General Principles of Pharmacology

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Topics

- Introduction
- Major Sources of Drugs
- Goals of Pharmacology
- Historical Trends in Pharmacology
- Sources of Drug Products
- Drug Names
- Components of Drug Profile
- Food & Drug Administration
- Pharmacokinetics
- Pharmacodynamics
Introduction

- Importance of thorough understanding of medications and dangers associated with drug administration

- Most prehospital medications are used for cardiovascular/cardiopulmonary emergencies
  - Agents have both life saving and life endangering potential
    - Dependent on when and how agents are used
  - Wrong drug or wrong dose or technique of administration of correct drug can result in morbidity or mortality
Introduction

Following information about medication therapy must be thoroughly understood:
- Effects of a drug
  - Action
- Proper dosing
  - Adult
  - Pediatric
  - Modification based on history
- Indications
- Contraindications

Administration techniques:
- Proper route
- Proper rate

Side effects/adverse effects

Incompatibility with other medications

Precautions

Antidotes
Introduction

Study of pharmacology

- Extensive
  - Encompasses complete study of drugs and how they effect the body

- Includes
  - Knowledge of history, source, physical and chemical properties
  - Drug compounding
  - Mechanism of action, absorption, distribution, biotransformation, and excretion (pharmacokinetics)
  - Biochemical and physiological effects (pharmacodynamics)
Drugs are chemicals used to diagnose, treat, and prevent disease.

Medication: any drug used for therapeutic purposes
Pharmacology is the study of drugs and their actions on the body.
FOUR GOALS OF PHARMACOLOGY

- Gain knowledge of various drug types
- Describe forms in which medications are administered
- Describe proper modes of administration
- Recognize toxicity and overdose
Historical Trends in Pharmacology

- Ancient health care
  - Use of herbs and minerals to treat the sick and injured has been documented as long ago as 2000B.C.
  - Ancient Egyptians, Arabs, and Greeks passed formulations down through generations
  - 17th and 18th centuries
    - Tinctures of opium, coca, and digitalis were available
    - 1796 Edward Jenner’s smallpox inoculation
Historical Trends in Pharmacology

19th century
- Atropine, chloroform, codeine, ether, and morphine were in use

20th century
- Animal insulin and penicillin dramatically changed the treatment of endocrine and infectious diseases

The present
- DNA technology
- Human insulin
- tPA
- Many medications previously available only by prescription are now sold over-the-counter
Major Sources of Drugs

- Natural: prototype drug, model for synthetic preparation
- Derived from 6 sources
  - Animals and humans
  - Vegetable
  - Mineral
  - Microorganisms
  - Synthetic (CTA)
    - Chemotherapeutic agents
    - Made in a laboratory
Sources of Drug Information

- United States Pharmacopoeia (USP)
- Physician’s Desk Reference (PDR)
- Hospital Formulary (HF)
- Drug inserts
- Monthly Prescribing Reference
- AMA Drug Evaluation
- EMS Field Guide
Components of a Drug Profile

- Name
- Classification
- Mechanism of Action
- Indications
- Pharmacokinetics
- Side Effects/adverse reactions

- Routes of Administration
- Contraindications
- Dosage
- How Supplied
- Special Considerations
DRUG NAMES

- **Official name**
  - Name listed in the United States Pharmacopoeia (USP)
  - Name listed in National Formulary (NF)
  - Generic name when drug is approved for use

- **Chemical name**
  - Most elemental
  - Precise description of drug’s chemical composition and molecular structure
DRUG NAMES

Generic name
- Often an abbreviated version of chemical name
- Name given to drug by first manufacturer/before drug has become official
- Generic medications usually have same therapeutic efficacy as nongeneric and are less expensive

Trade or proprietary name
- Name given a drug by manufacturer
  - May have several trade names (multiple manufacturers)
## Names of Drugs

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>7-chloro-1, 3-dihydro-1, methyl-5-phenyl-2h-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic Name</td>
<td>diazepam</td>
</tr>
<tr>
<td>Official Name</td>
<td>diazepam, USP</td>
</tr>
<tr>
<td>Brand Name</td>
<td>Valium®</td>
</tr>
</tbody>
</table>
Classification

The broad group to which a drug belongs. Knowing classifications is essential to understanding the properties of drugs.
Mechanism of Action

The way in which a drug causes its effects; its pharmacodynamics.
Indications

- Conditions that enable the appropriate administration of the drug (as approved by the FDA).
Pharmacokinetics

