

## Lecture

# I. Introduction

## A. Goal

1. In the prehospital setting
  - a. Reverse, prevent, or control various diseases and illnesses
  - b. You must be able to interpret a patient's history and physical findings, formulate a management plan, and incorporate appropriate treatment modalities.
2. Medication errors
  - a. Leading cause of patient safety errors in health care
  - b. All medications are poisons if given to the wrong patient or in toxic quantities.

# II. Historical Trends in Pharmacology

## A. Ancient Health Care

1. Basic first-aid techniques
2. Chemical compounds
  - a. Used to treat certain ailments
  - b. Documents found containing formularies for more than 700 medications

## B. The Pre-Renaissance and Post-Renaissance Periods

1. Medieval period
  - a. Doctors had no concept of viruses or bacteria.
  - b. Sickness represented punishment for one's sins.
  - c. Treatment centered on approaches to counteract the presenting symptoms.
  - d. Blood, phlegm, black bile, and yellow bile
  - e. After the Renaissance, medication use took on a slightly more scientific approach.

## C. Modern Health Care

1. 19th century
  - a. The modern pharmaceutical industry began.
  - b. Discovery of highly active medicinal compounds
  - c. Today \$243 billion industry
2. Pharmaceuticals
  - a. Expected to continue to make great strides in all aspects of disease treatment
  - b. Prevention and treatment progress
  - c. Biotechnology

# III. Medication Names

## A. Medication

1. A drug that has been approved by the government agency that regulates pharmaceuticals (FDA)
  - a. Cures or reduces symptoms
  - b. Assists in the diagnosis, treatment, or prevention of a disease
2. Prescription
  - a. Prescription-only medicines (POM)
  - b. Over-the-counter (OTC): do not require a prescription
3. Research and development
  - a. Pharmaceutical companies invest more than \$34 billion each year.
  - b. Patents: give their holder exclusive rights to produce and sell the drug until the patent expires
  - c. Generic drug: after it loses its patent, a drug can be made available from multiple sources.
4. Systematic naming system
  - a. Chemical name: describes the drug's chemical makeup (composition and molecular structure)
  - b. Generic name: general name for a drug (derived from the chemical name)
  - c. Trade name: unique name under which the manufacturer registers the new drug with the FDA
  - d. Official name: once the generic name has been approved by the US Adopted Names Council and the drug has been approved by the FDA

## IV. Sources of Drugs

### A. Overview

1. Four principal sources
  - a. Animal
  - b. Vegetable: roots, leaves, flowers, and seeds
  - c. Mineral: includes calcium, iron, and magnesium
  - d. Synthetic compounds: vitamins, steroids, narcotics

## V. Sources of Drug Information

### A. Overview

1. Continuing education
  - a. Stay abreast of newly approved medications and current research.
  - b. Print and electronic formats
  - c. See Table 7-2 Sources of Drug Information.
2. Internet
  - a. Reputable and reliable sources
  - b. Epocrates: software versions of resources

## VI. US Regulation of Pharmaceuticals

### A. Overview

1. Manufacture
  - a. Subject to a variety of laws and regulations
  - b. Protect consumers
  - c. Prohibit manufacturers from making false claims about their drugs
  - d. Outline standards for drug manufacture to ensure that drugs are of uniform strength and purity
  - e. United States Pharmacopeia and the National Formulary

### B. Drug-Related Legislation

1. Pure Food Act (1906)
  - a. First federal legislation aimed at protecting the public from mislabeled, poisonous, or otherwise harmful foods, medications, and alcoholic beverages
  - b. Required little more than the labeling of drugs
2. Food, Drug and Cosmetic Act (1938, amended in 1952 and 1962)
  - a. Required drug makers to label their products (potentially habit-forming substances and warnings about possible side effects)
  - b. Authorized the creation of the FDA
  - c. Mandated that dangerous drugs could be dispensed only with a prescription from a physician, dentist, or veterinarian
3. Harrison Narcotic Act (1914)
  - a. Regulated the import, manufacture, prescription, and sale of several nonnarcotic drugs and cocaine, opium, and their derivatives
  - b. Precise record keeping required
4. National Control Act (1956)
  - a. Increased the penalties for violation of the Harrison Act
  - b. Possession of heroin made illegal
  - c. Outlawed the acquisition and transportation of marijuana
5. Controlled Substances Act (1970)
  - a. Comprehensive legislation dealing with narcotic and nonnarcotic drugs that have the potential for abuse
  - b. Specifies requirements for registration, procurement, storage, distribution, and record keeping
  - c. Schedule I: drugs with highest abuse potential and a propensity for severe dependence (LSD, marijuana, MDMA, psilocybin, and mescaline)
  - d. Schedule II: drugs with a very high abuse potential, but with a lower propensity for addiction than Schedule I drugs (amphetamines, opiates, cocaine, Demerol, and short-acting barbituates)
  - e. Schedule III: lower potential for abuse than I and II (Vicodin, Tylenol with codeine)
  - f. Schedule IV: drugs with a low abuse potential and limited dependence potential (phenobarbital, chloral hydrate, Valium, and Ativan)

- g. Schedule V: lowest potential for abuse (cough syrups containing codeine)
- 6. State laws
  - a. May be more stringent than federal law

### **C. Manufacturing-Related Regulations**

- 1. Standardization of doses
  - a. Assures patients that they will receive the prescribed amount of the drug
  - b. Assay: analysis of a drug to evaluate its potency
  - c. Bioassay: procedure for determining the concentration, purity, and/or biological activity of a substance by measuring its effect on an organism, tissue, cell, or enzyme

### **D. Government Agencies That Regulate Drugs**

- 1. FDA
  - a. Enforces the Food, Drug and Cosmetic Act
  - b. Determines the safety and efficacy of drugs
- 2. Drug Enforcement Agency (DEA)
  - a. Formerly the Bureau of Narcotics and Dangerous Drugs (created by the Federal Controlled Substances Act of 1970)
  - b. Division of the Justice Department
  - c. Executes the provisions of the Federal Controlled Substances Act
  - d. Registration of physicians permitted to dispense controlled substances
- 3. Public Health Service (PHS)
  - a. Regulates biologic products (medications made from living organisms)
- 4. Federal Trade Commission (FTC)
  - a. Monitors drug advertising
  - b. Recommendations for direct-to-consumer advertisements

## **VII. The Drug-Approval Process**

### **A. Overview**

- 1. Commercialization process
  - a. Takes years
  - b. The average time for a drug to be developed, tested, and approved is about 9 years.
  - c. All drugs must go through animal studies and clinical trials in humans.

