, atherosclerosis, wounds, schizophrenia, and cancer.
- **Vitamin D** is a fat-soluble vitamin involved in the regulation of calcium and phosphorous metabolism. Vitamin D deficiency leads to rickets in children and osteomalacia in adults.
- **Vitamin E (Tocopherol)** is a fat-soluble vitamin and an antioxidant that prevents the destruction of red blood cells by preventing fatty acids in the red blood cells from taking on too much oxygen. It stimulates the production of an enzyme necessary to cell respiration and protects the cell membrane.
- **Vitamin K** The naturally occurring form of vitamin K is fat-soluble. However, many synthetic forms of vitamin K are water-soluble. Vitamin K is involved in the formation of prothrombin and other blood clotting factors. Deficiency results in an increase in blood clotting time.

**General and Local Anesthetics**

Generally speaking, anesthesia means “without feeling” and application of the word anesthetic to medication leads to the insensibility to pain.

- **General anesthetics** are usually gaseous or vaporized 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 MO. HMs may be called upon to assist in administering general anesthesia. HMs should become familiar 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 medications are administered parenterally or topically.

- **Nitrous Oxide** commonly called laughing gas and is used with oxygen in general anesthesia. It may produce a condition during which the patient may laugh and become quite talkative. It is commonly used in dentistry or as a preinduction agent to other general anesthetic.

- **Ketamine Hydrochloride (Ketalar®)** is a fast acting general anesthetic agent used as a preinduction agent for procedures that do not require skeletal muscle relaxation. One significant effect of this agent is that when the patient begins to recover from the drug, they may experience psychological manifestations ranging from pleasant dream-like states to hallucinations to delirium accompanied by confusion and irrational behavior. The effects of these manifestations may be minimized by keeping aural and tactile stimuli to a minimum. It is contraindicated for patients with hypertensive disease.

- **Fentanyl and droperidol (Innovar®)** Fentanyl and droperidol are a combination of a narcotic (fentanyl) and a tranquilizer (droperidol). Because of the self-potentiating combination, the combination must be used with extreme caution in patients with any respiratory problems.

- **Procaine hydrochloride (Novocain®)** Administered only by injection, it may be used for many types of anesthesia, including spinal anesthesia. It is available in various solutions for injection.

- **Lidocaine hydrochloride (Xylocaine®)** is the standard to which all other anesthetics are compared. It may be combined with epinephrine for vasoconstrictive effects. Lidocaine is also used to treat myocardial infarctions to prevent or suppress ventricular contractions.

**CAUTION:**
Total dosage injected in 24 hours should not exceed 0.05 g per patient when used with epinephrine.

- **Dibucaine (Nupecainal®)** is used as a topical local anesthetic on mucous membranes and may also be administered parenterally.

- **Proparacaine (Ophthecic®, Ophthaine®)** is a local ophthalmic anesthetic used topically. It is suited for almost every ophthalmic procedure. Proparacaine is fairly long lasting.
Oxytocics

Oxytocics are medications that produce a rhythmic contraction of the uterus. Although their action is selective for the uterus, other smooth muscles are affected.

- Ergonovine maleate (Ergotrate® Maleate) is used in the treatment of postpartum and post-abortal hemorrhage.
- Oxytocin (Pitocin®) is indicated for the initiation or improvement of uterine contractions or to control postpartum hemorrhage.

Immunizations

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 the package insert. Refer to BUMEDINST 6230.15 series, Immunizations and Chemoprophylaxis for more information.

Immunizing and chemoprophylaxis agents are stored, shipped, and handled in accordance with the pharmaceutical manufacturers’ instructions as outlined in the product’s package insert or other guidance.

The following is a descriptive list of the most common immunizing agents used by the U.S. armed forces to inoculate military personnel against disease.