- How the drug is absorbed, distributed, and eliminated; typically includes onset and duration of action.
Side Effects/Adverse Reactions

- The drug’s untoward or undesired effects.
Routes of Administration

How the drug is administered

- Examples
  - IV
  - Endotracheal
  - Rectal
  - IM
  - SQ
  - Oral
Routes of Drug Administration

- Inhalation
  - Nebulized medications
- Enteral (drugs administered along any portion of the gastrointestinal tract)
  - Sublingual
  - Buccal
  - Oral
  - Rectal
  - Nasogastric

![Diagram of nebulizer and gastrointestinal tract]
**ENTERAL ROUTE**

- Drugs administered along any portion of the GI tract
- Safest, most convenient and economical route
- Least reliable and slowest route due to frequent changes in GI environment
  - Food contents
  - Emotional state
  - Physical activity
Routes of Drug Administration

- Parenteral (any medication route other than the alimentary canal)
  - Subcutaneous
  - Intramuscular
  - Intravenous
  - Intrathecal
  - Pulmonary
  - Intralingual
  - Intradermal
  - Transdermal
  - Umbilical
  - Intraosseous
  - Nasal
  - Endotracheal
PARENTERAL ROUTE (INJECTION)

Subcutaneous administration

- Injection given beneath skin into the connective tissue or fatty layer immediately beneath the dermis
- Used only for small volumes of drugs (0.5ml or less) that do not irritate tissue
- Absorption rate is usually slow and can provide a sustained effect
- Common administration sites:
  - Upper outer arm
  - Anterior thigh
  - Abdomen
Intramuscular administration:

- Injection given into the skeletal muscle
- Absorption generally occurs more rapidly than SQ injection because of greater tissue blood flow
  - Administered only to patients with adequate perfusion
- Usually involve volumes of 1-3ml
- Common administration sites:
  - Deltoid muscle
  - Upper outer quadrant of gluteus muscle
Intravenous administration

- Injection given directly into bloodstream, bypassing absorption process
- Provides an almost immediate pharmacological effect
- Blood levels more predictable
- Most emergency pharmacology administered intravenously
- IV push vs IV bolus
PARENTERAL ROUTES

Endotracheal administration (transtracheal)

- Administration through an established endotracheal tube
- Permits drug delivery into pulmonary capillaries and systemic absorption via lung capillaries
- Absorption rate almost as rapid as IV administration due to large surface area of alveolar sacs
- Usually reserved for situations in which an IV line cannot be established
- ET medications: Lidocaine, Epinephrine, Atropine, Naloxone
- ET drug dose: 2-2.5 times intravenous dose diluted in 10cc of NS
Intraosseous administration

- Injection given directly into bone marrow cavity
- Agents are thought to circulate via medullary cavity of bone
  - Fluids and/or drugs rapidly enter central circulation through numerous venous channels of long bones
- Time from injection to entry into systemic circulation is thought to equal that of venous administration
- Method of second choice following IV
Medication administration by inhalation in the form of gas or fine mist (aerosol)

Bronchodilators are most common inhalation medications

Absorption in bloodstream is rapid due to large surface area and rich capillary network adjacent to alveolar membrane

Primarily local effects/little systemic absorption
  - rapid onset
  - smaller doses required
  - individual dosage titration available
Most emergency medications are given intravenously to avoid drug degradation in the liver.
Contraindications

- Conditions that make it inappropriate to give the drug.
- ...means a predictable harmful event will occur if the drug is given in this situation.
Dosage

- The amount of the drug that should be given.
  - Concentration
  - Volume
How Supplied

This typically includes the common concentration of the available preparations; many drugs come in different concentrations.
Drug Forms

- **Solid Forms:**
  - Such as pills, powders, suppositories, capsules.

- **Liquid Forms:**
  - Such as solutions, tinctures, suspensions, emulsions, spirits, elixirs, syrups.
Solid Forms

- **Pills**—drugs shaped spherically to be swallowed.
- **Powders**—not as popular as they once were.
- **Tablets**—powders compressed into disk-like form.
- **Suppositories**—drugs mixed with a waxlike base that melts at body temperature.
- **Capsules**—gelatin containers filled with powders or tiny pills.
Liquid Forms

- **Solutions**—water or oil-based.
- **Tinctures**—prepared using an alcohol extraction process.
- **Suspensions**—preparations in which the solid does not dissolve in the solvent.
- **Emulsions**—suspensions with an oily substance in the solvent.
Liquid Forms (2 of 2)

- **Spirits**—solution of a volatile drug in alcohol.
- **Elixirs**—alcohol and water solvent; often with flavoring.
- **Syrups**—sugar, water, and drug solutions.
Knowing and obeying the laws and regulations governing medications and their administration is an important part of a paramedic’s career. These include federal, state, and agency specific regulations.
Federal...