### **B. Animal Studies**

- 1. Identify tissues and organs sensitive to the drug's actions
  - a. Also to elucidate the drug's pharmacodynamic and pharmacokinetic properties
  - b. At least two animals species required by law

### **C. Clinical Trials**

- 1. Four phases

- a. Phase I: tested in healthy volunteers to compare human data with those in animals, to determine safe doses, and to assess its safety
- b. Phase II: performed in homogenous populations of patients; double-blind studies; to evaluate the drug's efficacy and safety and to establish which form is the most effective dose
- c. Phase III: drug made available to a larger group of patients; usually lasts several years; to evaluate the drug's efficacy and to monitor the nature and incidence of side effects
- d. Phase IV: to compare the new drug with others on the market and to examine the drug's long-term efficacy and cost-effectiveness

#### **D. FDA Classification of Newly Approved Drugs**

1. Center for Drug Evaluation and Research (CDER)
  - a. Streamlined process to assign a numeric and letter classification to aid in the approval process
  - b. Reflect the type of drug being submitted and its intended uses
2. Numeric classifications
  - a. 1: a new molecular drug
  - b. 2: a new salt of a previously approved drug
  - c. 3: a new formulation of a previously approved drug
  - d. 4: a new combination of two or more drugs
  - e. 5: an already marketed drug product
  - f. 6: a new indication or claim for a drug that is already being marketed
  - g. 7: a drug that is already marketed with no new drug application
3. Letter classifications
  - a. S: standard review of drugs that are similar to currently available drugs
  - b. P: priority review for drugs that represent significant advances over treatments that currently exist
  - c. O: orphan drugs
  - d. AA: drugs indicated for acquired immunodeficiency syndrome (AIDS) and human immunodeficiency virus (HIV)-related disease
  - e. E: drugs developed or evaluated under special procedures to treat life-threatening or severely debilitating illnesses

## **VIII. Special Considerations in Drug Therapy**

### **A. Pregnant Patients**

1. Pharmacologic challenges
  - a. Alert the mother's anatomy and physiologic functions
  - b. Potential to directly harm the fetus
  - c. You must be familiar with how a particular medication might affect the fetus before administration.
  - d. Rating scale developed by the FDA (A, B, C, D, and X)

**B. Pediatric Patients**

1. Different effects in adults vs. children
  - a. Babies have a sharply reduced metabolic capacity.
  - b. Children can metabolize some medications much more quickly than adults.
  - c. Incomplete development of the gastrointestinal tract slows absorption of oral medications and delays elimination.

**C. Geriatric Patients**

1. Changes in pharmacokinetics
  - a. Comparable to those in young children
  - b. Metabolism and gastrointestinal activity slow.
  - c. Often take several medications
  - d. Unintentionally overdose on a particular drug or forget to take it

**D. You are the Provider**

1. Present the case study provided on the slide:
  - a. You are dispatched to an office building for a 48-year-old woman with sudden onset of lethargy. The patient is confused and experiencing blurred vision and slurred speech. You find information about herbal remedies for stress reduction on her desk. A coworker tells you that the patient had mentioned "taking something."
    - One of the keys of patient care is to not rely upon past experiences and assume the same is happening with this patient. Patient may be leery of answering questions due to location or surroundings.

## IX. The Scope of Management

**A. Safe and Effective Drug Administration**

1. Administration of pharmacologic agents
  - a. Lifesaving and life-endangering potential
  - b. Ignorance or carelessness can do great harm

**B. Legal, Moral, and Ethical Responsibilities**

1. Legally responsible
  - a. Appropriate use and documentation of therapy
  - b. Even if another paramedic prepares the medication
2. Guidelines
  - a. Make certain you understand the precautions and contraindications associated with each medication.
  - b. Practice proper administration techniques.
  - c. Know the side effects associated with the particular medication, and understand how to observe for, and document, side effects experienced by your patient.
  - d. Understand the pharmacokinetics and pharmacodynamics of the medications.
3. Information
  - a. Obtain concise yet thorough information.

- b. Get an accurate list of the patient's current prescribed medications.
  - c. Avoid potentially dangerous drug interactions.
4. Patient's rights
- a. Right to refuse treatment
  - b. Fully inform your patient about the care you are giving (potential effects and side effects of medications).

## X. Pharmacology and the Nervous System

### A. Central Nervous System

1. Control center
  - a. Receives input, interprets the stimulus, and makes decisions and directs actions

### B. Peripheral Nervous System

1. All nervous tissue outside of the brain and spinal cord
  - a. Somatic nervous system
  - b. Autonomic nervous system (ANS): particularly vulnerable to medications
  - c. Ganglia: groupings of nerve cell bodies that act as relay stations
2. Sympathetic nervous system
  - a. Responsible for fight-or-flight response
  - b. Dominant system during periods of stress and activity
  - c. Regulates hypoglycemia, hypothermia, and trauma
  - d. Nerves originate in the thoracic and lumbar sections of the spinal cord.
  - e. Heart rate and force of contraction
  - f. Sympathomimetic response: increased systemic heart rate and blood pressure
3. Parasympathetic nervous system
  - a. Dominant system during rest and relaxation
  - b. Nerves originate in the brain stem and sacral segments of the spinal cord.
  - c. Innervate most of the body (eyes, salivary glands, ears, lungs, and abdominal organs)
  - d. Decreases the rate and contractility of the heart

### C. Neurochemical Transmission

1. Neurotransmission
  - a. Process of chemical signaling between cells
  - b. Synthesis of chemical signals
  - c. Signals stored in nerve terminal
  - d. Signals released from the nerve ending
  - e. Signals bound to a receptor
  - f. Receptor: unique molecular structures or sites that bind with substances (hormones, drugs, and neurotransmitters); highly specialized
  - g. Degradation of signal

### D. Other Receptors

1. Local mediators and secretion of hormones
  - a. Locally released chemicals (most are destroyed or removed)
  - b. Hormones transmitted throughout the entire body

#### **E. Altering Neurotransmission With Drugs**

1. Necessary to alter normal neurotransmission
  - a. Drugs that mimic or inhibit neurotransmission
  - b. Inhibit the release of neurotransmitters
  - c. Block receptor sites

#### **F. Selective Drug Action: Nicotinic and Muscarinic Receptors**

1. Nicotinic receptors
  - a. Present in many tissues in the body
  - b. Function at the neuromuscular junctions of somatic muscles
  - c. Stimulation causes muscular contraction.
  - d. Triggered by ACh; also opened by nicotine
  - e. Effects: sympathetic overactivity and neuromuscular dysfunction (tachycardia, hypertension, dilated pupils, muscle fasciculation, and muscle weakness)
2. Muscarinic receptors
  - a. Found throughout the body as subcomponents of the CNS and ANS
  - b. Primary neurotransmitters are ACh and muscarine.
  - c. Effects: parasympathetic overactivity (bradycardia, miosis, sweating, blurred vision, excessive lacrimation, excessive bronchial secretions, wheezing, shortness of breath, coughing, vomiting, abdominal cramping, diarrhea, and urinary and fecal incontinence)
  - d. Atropine: common medication given in prehospital setting to reverse these effects

## **XI. General Properties of Medications**

### **A. Overview**

1. Drugs adjust or influence the body's existing functions.
  - a. Do not provide the body with functions it does not already have
  - b. Interact with various cells and tissues in the body
  - c. Bind to a receptor site and trigger a stimulus
2. Affinity
  - a. Attraction between a medication and its receptors
3. Agonist
  - a. Medication that stimulates a response in a receptor site
  - b. The strength of the effect depends on the concentration of the agonist at the receptor site.
  - c. Determined by the dose administered and the drug's rate of absorption, distribution, and metabolism

## XII. Drug Forms

### A. Liquid Drug Forms

1. Solution
  - a. Liquid containing one or more chemical substances entirely dissolved (usually in water)
2. Suspension
  - a. Preparation of a finely divided drug intended to be incorporated in a suitable liquid
3. Fluid extract
  - a. Concentrated form of a drug prepared by dissolving the crude drug in the fluid in which it is most readily soluble
4. Tincture
  - a. Dilute alcoholic extract of a drug
5. Spirits
  - a. Preparation of a volatile substance dissolved in alcohol
6. Syrup
  - a. Drug suspended in sugar and water to improve its taste
7. Elixir
  - a. Syrup with alcohol and flavoring added
8. Milk
  - a. Aqueous suspension of an insoluble drug
9. Emulsion
  - a. Preparation of one liquid distributed in small globules in another liquid
10. Liniments and lotions
  - a. Preparations of drugs for external use