- Anthrax immunization is administered to prevent anthrax infection by any route of exposure due to spores or the bacteria Bacillus anthracis. Inhalational anthrax is almost uniformly fatal once symptoms develop.
- Hepatitis A vaccine is given to prevent hepatitis A, an acute infection of the liver, acquired by consuming food or water contaminated with hepatitis A virus during deployment or travel to areas with poor food, water, and sewage sanitation. Hepatitis A is endemic worldwide.
- Hepatitis B vaccine is given to prevent hepatitis B, an acute or potentially chronic infection of the liver that is acquired through percutaneous, sexual, and other percutaneous exposure to blood and body fluids from people infected with hepatitis B virus. Hepatitis B infections occur worldwide, and some infected people maintain a chronic carrier state.
- Influenza A and B vaccine is used to prevent influenza A and B, which are acute febrile respiratory viral infections that can cause epidemics within military populations, especially under conditions of crowding, such as initial entry training, aboard ship, extended air transport, or deployment settings.
- Measles, mumps, and rubella (MMR) vaccine is indicated to prevent Measles, mumps, and rubella, primarily by boosting immunity acquired from childhood immunization. These 3 acute viral infections are spread by the respiratory route or person-to-person contact. In military trainee populations, each can cause disease outbreaks. Rubella usually causes a mild infection, but infection during the first trimester of pregnancy puts the fetus at high risk of congenital rubella syndrome and birth defects. Young adults may experience more severe complications from mumps infection. All 3 diseases occur worldwide, primarily among children.
- Smallpox vaccine In 1980, the World Health Organization (WHO) declared the global eradication of naturally occurring smallpox. Stocks of variola virus, the causative agent of smallpox, could be used as a biological warfare agent. Designated military personnel are vaccinated according to DOD policy and Service-specific implementation plans.
• **Tetanus, diphtheria, and pertussis** is indicated to prevent tetanus, diphtheria, and pertussis, primarily by boosting immunity acquired from childhood immunization. Tetanus is an acute illness caused by an exotoxin of *Clostridium tetani*, bacteria that grows at the site of wounds contaminated with its spores. The *C. tetani* spores are ubiquitous in the environment worldwide. Diphtheria is an acute disease caused by a cytotoxin of the bacteria *Corynebacterium diphtheriae*. Diphtheria occurs worldwide. Pertussis is an acute illness caused by the bacteria *Bordetella pertussis*. Available vaccines include bivalent tetanus–diphtheria (Td) toxoids and Td combined with acellular pertussis (Tdap) antigens. The Tdap is preferred so that people vaccinated sustain immunity to pertussis.

• **Yellow fever** is administered to prevent yellow fever, a mosquito-borne viral disease, and to meet international health requirements during deployment or travel to yellow–fever–endemic areas.

**NOTE:**
Always refer to the most recent BUMED instruction for current immunization requirements.

**PHARMACY CALCULATIONS**

**LEARNING OBJECTIVES:**

Identify the various pharmaceutical weight and measurement system.

Recognize medication dosage by using the conversion process or the percentage and ratio calculations.

This section will provide the HM with a basic introduction to the field of pharmacy and help in preparing for these responsibilities.

**METROLOGY AND CALCULATION**

Metrology, called the arithmetic of pharmacy, is the study and science of weights and measures. The use of metrology in pharmacy applies to medications, their dosage, preparation, compounding, and dispensing. It is absolutely vital for HMs to thoroughly understand the principles and applications of metrology in pharmacy. Errors in this area may endanger the health and even the life of the patient.

**THE METRIC SYSTEM OR INTERNATIONAL SYSTEM OF UNITS (SI)**

The Metric System, also called the International System of Units (SI), 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. HMs 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, ten, one hundred, and one thousand, respectively, and the prefixes micro, milli, centi, and deci for one-tenth thousandth, one-thousandth, one-hundredth, and one-tenth, respectively, makes up the basic structure of the Metric System.
By applying the appropriate basic unit to the scale of Figure 18-1, the HM can readily determine its proper terms. For example, using the gram as the basic unit of weight, the HM 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.

- Symbols should not be combined with spelled-out terms in the same expression. **Example:** 3 mg/mL, **not** 3 mg/milliliter.
- A zero should be placed in front of a leading decimal point to prevent medication errors caused by *uncertain* decimal points. **Example:** 0.5 g, **not** .5 g.

**NOTE:**
It is critically important to recognize that a misplaced or misread decimal point can lead to an error in calculation or dispensing of a minimum of one tenth or ten times the desired quantity.

- To prevent misreading and medication errors, “trailing” zeros should not be placed following a whole number on prescriptions or medication orders. **Example:** 5 mg, **not** 5.0 mg. **Exceptions:** A “trailing zero” may be used only where required to demonstrate the level of precision of the value being reported, such as for laboratory results, imaging studies that report size of lesions, or catheter/tube sizes. It may not be used in medication orders or other medication-related documentation.

**OTHER SYSTEMS OF MEASUREMENT**

In addition to the metric system, the HM should be aware of two other systems of measurement: the avoirdupois and apothecaries’ systems.

**The Apothecaries’ System**

Although fast becoming obsolete, is a system for weighing and calculating pharmaceutical preparations. It is still used and must be taken into consideration. It has two divisions of measurement: weight and volume. In the Apothecaries’ system, the basic unit of weight is the **grain** ("gr"), and the basic unit of volume is the **minim** ("m").
The Avoirdupois System

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 18-1, a table of weights and measures with metric doses and their equivalents.