- Pure Food & Drug Act of 1906
- Harrison Narcotic Act of 1914
- Federal Food, Drug, & Cosmetic Act of 1938
- Comprehensive Drug Abuse Prevention & Control Act of 1970
PURE FOOD AND DRUG ACT 1906

- Enacted by congress establishing the Food and Drug Administration (FDA)
- USP and NF were given official status
- Prohibited sale of useless drugs
- Restricted sale of medications that had potential for abuse
- First federal legislation aimed at protecting public
HARRISON NARCOTIC ACT

- Established in 1914-15
- Regulated importation, sale and manufacturing of opium and its derivatives

Narcotic Control Act
- Established in 1956
- Amended Harrison Act by increasing penalties for violations
- Made possession of heroin unlawful
- Made acquisition and transportation of marijuana illegal

Truth in labeling clause
- Required names of ingredients used in preparation be listed on label
- Required directions for drug’s use
- Gives authority to Federal Food and Drug Administration

Required dangerous drugs be issued only by prescription
- Physician
- Dentist
- Veterinarian
CONTROLLED SUBSTANCE ACT

- Major update in control and classification of drugs
- Lists requirements for control, sale and dispensing of narcotics and dangerous drugs
- Prescriptions in this class must be filled within 72 hours
- Enforced by Drug Enforcement Agency (DEA)
- Classified drugs into five schedules
- Schedule 1-5 defines drugs in terms of decreasing potential of abuse, physical dependence and increasing medical use
Schedule of Controlled Substances

Schedule I

- High abuse potential
- No currently accepted medical use
  - For research, analysis, or instruction only
  - May lead to severe dependence
- Examples
  - Heroin
  - LSD
  - Mescaline
Schedule of Controlled Substances

Schedule II

- High abuse potential
- Accepted medical uses; may lead to severe physical and/or psychological dependence
- Examples
  - Opium
  - Morphine
  - Codeine
  - Oxycodone
  - Methadone
  - Cocaine
  - Secobarbital
Schedule of Controlled Substances

Schedule III

- Less abuse potential than drugs in Schedules I and II
- Accepted medical uses; may lead to moderate/low physical dependence or high psychological dependence
- Examples
  - Preparations containing limited opioid quantities, or combined with one or more active ingredients that are noncontrolled substances
    - Acetaminophen with codeine
    - Aspirin with codeine
Schedule of Controlled Substances

Schedule IV

- Lower abuse potential compared to Schedule III
- Accepted medical uses; may lead to limited physical or psychological dependence
- Examples
  - Phenobarbital
  - Diazepam
  - Lorazepam
Schedule of Controlled Substances

Schedule V

- Low abuse potential compared to schedule IV
- Accepted medical uses; may lead to limited physical or psychological dependence

Examples
- Medications, generally for relief of coughs or diarrhea, containing limited quantities of certain opioid controlled substances
Standardization of Drugs

- Standardization is a necessity
- Techniques for measuring a drug’s strength and purity
  - Assay: test that determines the amount and purity of a given chemical in a preparation in the laboratory
  - Bioassay: test to ascertain a drug’s availability in a biological model
  - Bioequivalence: relative therapeutic effectiveness of chemically equivalent drugs
- The United States Pharmacopeia (USP)
  - Official volumes of drug standards
Investigational Drugs

Prospective drugs may take years to progress through the FDA testing sequence

- Animal studies to ascertain
  - Toxicity
  - Therapeutic index
    - Ratio of a drugs lethal dose to its effective dose
  - Modes of absorption, distribution, metabolism (biotransformation), and excretion
- Human studies
Investigational Drugs

- FDA approval process
  - Phases of investigation (4 phases)
    - Phase 1: determines pharmacokinetics, toxicity, safe dose in humans
    - Phase 2: find therapeutic dose in target audience
    - Phase 3: refine therapeutic dose and determine side effects
      - Usually double blinded study
    - Phase 4: postmarketing analysis during conditional approval period
Investigational Drugs