### B. Solid Drug Forms

1. Extract
  - a. Concentrated preparation of a drug made by putting the drug into solution and evaporating the excess solvent until the concentration reaches a prescribed standard
2. Powder
  - a. A drug that has been ground into pulverized form
3. Pill
  - a. A drug shaped into a ball or oval to be swallowed
4. Capsule
  - a. A cylindrical gelatin container enclosing a dose of medication
5. Pulvule
  - a. Resembles a capsule, but is not made of gelatin and does not separate
6. Tablet
  - a. Powdered drug that has been molded or compressed into a small disk
7. Suppository

- a. A drug mixed in a firm base that melts at body temperature and is shaped to fit the rectum, urethra, or vagina
8. Ointment
  - a. A semisolid preparation for external application to the body, usually containing a medicinal substance
9. Patch
  - a. A medication impregnated into a membrane or adhesive that is applied onto the surface of the skin

### C. Gaseous Drug Forms

1. Vapor
  - a. Primarily used in operating suite anesthesia
  - b. Medication in a liquid form placed into a machine that promotes vaporization
  - c. Inhaled by the patient

## XIII. Overview of the Routes of Drug Administration

### A. Rates of Drug Absorption

1. Administration affects absorption.
  - a. The speed with which a drug works is influenced by the route of administration.
  - b. IV or IO enter the circulation the fastest.
  - c. Absorption across the respiratory mucosa when drugs are sprayed down an endotracheal tube or breathed in from an inhaler is almost as fast.
  - d. Intramuscular injection is slower, as is subcutaneous injections.
  - e. Orally administered drugs are near the slowest end.
  - f. The slowest absorption is across intact skin.
  - g. See Table 7-3 Rates of Absorption by Different Routes.

### B. Local or Systemic Effects

1. Local effects
  - a. Result from the direct application of a drug to a tissue, ie, lotion to the skin to relieve itching
2. Systemic effects
  - a. Occur after the drug is absorbed by any route and distributed by the bloodstream
  - b. Almost invariably involve more than one organ
  - c. Response of one or another organ may predominate
3. Drug action
  - a. Rarely a completely fixed property of the medication
  - b. The effect of any drug typically varies depending on the patient, the dose, the route by which the drug is given, and the drug's metabolic rate.

## XIV. Routes of Drug Administration

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## A. Overview

1. Three categories
  - a. Percutaneous: applied to and absorbed through the skin or mucous membranes
  - b. Enteral: administered and absorbed somewhere along the gastrointestinal tract
  - c. Parenteral: any route that does not cause the drug to be absorbed through the skin, mucous membranes, or gastrointestinal tract

## B. Percutaneous Routes

1. Absorbed through the skin or through a mucous membrane
  - a. May be applied topically (on the surface)
  - b. Intact skin is ordinarily an effective barrier to absorption of drugs.
  - c. Some drugs have been specially prepared to cross the barrier at a very slow rate.
  - d. Useful for sustained release of drugs for a long period
  - e. Nitroglycerin and estrogens
2. Transdermal route
  - a. Placing medication directly onto the patient's skin
  - b. Easily controlled by simply removing and wiping the medication from the skin
  - c. Rate of absorption is consistent, steady, and predictable.
  - d. Rate can be affected by the thickness of the skin and the presence of scar tissue at the site of administration.
  - e. Peripheral circulation can affect the absorption rate as well.
3. Mucous membranes
  - a. Becoming increasingly popular in the prehospital setting
  - b. Medication absorbed at a moderate to rapid rate
  - c. Sublingual: giving a medication under the tongue; rapidly absorbed
  - d. Buccal: between the cheeks and gums
  - e. Nasal route: aerosolize and administer medications; quickly absorbed into the blood vasculature in the nasopharynx
4. Pulmonary route
  - a. Deliver medication directly to the pulmonary system through inhalation or injection
  - b. Inhalation: drug is placed in a nebulizer that reduces it to a mist breathed in by the patient
  - c. Endotracheal tube used to administer liquids directly to the bronchioles and alveolar sacs (NAVEL)

## C. Enteral Routes

1. Absorbed somewhere along the gastrointestinal tract
  - a. Oral route: painless, convenient, and economical; most patients take their daily medications at home through this route; absorbed at an unpredictable but generally slow rate from the stomach and intestines; rarely used in emergency situations
2. Rectal administration

- a. For local effect
- b. Or if the medication is irritating given orally or because the patient cannot take an oral medication (vomiting)
- c. Considered if quick IV access is impractical.
- d. The extreme vascularity of the rectum promotes rapid but sometimes unpredictable absorption.

#### **D. Parenteral Routes**

1. Any route other than the alimentary canal (digestive tract), skin, and mucous membranes
  - a. Generally administered via syringes and needles
  - b. In most cases, allow for the fastest absorption rate
2. IV route
  - a. Most rapidly effective
  - b. Most dangerous route of administration
  - c. Drugs go directly into the bloodstream and to the target organs.
  - d. Known quantity of drug over a known period
  - e. Dangerous because it delivers the entire dose at once
  - f. Cardiac arrest: an IV drug will take three to four times as long to reach its target organ; administer during compression cycles
  - g. Should be given slowly, unless you receive contrary orders
  - h. In the field, it is unacceptable to administer a medication by direct venipuncture (infiltration of the drug into the surrounding tissue).
3. Intraosseous (IO) route
  - a. Becoming increasingly popular in the prehospital setting
  - b. Convenient devices for adult use
  - c. Quickly becoming a standard when quick IV access is not practical
  - d. Rate and time of onset identical if not better than IV
4. Intramuscular (IM) route
  - a. Take longer to act
  - b. Must be absorbed from the muscle into the bloodstream
  - c. Longer duration of action (absorbed gradually during a period of minutes to hours)
  - d. Given only to patients with adequate perfusion
  - e. Usually into the deltoid muscle of the upper arm or into the upper outer quadrant of the gluteus muscle of the buttocks
5. Subcutaneous (SC or SQ) route
  - a. A small amount of drug is injected into the fat or connective tissue beneath the skin.
  - b. Absorbed more slowly and over a more prolonged period
  - c. Peak effect in about 30 minutes
  - d. Upper outer arm, anterior thigh, or abdomen

#### **E. You are the Provider (continued)**

1. Continue reading the case study provided on the slide:

- a. There is no pertinent past medical history and no prescribed medications. The patient had used nicotine patch and then Zyban therapy to quit smoking approximately 2 months ago. The patient tells you she considered herbals for stress reduction but denies any use.
- b. Is there any risk of using herbal preparations with prescriptive medications?
  - Bupropion hydrochloride is available under the name of Zyban is also used as an antidepressant (under the name Wellbutrin it is commonly prescribed for depression). Herbal medicine does have some known adverse interactions with prescription medications.