<table>
<thead>
<tr>
<th>Systems of Weights</th>
<th>Systems of Volume Measures</th>
<th>Linear Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AVOIRDUPOIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary unit of weight is the grain.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>437.5 grains = 1 ounce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(av. oz.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.0 ounces = 1 pound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(av. lb.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>APOTHECARY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary unit of weight is the grain.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 grains (gr) = 1 scruple (s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 scruples = 1 dram (d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 drams = 1 ounce (o)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(480 gr) = 1 pound (lb)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>METRIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary unit of weight is the gram.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000,000 grams = 1 kilogram (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100,000 grams = 1 hectogram (hg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000 grams = 1 dekagram (dg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 grams = 1 gram (gm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1 gram = 1 decigram (dg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01 gram = 1 centigram (cg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.001 gram = 1 milligram (mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>METRIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary unit of volume is the liter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000,000 liters = 1 kiloliter (kl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100,000 liters = 1 hectoliter (hl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000 liters = 1 dekaliter (dkl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 liters = 1 liter (l)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1 liter = 1 deciliter (dl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01 liter = 1 centiliter (cl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.001 liter = 1 milliliter (ml)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: The relationship of the basic units in the Metric System should be noted. The meter, which is 1/10,000,000 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 18-1.—Table of Metric Doses with Approximate Equivalents
CONVERTING WEIGHTS AND MEASURES

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. Patients are not expected to be familiar with either system. Therefore, the HM must always translate the dosage directions on the prescription into terms the patient can easily understand. Household measurements are standardized on the assumption that the utensils are common enough to be found in any home. Table 18-2 is a table of household measures, with their metric and apothecary equivalents.

### Table 18-2. Household Measurements with Metric and Apothecary Equivalents

<table>
<thead>
<tr>
<th>Metric</th>
<th>Apothecary</th>
<th>Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ml</td>
<td>1 fl dr</td>
<td>1 teaspoonful*</td>
</tr>
<tr>
<td>10 ml</td>
<td>2 fl dr</td>
<td>1 dessertspoonful</td>
</tr>
<tr>
<td>15 ml</td>
<td>4 fl dr</td>
<td>1 tablespoonful (½ fl oz)</td>
</tr>
<tr>
<td>30 ml</td>
<td>8 fl dr</td>
<td>2 tablespoons (1 fl oz)</td>
</tr>
<tr>
<td>60 ml</td>
<td>2 fl oz</td>
<td>1 wineglassful</td>
</tr>
<tr>
<td>120 ml</td>
<td>4 fl oz</td>
<td>1 teacupful</td>
</tr>
<tr>
<td>240 ml</td>
<td>8 fl oz</td>
<td>1 tumblerful</td>
</tr>
<tr>
<td>480 ml</td>
<td>16 fl oz</td>
<td>1 pint</td>
</tr>
<tr>
<td>960 ml</td>
<td>32 fl oz</td>
<td>1 quart</td>
</tr>
</tbody>
</table>

*Official U.S.P. teaspoonful is 5 ml.

### CAUTION:

Exact equivalents must be used when converting specific quantities in a prescription and when converting a pharmaceutical formula from one system to another.

When quantities in units of the apothecaries or avoirdupois systems are encountered they should be converted to equivalent quantities in metric units.

The required calculation should then be solved in the usual manner.

CONVERSION

In the practice of pharmacy, it may be necessary to convert from one system to another in order to dispense the proper amounts of medications that have been ordered. Although the denominations of the metric system are not the same as the other 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 18-2 and 18-3) are more than sufficient for practical use. Table 18-4 provides examples of conversions. If potent agents are involved, the HM must use a more precise conversion factor for purposes of calculation.

### Conversion Table for Weights and Liquid Measures

<table>
<thead>
<tr>
<th>Metric</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 grain</td>
<td>0.065 gram or 65 milligrams</td>
</tr>
<tr>
<td>1 gram</td>
<td>15.432 grains</td>
</tr>
<tr>
<td>1 milliliter</td>
<td>16.23 minims</td>
</tr>
<tr>
<td>1 fluid ounce</td>
<td>29.57 milliliters</td>
</tr>
</tbody>
</table>

Table 18-3.—Conversion Table for Weights and Liquid Measurements
SOLVING PERCENTAGE PROBLEMS

A popular method for solving percentage problems is illustrated below. This method is often preferred since it eliminates errors that may result from misinterpreting the values given in the problem.

\[
\% \text{ strength} = \frac{\text{amount of active ingredient} \times 100(\%)}{\text{total amount of preparation}}
\]

**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).

\[
X = \frac{6}{120} \times 100(\%) = 5 (\%)
\]

Therefore, \( X = 5 \), which is the percent strength of the solution.