## XV. Pharmacokinetics

### A. Overview

1. Study of metabolism and action of medications within the body
  - a. Particular emphasis on the time required for absorption, duration of action, distribution in the body, and method of excretion

### B. Absorption

1. Transfer of medication from its site of administration into the body to specific target organs and tissues
  - a. The ultimate goal is to reach a therapeutic concentration in the bloodstream.
  - b. Depends partially on the rate and extent to which the drug is absorbed
  - c. Rate and extent depend on the ability of the medication to cross the cell membrane.
2. Mechanisms of medication absorption
  - a. Active transport: specialized proteins that span the membrane of a cell facilitate the movement of the medication inside target tissue and cells; energy-dependent process using a carrier-mediated mechanism to assist the medication into the cell.
  - b. Passive diffusion: does not use energy or carrier-mediated mechanisms; medication moves from an area of high concentration to an area of low concentration.
3. Blood flow and medication absorption
  - a. A properly functioning circulatory system greatly enhances the rate of medication absorption.
  - b. If good vascular system and rich blood supply, absorption is enhanced; if the opposite is true the rate may be delayed.
  - c. Patients in profound states of shock or circulatory compromise may have a delayed absorption rate.
4. Surface areas and medication absorption
  - a. All medications must pass through nontarget cells to reach their intended receptor target.
  - b. Skin, mucosa, and intestinal tissue
  - c. The larger the surface area, the greater the amount of absorption and the more quickly the medication can reach its target and take effect.
  - d. Single layers of cells readily transport medications.
  - e. Multilayer tissues require more time for absorption.

5. Medication concentration and absorption
  - a. Concentration affects absorption.
  - b. Pharmaceutical manufacturers alter a medication's coating to tweak the ultimate rate of absorption.
  - c. Higher doses are absorbed more quickly than lower doses.
  - d. The higher the concentration in the body the greater the absorption.
  - e. Loading dose: a large dose of the same concentration that temporarily exceeds the body's ability to eliminate the medication
  - f. Maintenance dose: a smaller dose administered over time and intended to maintain a therapeutic level of the medication at the receptor site
6. Environmental pH and medication absorption
  - a. Most medications are weak acids or weak bases.
  - b. In solution they become ionized (electrically charged).
  - c. Most reach a state of equilibrium facilitating absorption.
  - d. pH affects a medication's ability to ionize.
  - e. Given by any route, medications inevitably undergo side reactions before they reach their intended destination.
  - f. Bioavailability: how much of the drug is still active by the time it reaches its target organ

### **C. Distribution**

1. Process by which a medication moves throughout the body
  - a. Blood is the primary distribution vehicle.
  - b. Factors that change the way blood flows will change the way medications are transported.
2. "Free drug"
  - a. Not bound with anything else
  - b. Only way a medication molecule can actually be used by the body
  - c. The extent to which the medication binds with nontarget cells affects its intensity and duration of action.
  - d. Medications have a tendency to collect in certain areas of the body.
  - e. Typically bind to fat, muscle tissue, and bone
3. Plasma binding
  - a. Cannot be used by the body
  - b. Lowers the therapeutic concentration of the drug
  - c. Albumin: plasma protein; too large to diffuse out of the bloodstream
4. Other aspects preventing distribution
  - a. Capillary endothelial cells: allow only lipid-soluble medications to enter the brain and cerebrospinal fluid
  - b. Pregnant patient: placental barrier does not permit most non-lipid-soluble medications to pass to the fetus; not an impregnable barrier.

### **D. Biotransformation**

1. Manner in which the body metabolizes medications
  - a. Transforming the medication into a metabolite
  - b. Or by making the medication more water soluble
  - c. Only free-drug molecules are able to be biotransformed.
  - d. Prodrugs: manufactured to become active only after they undergo biotransformation
  - e. Takes place in the liver for the most part
  - f. The endoplasmic reticulum of hepatocytes contains the enzymes primarily responsible for biotransformation.
2. Directly affects the route chosen to deliver a medication
  - a. All blood from the gastrointestinal tract must pass through the liver before moving on to the rest of the body.
  - b. First-pass effect: the liver has the opportunity to partially or completely inactivate drugs long before they reach the intended target tissue; some medications can be given only parenterally.
3. Liver enzymes
  - a. Phase 1: enzymes oxidize the drug or bind it with oxygen molecules; may also hydrolyze the medication, decomposing it by a reaction with water.
  - b. Phase 2: medication molecules combine with a chemical found in the body; known as a conjugation reaction.

## **E. Excretion**

1. The body eliminates the remnants of the drug.
  - a. Could be toxic or inactive metabolites
  - b. Occurs primarily through the kidneys via three mechanisms
    - i. Glomerular filtration: passive process in which blood flows through the glomeruli of the kidneys
    - ii. Tubular secretion: active transport process in which medications are bound to specific transporters aiding in their elimination
    - iii. Partial reabsorption: occurs when some amount of the drug is reabsorbed after being filtered
  - c. Environmental pH: in this case the pH of the urine; some medications (acidic) will more readily move into the urine for excretion

# **XVI. Pharmacodynamics**

## **A. Overview**

1. Way in which a medication produces the intended response
  - a. Also known as the mechanism of action
  - b. Encompasses the factors that may alter the intended response and any side effects or unexpected effects

## **B. Theories of Drug Action**

1. Four mechanisms
  - a. Bind to a receptor site

- b. Change the physical properties of cells (typically by changing the osmotic balance)
  - c. Chemically combine with other chemicals
  - d. Alter a normal metabolic pathway
2. Binding to a receptor site
- a. Most prevalent medications
  - b. Stimulate the receptor site to cause the response it normally does (agonist)
  - c. Block the receptor site from being stimulated by other chemical mediators and inhibit the normal response (antagonist)
  - d. Some perform both roles.
  - e. Initiates a chemical change that produces the expected effect
  - f. The number of available receptors is inconsistent.
  - g. Down-regulation: as medication molecules bind to the receptor sites, the number of receptors decreases.
  - h. Up-regulation: medications that increase the number of available receptor sites

### C. Drug-Response Relationship

1. Correlates the amount of medication given and the response it causes
- a. Most of the information comes from plasma-level profiles (describe the length of onset, duration, and termination of action).
  - b. Determine the minimum level of medications to be effective and how much it would take to become toxic to the patient
  - c. Onset of action: how long it will take for the concentration of the medication at the target tissue to reach the minimum effective level
  - d. Duration of action: how long the medication can be expected to remain above the minimum level to provide the intended action
  - e. Termination of action: the amount of time after the concentration level falls below the minimum level to the time it is eliminated from the body
  - f. Therapeutic index: the ratio of a drug's lethal dose for 50% of the population to its effective dose for 50% of the population; margin of safety
  - g. Biologic half-life: the time it takes the body to eliminate half of the drug

### D. Factors Affecting Drug Responses

1. The chief variable is patient characteristics.
- a. Age
  - b. Weight
  - c. Sex: general differences in body mass
  - d. Environment: psychologic and physiologic stresses imposed on the patient
  - e. Time of administration
  - f. Condition of the patient: patient's overall state of health
  - g. Genetic factors
  - h. Psychological factors

### E. Predictable Responses

1. Generally have a good idea of what a particular drug will do to the patient.

- a. Extensive research in developing and testing
- b. Expect to see the desired response.
- c. Anticipate responses beyond the desired effect.
- d. Side effects: reactions that can manifest as signs and symptoms that are not what we wanted to happen but are expected based on how the medication works.
- e. Risk-benefit ratio

## **F. Iatrogenic Responses**

1. Unanticipated adverse reactions
  - a. The most common is allergic reaction.
  - b. Idiosyncrasy: unique response specific to that patient
2. Tolerance
  - a. Patients who take a particular medication for an extended period can develop this.
  - b. Decreased response to the same amount of medication
  - c. Cross-tolerance: develops as a result of prolonged administration of a separate medication, causing a tolerance to other similar medications (most often seen in pain medications)
  - d. Tachyphylaxis: condition in which the patient rapidly becomes tolerant to a medication
3. Minimum concentration
  - a. Concentration needed to become effective
  - b. Cumulative effect: increased effect when a medication is given in several successive doses
4. Drug dependency
  - a. Prolonged administration may lead to this.
  - b. Significant symptoms if he or she stops using the medication
5. Multiple medications
  - a. Possible for the effects of one medication to alter the response of another medication (drug interaction)
  - b. Possible to see the opposite response or a completely unrelated response
  - c. Summation effect: additive effect
  - d. Synergism: two drugs that have the same effect but together produce a response greater than the sum of their individual responses
  - e. Potentiation: interaction between two medications causing one drug to enhance the effect of another
  - f. Interference: direct biochemical interaction that takes place between two drugs

## **XVII. Drug Storage**

### **A. Overview**

1. Altered
  - a. By extremes of temperature, exposure to direct sunlight, or excessive humidity
  - b. In most cases, the potency of the medication is decreased.

- c. Actual molecular components can be degraded and made inactive.
- d. Each manufacturer must provide guidance on the proper storage for each medication that is approved by the FDA.
- e. In general, medications should be kept out of direct sunlight and stored in temperatures between 55°F and 85°F.
- f. Every department should have a written protocol or procedure for the specific handling of every medication, fluid, or diluent on the vehicle or in the station.

## **B. Security of Controlled Medications**

1. Prescription medication
  - a. Some are controlled substances (more stringent control guidelines).
  - b. Minimum requirements include a securely locked, substantially constructed cabinet with no sign or any other indication that the cabinet is used for the storage of controlled substances.
  - c. A controlled substance disposition record must be maintained.
  - d. Thorough documentation for any use of a controlled substance (disposal of any leftover waste medication)

# **XVIII. Components of a Drug Profile**

## **A. Drug Names**

1. Generic and trade names included
  - a. Also common to find chemical name and a graphic representation of the drug molecule

## **B. Classification**

1. Based on its effect and its mechanism of action
  - a. Simplifies the inherent memorization process involved with learning the drugs

## **C. Mechanisms of Action**

1. How the medication causes its intended effect
  - a. Binding to a receptor site
  - b. Changing the physical properties of cells
  - c. Chemically combining with other chemicals
  - d. Altering a normal metabolic pathway

## **D. Indications**

1. Reasons or conditions for which the medication is given
  - a. Based on what the medication was designed to accomplish and what has been approved by the FDA

## **E. Pharmacokinetics**

1. Describes how the medication is absorbed, distributed, and eliminated from the body
  - a. Useful when determining route of administration

- b. Quantifies the medication's expected time of onset and its duration of action

#### **F. Side and Adverse Effects**

1. Undesired effects from the medication found during the development of the drug
  - a. Discuss these with your patient.

#### **G. Routes of Administration**

1. Variety of routes
  - a. A drug that is therapeutic when given by one route may be lethal when given by another.

#### **H. Drug Forms**

1. Available forms and their concentrations
  - a. Tablets, ampules, or vials

#### **I. Doses**

1. Amount of the medication that should be administered for a particular condition
  - a. Consider the patient's age and weight and the form in which the drug is usually supplied.

#### **J. Contraindications**

1. Conditions under which it is inappropriate to administer a particular medication

#### **K. Special Considerations**

1. Information necessary to safely and effectively administer the medication to specific groups
  - a. Pediatric patients
  - b. Geriatric patients
  - c. Pregnant patients
  - d. Other groups

#### **L. You are the Provider (continued)**

1. Continue reading the case study provided on the slide:
  - a. Vital signs include: pulse 160, BP 108/78, respiration rate of 24, pupils dilated and slow to respond. Patient states that she had three alcoholic drinks at lunch.
  - b. If illicit drugs are suspected, what are some techniques to obtain accurate information?
  - c. *Can you always assume that patients will give you the truth?*
    - Abnormal vital signs may be the first clue to add to your general impression about a drug reaction once other differential diagnosis are considered. Giving the patient privacy from coworkers may be helpful in gaining the trust and obtaining a truthful response. Even after the patient gains confidence in you, they may be very suspicious of any questions regarding drug use or abuse.

## **XIX. Drugs by Classifications**

## A. Overview

1. Based on the effect the drug will have on a particular part of the body or on a specific condition
  - a. Many fall into more than one classification

## B. Analgesics and Antagonists

1. Analgesics
  - a. Medications that relieve pain
  - b. Analgesia: absence of the sensation of pain
  - c. Opioid agonists: similar to or derived from the opium plant; bind to opiate receptors, preventing neurons from sending pain signals
  - d. Morphine: popular option for the prehospital induction of analgesia; tendency to cause a euphoric feeling; decreases the workload on the heart and the heart's consumption of oxygen
2. Nonopioid analgesics
  - a. Many exist as OTC drugs.
  - b. Many have antipyretic properties (reduce fever).
  - c. All alter the production of prostaglandins and cyclooxygenase to produce their effects.
  - d. Salicylates: aspirin
  - e. Nonsteroidal anti-inflammatory drugs (NSAIDs): ibuprofen
  - f. Para-aminophenol derivatives: acetaminophen (Tylenol)
3. Opioid antagonists
  - a. Reverse the effects of opioid drugs
  - b. Competitively bind with the opiate receptors in an antagonistic manner
  - c. The most common is naloxone (Narcan).
4. Opioid agonist-antagonists
  - a. Decrease pain but do not diminish the function of the respiratory system or lead to dependence or addiction

## C. Anesthetics

1. Medications intended to induce a loss of sensation to touch or pain
  - a. Systemically, regionally, or locally
    - i. Systemic anesthesia: also known as general anesthesia; inhalation of volatile vaporized liquids; predominantly reserved for operating room use
    - ii. Regional anesthesia: focuses on a particular portion of the body
    - iii. Local anesthesia: causes a loss of sensation to touch or pain at a specific isolated spot on the body
  - b. Regional and local are achieved through the injection of a medication into particular locations to block nerve impulses
2. Grouped
  - a. Based on their onset of action and the duration of their effects
  - b. Ultra-short-acting agents

- c. Short-acting agents
  - d. Intermediate agents
  - e. Long-acting agents
3. Drawbacks
- a. Slow the functioning of the respiratory system, CNS, and cardiovascular system
4. Prehospital
- a. Desired before invasive procedures (endotracheal intubation or cardioversion)
  - b. Typically administer benzodiazepines, opioids, or nonbarbituate hypnotics.