A variation of the alternate percentage equation, illustrated below, uses "parts per hundred" instead of percent, with \( X \) used as the unknown.

\[
\frac{\text{amt of active ingredient}}{\text{amt of total preparation mixture}} = \frac{\text{parts of active ingredient}}{100 \text{ parts (total mixture)}}
\]

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. Ratios can also be written as a fraction with the first term as the numerator and the second term as the denominator. 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 the expression of equality of two ratios. It may be written in any one of the following three standard forms:

- \( a:b = c:d \)
- \( a:b :: c:d \)
- \( a/b = c/d \)

Each of these expressions is read: \( a \) is to \( b \) as \( c \) is to \( d \), and \( a \) and \( c \) are called the extremes (meaning “outer members”) and \( b \) and \( c \) the means (“middle members”).

**Application of Proportion**

In any proportion, the product of the extremes is equal to the product of the means. This principle assists the HM to find the missing term in any proportion when the other three terms are known. If the missing term is a mean, it will be the product of the extremes divided by the given mean, and if it is an extreme, it will be the product of the means divided by the given extreme.

The important factor when working proportions is to put the right values in the right places within the proportion. If the proportion is set up properly, the position of the unknown term does not matter. By following a few basic rules, the HM can accomplish this without difficulty and solve the problem correctly.

When solving calculations that relate to medication products, assess the information provided and write out the first fraction using the “given” information, usually the strength or dosage provided on the stock bottle. This is usually the dose in milligrams over the volume needed to represent one dose. For example, if the HM has a product that is 10 mg/ml, this means that there are 10 mg of active ingredient in each milliliter. This is the same as 10 mg / 1 ml.

The second fraction contains the unknown, represented by \( x \), and the other element provided in the problem.

To find out how many milligrams are in 10 mL, set up the following ratio and proportion.

\[
\begin{align*}
10 \text{ mg} & \quad x \text{ mg} \\
1 \text{ ml} & \quad 10 \text{ ml}
\end{align*}
\]

The key to setting up ratio and proportions is to keep like units consistent. If the first fraction is stated as mg/ml, the second fraction should be stated the same way. Doing this will enable the HM to solve the equation and identify the answer using the correct units. The HM must be aware of which units are needed for the final answer, such as milligrams, milliliters, and liters.

**Example:** Medication B is supplied as 15 mg / ml. How many milliliters of medication B are required to provide a patient with a 20 milligram dose?

Set up the first fraction with the given information, 15 mg / ml. The second fraction is set up in the same manner, mg / ml.

\[
\begin{align*}
15 \text{ mg} & \quad 20 \text{ mg} \\
1 \text{ ml} & \quad x \text{ ml}
\end{align*}
\]

Multiply the means \((20 \times 1)\) and divide by the extremes \((15)\). \(20 \times 1\) / 15 = 1.33 ml

**PHARMACEUTICAL PREPARATIONS**

**LEARNING OBJECTIVE:**

*Identify the composition and physical characteristics of commonly used pharmaceutical preparations.*

While assigned to a pharmacy in a treatment facility, the HM may be required to make pharmaceutical preparations. The following sections provide information 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 a consistency 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.

SUPPOSITORYIES

Suppositories are solid bodies intended to introduce medicinal substances into the various orifices of the body (rectum, vagina, and urethra). The ingredients are incorporated into 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.

PHARMACEUTICAL INSTRUMENTS

LEARNING OBJECTIVE:

Identify commonly used pharmaceutical instruments and describe the purpose of each.

In the process of preparing some pharmaceutical preparations, the HM may need to use specialized instruments. The following sections provide commonly used pharmaceutical instruments, a description of each instrument, and an explanation of their purpose. See Figure 18-2 for an illustration of each instrument discussed.

Figure 18-2.—Pharmaceutical Instruments
PHARMACEUTICAL BALANCES

Pharmaceutical balances are used for weighing substances. Two types of pharmaceutical balances are in common use in the Navy: torsion balances and electronic balances. Torsion balances, also called Class A prescription 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. Most pharmacies now use electronic balances because they provide greater accuracy and are easier to use (Fig. 18-3).

ERLENMEYER FLASK

An 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

A mortar and pestle are used to reduce substances to fine powders. These two items always go together, one being useless without the other. The mortar is a heavy bowl, with one distinct property: the inside concavity is geometrically hemispheric. The accompanying pestle is a hand tool 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 Wedgwood. 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 medications are likely to react with the metals.

SPATULA

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

Graduates are corical or cylindrical clear glass containers graduated in specified quantities and used to measure liquids volumetrically. Measuring should always be done at eye level. It is best to select the graduate with a capacity equal to or just exceeding the volume to be measured to ensure the most accurate measurement\(^\text{19}\) (Fig. 18-4).

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**Figure 18-4.—Graduate Conversion**

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18-32