#### **D. Antianxiety, Sedative, and Hypnotic Drugs**

1. Sedation
- a. Drugs given to counteract the anxiety before an invasive procedure
  - b. Hypnosis: drugs given to ensure that the patient sleeps through the event
  - c. Benzodiazepines, barbituates, opioid agonists, and nonbarbituate hypnotics
2. Benzodiazepines
- a. Sedatives most commonly used to prepare patients for invasive procedures
  - b. Believed to affect the inhibitory neurotransmitter gammaaminobutyric acid (GABA) in the brain
  - c. Causes brain activity to slow
  - d. Midazolam: short acting (30- to 60-minute duration of action)
  - e. Diazepam: 30- to 90-minute duration of action with a slower onset (approximately 5 minutes)
3. Barbituates
- a. Believed to work similar to benzodiazepines
  - b. Thiopental: short acting (onset of action of 10 to 20 seconds and a duration of action of 5 to 10 minutes)
4. Nonbarbituate hypnotics
- a. Have comparatively fewer side effects (cardiovascular compromise)
  - b. Etomidate: ultra-short-acting medication; minimal effects on hemodynamic stability and decreases intracranial pressure and cerebral oxygen metabolism
  - c. Propofol: extremely rapid time of onset but short-lived effects

#### **E. Anticonvulsants**

1. Seizure
- a. State of neurologic hyperactivity
  - b. Active seizure: requires treatment in the prehospital setting
2. Mechanism of anticonvulsants
- a. Believed to work by inhibiting the influx of sodium into cells
  - b. Decrease the cell's ability to depolarize and propagate the seizures

#### **F. CNS Stimulants**

1. Mechanisms of action
- a. Increasing excitatory neurotransmitters

- b. Decreasing inhibitory neurotransmitters
- 2. Amphetamines
  - a. Increase the release of dopamine and norepinephrine to increase wakefulness and awareness
  - b. Increase tachycardia and hypertension and can cause seizures and psychosis

### **G. Psychotherapeutic Drugs**

- 1. Block dopamine receptors in the brain
  - a. Patients may occasionally have ill effects from their use or overuse.
  - b. Schizophrenia
  - c. Side effects: extrapyramidal symptoms, orthostatic hypotension, and sedation (tendency to cause sexual dysfunction)
  - d. Extrapyramidal symptoms: involuntary movements, tremors, rigidity, muscle contractions, restlessness, and changes in breathing and heart rate
- 2. Depression
  - a. Common disorder
  - b. Selective serotonin reuptake inhibitors and monoamine oxidase inhibitors
  - c. Tricyclic antidepressants: block the neurotransmitters norepinephrine and serotonin from being reabsorbed; block ACh from reaching its receptors, which may lead to tachycardia; block alpha-1 receptors, which may produce orthostatic hypotension

### **H. Drugs for Specific CNS and PNS Dysfunctions**

- 1. CNS agents
  - a. Class of drugs that produce physiologic and psychologic effects through a variety of mechanisms
  - b. Specific agents: bring about an identifiable mechanism with unique receptors for the agent
  - c. Nonspecific agents: produce effects on different cells through a variety of mechanisms
  - d. Stimulants: exert their action by excitation of the CNS
  - e. Depressants: agents used to slow brain activity; prescribed to treat anxiety, muscle tension, pain, insomnia, stress, panic attacks, and, in some cases, seizures

### **I. Drugs Affecting the Parasympathetic Nervous System**

- 1. Stimulation of the parasympathetic nervous system
  - a. Pupil constriction and bronchoconstriction
  - b. Cardiac effects
- 2. Cholinergic medications
  - a. All preganglionic and postganglionic parasympathetic nerves use ACh as the neurotransmitter.
  - b. Nicotinic receptors
  - c. Muscarinic receptors
  - d. Stimulate the cholinergic receptors
  - e. May act directly or indirectly on cholinergic receptors

### 3. Anticholinergic medications

- a. Work in opposition to the parasympathetic nervous system by blocking receptors
- b. Muscarinic cholinergic antagonists: block ACh exclusively at the muscarinic receptors
- c. Nicotinic cholinergic antagonists: block ACh exclusively at the nicotinic receptors (effectively disables the ANS)
- d. Neuromuscular blocking agents: induce paralysis
- e. Depolarizing neuromuscular blocking agents: stimulate depolarization of the muscle cells
- f. Nondepolarizing neuromuscular blocking agents: bind in a competitive but nonstimulatory manner to part of the ACh receptor
- g. Succinylcholine: depolarizing agent; paralytic of choice for prehospital airway management
- h. Vecuronium: newer nondepolarizing neuromuscular blocker
- i. Rocuronium: may be substituted for succinylcholine if the extended recovery time is acceptable
- j. Pancuronium

## J. Drugs Affecting the Sympathetic Nervous System

1. Stimulate or inhibit the sympathetic nervous system
  - a. Sympathomimetics: stimulate
  - b. Sympatholytics: inhibit
  - c. Adrenal medulla: releases norepinephrine and epinephrine
  - d. Dopaminergic receptors: stimulation produces dilation of the renal, coronary, and cerebral arteries
2. Adrenergic receptors
  - a. Alpha-1 receptors: produce peripheral vasoconstriction
  - b. Alpha-2 receptors: control the release of norepinephrine
  - c. Beta-1 receptors: increase the heart rate, cause cardiac muscle to contract, produce automaticity, and trigger cardiac electrical conduction
  - d. Beta-2 receptors: stimulate vasodilation and bronchodilation
3. Prehospital setting
  - a. Often agonize the beta-1 receptors in an attempt to treat cardiac arrest and hypotension
  - b. Stimulation of the beta-2 receptors allows us to treat asthma and other diseases that cause excessive narrowing of the bronchioles.

## K. Skeletal Muscle Relaxants

1. Types
  - a. Central acting: produce CNS depression in the brain
  - b. Direct acting: medications target the muscles themselves to produce relaxation
  - c. Neuromuscular blockers: produce complete paralysis

## L. Drugs Affecting the Cardiovascular System

1. Classified according to their effects on specialized cells
  - a. Chronotropic effect: medications that affect the heart rate
  - b. Inotropic effect: change in the force of contraction
  - c. Dromotropic effect: alter the velocity of the conduction of electricity through the heart
  - d. Positive or negative
  - e. Cardiac glycosides: derived from plants; block certain ionic pumps in the heart cells' membranes; in general have a small therapeutic index
  - f. Antiarrhythmic medications: treat and prevent cardiac rhythm disorders
  - g. Sodium channel blockers: slow the conduction through the heart
  - h. Beta blockers: reduce the adrenergic stimulation of the beta receptors
  - i. Potassium channel blockers: increase the heart's contractility and work against the reentry of blocked impulses
  - j. Calcium channel blockers: block the inflow of calcium into the cardiac cells, thereby decreasing the force of contraction and automaticity
2. Antihypertensive medications
  - a. Treatment goals: keep blood pressure within normal limits, maintain or improve blood flow, and reduce the stress placed on the heart
  - b. Diuretic medications: cause the kidneys to remove excess amounts of salt and water in the body, reducing the level of stress placed on the cardiovascular system (thiazides)
  - c. Loop diuretics: lower the concentration of sodium and calcium ions in the body
  - d. Vasodilator medications: act on the smooth muscles of the arteries and veins; prompt a response from the sympathetic nervous system
  - e. Sympathetic blocking agents: include beta blockers and adrenergic inhibitors
  - f. Angiotensin-converting enzyme (ACE) inhibitors: suppress the conversion of angiotensin I to angiotensin II
  - g. Angiotensin II receptor antagonists: block angiotensin II from binding to its receptor sites
  - h. Calcium channel blockers: antiarrhythmic and antihypertensive properties; prevent the contraction of smooth vascular muscle
3. Anticoagulants, fibrinolytics, and blood components
  - a. Antiplatelet agents: interfere with the aggregation, or collection, of platelets; prevent further build-up
  - b. Anticoagulant drugs: work against coagulation, preventing thrombi from forming
  - c. Fibrinolytic agent: administered to dissolve the thrombus and prevent it from breaking off and entering the blood stream

### **M. You are the Provider (continued)**

1. Continue reading the case study provided on the slide:
  - a. En route to the hospital, the patient states that in addition to the alcohol she took five or six 25 mg tablets of diphenhydramine.
  - b. *Does alcohol have any effect on prescribed medications?*
  - c. *What are your treatment priorities for this patient?*

- Maximum dose of medication over 24 hours is 300 mg. The alcohol will intensify the adverse effects of the medication. With some medications alcohol may not have any effect, but on others it will be detrimental for the patient. Initial treatment for this patient is to make sure that an airway remains patent.

## **N. Antihyperlipidemic Medications**

1. Reductase inhibitors
  - a. Commonly referred to as statins
  - b. Disrupt the cholesterol production pathway in the body

## **O. Mucokinetic and Bronchodilator Drugs**

1. Severe narrowing of any portion of the respiratory tract
  - a. Emergency treatments attempt to expand the respiratory tract.
  - b. Nonselective: affect alpha, beta-1 and beta-2 receptors
2. Complications
  - a. Patients with respiratory emergencies experience decreased amounts of oxygen to vital organs.
  - b. Preferable to treat with medications specific to beta-2 receptors
3. Xanthines
  - a. Second-line treatment
  - b. Relieve airway constriction by relaxing smooth muscles of the bronchioles and stimulating cardiac muscles to work harder
  - c. Caffeine

## **P. Oxygen and Miscellaneous Respiratory Drugs**

1. Oxygen
  - a. Most commonly used medication in the prehospital setting
  - b. Appropriate and inappropriate uses
  - c. Supplementary oxygen therapy is covered in Chapter 11.
2. Find out what medications your patient is taking.
  - a. Decongestants and other OTC drugs
  - b. Readily available

## **Q. Drugs Affecting the Gastrointestinal System**

1. Several classes
  - a. The exact drug depends on the specific complaint.
  - b. Antihistamines
  - c. See Table 7-4 Gastrointestinal Agents.

## **R. Eye Medications**

1. Almost always in the form of drops
  - a. Directly into the eye
  - b. The exact treatment depends on the condition.
  - c. Anti-infective agents and drugs intended to reduce swelling

- d. Generally limited in the prehospital setting to anesthetic purposes
  - e. Tetracaine: topical anesthetic used with a Morgan lens to flush debris or contamination from the eye; reduces pain and discomfort
2. Antiglaucoma drugs
- a. Glaucoma: eye disease characterized by abnormally high intraocular fluid pressure, damaged optic disc, hardening of the eyeball, and partial to complete loss of vision
  - b. Several medications are contraindicated in the presence of glaucoma.

### **S. Ear Medications**

1. Generally administered in the form of drops
- a. Exception occurs in the rare case of a significant infection of the ear (systemic antimicrobial medications)
  - b. Anti-infective and anti-inflammatory effects
  - c. Prehospital administration is not indicated.

### **T. Drugs Affecting the Pituitary Gland**

1. Not used in the prehospital setting
- a. Administered to shrink or eradicate pituitary tumors
  - b. Block the pituitary gland from making too much hormone

### **U. Drugs Affecting the Parathyroid and Thyroid Glands**

1. Thyroid disorders
- a. Common finding in patients treated by paramedics
2. Two medical options for treatment
- a. Medications that suppress the activity of the thyroid (hyperthyroidism)
  - b. Medications that replace missing thyroid hormones (hypothyroidism)

### **V. Drugs Affecting the Adrenal Cortex**

1. Corticosteroids
- a. Anti-inflammatory properties
  - b. Profound metabolic effects

### **W. Drugs Affecting the Pancreas**

1. Variety of medications
- a. Sulfonylureas: increase insulin secretion from the pancreatic beta cells
  - b. Thiazolidinediones and biguanides: increase insulin sensitivity; oral hypoglycemic agents

### **X. Drugs for Labor and Delivery**

1. Use of medications for women in labor
- a. Generally limited to situations in which the delivery is abnormal or complicated
  - b. If the labor were normal you probably would not be there.
2. Medications have one of two effects.
- a. Precipitating labor

- b. Inhibiting labor
- c. Oxytocin: only FDA-approved medication to facilitate labor; increases force and frequency of contractions
- d. Tocolytic medications: suppress the force and frequency of uterine contractions

## **Y. Drugs Affecting the Reproductive System**

1. Medications and the male reproductive system
  - a. Majority to treat erectile dysfunction
  - b. Phosphodiesterase inhibitors: prescribed to relax the smooth muscles of the corpora cavernosa and induce vasodilation (Viagra, Levitra, and Cialis)
  - c. Using other vasodilatory medications (particularly nitroglycerin) within 24 to 48 hours of these drugs can have serious implications on blood pressure.
2. Medications and the female reproductive system
  - a. Variety of functions (from contraception to promoting conception)
  - b. Most alter the reproductive hormones
  - c. Contraceptive medications: contain synthetic hormones that trick the body into believing the ovary has already released an ovum
  - d. Antibiotics and antifungal medications used for specific conditions

## **Z. Antineoplastic Drugs**

1. Designed to combat cancer
  - a. Chemotherapy medications: target the DNA within cancerous cells
  - b. Significant systemic side effects

## **AA. Drugs Used in Infectious Diseases and Inflammation**

1. Drugs used to treat HIV infection
  - a. Nucleoside reverse transcriptase inhibitors: interrupt the virus during an early stage of replication; may slow the spread of HIV in the body and delay the acquisition of opportunistic infections
  - b. Protease inhibitors: interrupt the virus during replication at a later stage in its life cycle
  - c. Fusion inhibitors: prevent the virus from entering immune cells; designed for use in combination with other anti-HIV treatment
2. Antibiotics
  - a. Subclassification of antimicrobial medications
  - b. Categories based on their composition and the types of bacteria they target
  - c. Generally work by killing the bacteria or by preventing multiplication of the bacteria and allowing the body's immune system to overcome the infectious invaders
  - d. Patients may be allergic to certain antibiotics.
  - e. Not administered in the prehospital setting
3. Antifungal, antiviral, and antiparasitic medications
  - a. Treating fungal infections can be more difficult than treating bacterial infections.
  - b. Challenge to identify a medication that will not harm human cells

- c. Polyene medications: cause fungal cell contents to leak out, killing them
  - d. Imidazoles and triazoles: inhibit certain enzymes, blocking the fungal cell wall synthesis
  - e. Antiviral medications: inhibit the replication of RNA and DNA in the virus, inhibit the penetration and uncoating of the virus in the host cells, or boost the effectiveness of other antiviral medications given concurrently
  - f. Antiparasitic medications: target parasites
  - g. See Table 7-5 Antifungal, Antiviral, and Antiparasitic Agents.
4. Nonsteroidal anti-inflammatory drugs
- a. Designed to reduce pain, inflammation, and fever
  - b. Inhibit COX enzymes (produce prostaglandin)
  - c. Prostaglandin: promotes pain, inflammation, and fever
  - d. Aspirin: targets COX-1 enzymes to reduce platelet aggregation; great benefit in myocardial infarction

## **BB. Uricosuric Drugs**

- 1. Uric acid
  - a. Found in the blood
  - b. Excreted by the kidneys
  - c. If levels are too high, uric acid is deposited in the form of solid crystals in the joints (gout).
  - d. Medications are designed to lower the uric acid levels in the blood by increasing its excretion by the kidneys into the urine.

## **CC. Serums, Vaccines, and Other Immunizing Agents**

- 1. Immunobiologic medications
  - a. Can consist of antigens or antibodies
  - b. Toxoid: modified bacterial toxin that has been made nontoxic but retains the ability to stimulate the formation of the antibodies
  - c. Vaccine: a suspension of whole (live or inactivated) or fractionated bacteria or viruses that have been made nonpathogenic; given to induce an immune response and prevent disease

## **DD. Drugs Affecting the Immunologic System**

- 1. Immunosuppressant medications
  - a. Prescribed to patients who undergo organ transplantation or have an autoimmune disease
  - b. Intended to inhibit the body's ability to attack the "foreign" organ
  - c. In the case of autoimmune diseases, inhibit the body's attack on itself
  - d. Generally derived from fungi or bacteria and tend to have a complicated mechanism of action

## **EE. Dermatologic Drugs**

- 1. The medication used will be determined by the condition itself.
  - a. The majority of the drugs will be applied topically.

- b. Other medications used to affect other areas of the body can be given through the skin transdermally.

## **FF. Vitamins and Minerals**

1. Necessary substances
  - a. Allow for normal metabolism, growth and development, and cellular function
  - b. Patients may be taking supplements to replace deficient items or as a preventative measure.
  - c. Thiamine (vitamin B<sub>1</sub>): converts carbohydrates into energy; alcoholics have a propensity to be deficient in this vitamin

## **GG. Fluids and Electrolytes**

1. Several types of IV fluids
  - a. Crystalloid solutions: typically used in prehospital setting; can be isotonic, hypotonic, or hypertonic
    - i. Isotonic: provide a stable medium for the administration of medication and provide effective fluid and electrolyte replacement
    - ii. Hypertonic: provide nutrition
    - iii. Hypotonic: beneficial in dehydration situations but not in hypovolemic cases
  - b. Colloid solutions may also be used.
  - c. IV fluids are discussed in detail in Chapter 8.

## **HH. Antidotes and Overdoses**

1. Management of overdose
  - a. Reflects the agent that the patient has consumed
  - b. Antidotes can function antagonistically by blocking receptor sites that would otherwise be stimulated by the agent.
  - c. They may transform the agent into an inert, nonhazardous form to facilitate excretion or they may bind to an agent to prohibit its absorption into the bloodstream.
  - d. Overdoses and their antidotes are discussed in depth in Chapter 33.

# **XX. Tying It All Together**

## **A. Medication Administration**

1. A tremendous amount of information can be obtained about your patient's current condition and medical history based on medications taken.
  - a. Understanding which types of medications have specific functions allows you to more effectively assess your patient's condition.
  - b. Significant information about the patient's medical history
  - c. A patient's medications may alter the clinical presentation of some conditions.
  - d. Develop a treatment plan that will treat the patient's condition while considering the negative effects and interactions with the patient's other medications.

## **B. You are the Provider Summary**

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Slide: 153

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Lecture/Discussion

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1. Continue reading the case study provided on the slide:
  - a. Medications have been shown to work the way they were designed. The dangers of misuse and abuse of pharmaceuticals can be deadly.

### C. Summary

1. Medication profiles and regulation
2. Pharmacology and the nervous system
3. General properties of medication
4. Routes of administration
5. Pharmacokinetics and pharmacodynamics
6. Drug classifications

### Answers to Multiple-Choice Questions

*You and your partner have responded to a call for chest pain. The patient is a 68-year-old man who describes the pain as being a 20 on a 1–10 scale with 10 being the worst pain ever. As your partner connects the patient to the monitor, you start gathering your patient's history. The patient has had a previous cardiac event and has been prescribed a "beta blocker."*

1. What is the primary action of a beta blocker?
  - A. It reduces the adrenergic stimulation of the beta receptors in the heart.
  - B. It increases the adrenergic stimulation of the beta receptors in the heart.
  - C. It reduces the cholinergic stimulation of the beta receptors in the heart.
  - D. It increases the cholinergic stimulation of the beta receptors in the heart.

**Answer: A.** Beta blockers are a subclassification of antidysrhythmics. Beta blockers are designed to control the effects of beta stimulation on the heart.

2. You decide to give your patient salicylic acid once you determine that he is not allergic to it. Salicylic acid is a(n):
  - A. calcium channel blocker.
  - B. sympathomimetic.
  - C. antiplatelet agent.
  - D. antihypertensive.

**Answer: C.** Salicylic acid is another name for aspirin. Aspirin is given for chest pain to help keep the blood flowing through narrowed vessels. This is done by interfering with the collection of platelets.

3. Your patient has not taken any of his own nitroglycerin, so you decide to give him a dose of yours. How are you going to deliver the medication?
  - A. IV push
  - B. Sublingual

- C. Intramuscular
- D. Subcutaneous

**Answer: B.** Nitroglycerin is given by placing a tablet or delivering a spray under your patient's tongue. This route is called the sublingual route.

4. How long should it take for the nitroglycerin to take effect through this route of administration?
- A. 15–20 minutes
  - B. 10–15 minutes
  - C. 5–10 minutes
  - D. Less than 5 minutes

**Answer: D.** The sublingual route of medication administration should deliver the desired effects in 3 to 5 minutes as the medication passes through the mucous membranes.

5. Your patient is still having substantial chest pain after the nitroglycerin, and you decide that he will benefit greatly from analgesia. Which medication is an analgesic?
- A. Morphine
  - B. Narcan
  - C. Oxygen
  - D. Albuterol

**Answer: A.** Analgesics are used to reduce the perception of pain. Morphine is an analgesic that is especially useful for patients having cardiac-related chest pain.

6. What is a specific cardiac action of the analgesic mentioned in question 5 that should benefit this patient?
- A. It has a chronotropic action that slows the heart rate.
  - B. It decreases the workload on the heart.
  - C. It increases the workload on the heart.
  - D. It decreases ectopic beats.

**Answer: B.** Besides morphine's action of decreasing the perception of pain, it delivers a decrease in preload and afterload of the heart. This is extremely important for reducing the overall workload of the heart, thereby reducing muscle damage.

### Challenging Question

7. If this patient had taken three doses of his own nitroglycerin, would you still give him three doses of yours?

**Rationale:** The most common field protocols direct paramedics to administer their own nitroglycerin on top of what the patient had already taken. There are numerous reasons for this direction, but the most frequent reason is the unknown potency of the patient's nitroglycerin. Cardiac patients usually do not use their nitroglycerin on a frequent basis, so the expiration date is not noticed in many cases. As long as the patient's blood

pressure remains adequate, it is prudent to try one dose from a container that you have already ensured has not expired.

## II. Lesson Review

1. What are the four principal sources of drugs? (Lecture IV-A)
2. Why are pregnant women considered a pharmacologic challenge? (Lecture VIII-A)
3. Why are geriatric patients considered a pharmacologic challenge? (Lecture VIII-C)
4. What are some of the legal and ethical guidelines in medication administration? (Lecture IX-B)
5. Do drugs provide the body with functions it does not already have? (Lecture XI-A)
6. Describe the relationship between routes of administration and absorption rates. (Lecture XIII-A)
7. What is the difference between local and systemic effects of a medication? (Lecture XIII-B)
8. Explain the pros and cons of administering medications parenterally. (Lecture XIV-D)
9. What is meant by “pharmacodynamics,” and why is it important for paramedics to understand? (Lecture XVI-A)
10. Name several drugs that affect the sympathetic nervous system and explain their indications. (Lecture XIX-J)