- FDA classification of newly approved drugs
  - Numerical classification (chemical)
    - New molecular drug
    - New salt of a marketed drug
    - New formulation or dosage form
    - New combination
    - Generic duplication of drug already on the market
    - Drug already marketed by the same company (new indication)
    - Drug on the market without an approval (New Drug Application)
Investigational Drugs

- FDA classification of newly approved drugs
  - Letter classification (treatment or therapeutic potential)
    - Drug offers an important therapeutic gain (P-priority)
    - Drug is similar to drugs already on the market (S-similar)
  - Other classifications
    - Drugs indicated for AIDS or HIV-related disease
    - Drugs developed to treat life-threatening or severely debilitating illness
    - Orphan drugs
Paramedics are held responsible for safe and therapeutically effective drug administration.

Paramedics are personally responsible - legally, morally, and ethically - for each drug they administer.

Basic guidelines

- Know the precautions and contraindications for all medications you administer.
- Practice proper technique.
- Know how to observe and document drug effects.
Providing Patient Care Using Medications (2 of 4)

- Maintain a current knowledge in pharmacology.
- Establish and maintain professional relationships with other healthcare providers.
- Understand pharmacokinetics and pharmacodynamics.
Have current medication references available.

Take careful drug histories including:

- Name, strength, dose of prescribed medications;
- Over-the-counter drugs;
- Vitamins;
- Herbal medications;
- Allergies.
Providing Patient Care Using Medications  (4 of 4)

- Evaluate the patient’s compliance, dosage, and adverse reactions.
- Consult with medical direction as needed.
Six Rights of Medication Administration

- Right medication
- Right dose
- Right time
- Right route
- Right patient
- Right documentation
Special Considerations

Pregnant patients

- Before using any drug during pregnancy, the expected benefits should be considered against the possible risks to the fetus.
- The FDA has established a scale (Categories A, B, C, D, and X) to indicate drugs that may have documented problems in animals and/or humans during pregnancy.
- Many drugs are unknown to cause problems in animals and/or human during pregnancy.
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Adequate studies in pregnant women have not demonstrated a risk to the fetus in the first trimester or later trimesters.</td>
</tr>
</tbody>
</table>
| B        | Animal studies have not demonstrated a risk to the fetus, *but* there are no adequate studies in pregnant women.  
OR  
Adequate studies in pregnant women have not demonstrated a risk to the fetus in the first trimester and there is no risk in the last trimester, *but* animal studies have demonstrated adverse effects. |
| C        | Animal studies have demonstrated adverse effects, *but* there are no adequate studies in pregnant women; however, benefits may be acceptable despite the potential risks.  
OR  
No adequate animal studies or adequate studies of pregnant women have been done. |
| D        | Fetal risk has been demonstrated. In certain circumstances, benefits could outweigh the risks. |
| X        | Fetal risk has been demonstrated. This risk outweighs any possible benefit to the mother. Avoid using in pregnant or potentially pregnant patients. |
Special Considerations

- Pregnant patients
  - Pregnancy causes a number of anatomical and physiological changes
  - Drugs may cross the placenta during lactation
  - Fetus does not have a functioning blood brain barrier, so the volume of distribution is different
    - All medications will enter the baby’s brain
Pregnant Patients

- Ask the patient if there is a possibility that she could be pregnant.
- Some drugs may have an adverse effect on the fetus of a pregnant female.
- Teratogenic drug…is a medication that may deform or kill the fetus.
Special Considerations

- Pediatric patients
  - Based on child’s weight or body surface area
  - Special concerns for neonates
    - Higher proportion of extracellular fluid (nearly 80%)
  - Less protein binding
  - Length-based resuscitation tape
    - Broslow
Special Considerations

Geriatric patients

- Physiological effects of aging can lead to altered pharmacodynamics and pharmacokinetics
  - Slower absorption of oral medications due to decrease in GI motility
  - Decreased plasma protein concentration
  - Body fat increases and muscle mass decreases (less absorption)
  - Decreased liver function may delay or prolong drug action
  - Polydrug use and medication interactions
General Properties of Drugs

- Drugs do not confer any new functions on a tissue or organ in the body
  - Modify existing functions
- Drugs exert multiple actions rather than a single effect
- Drug action results from a physiochemical interaction between the drug and a functionally important molecule in the body
- Drugs that interact with a receptor to stimulate a response are known as agonists
- Drugs that attach to a receptor but do not stimulate a response are called antagonists
- Drugs that interact with a receptor to stimulate a response, but inhibit other responses are called partial agonists
General Properties of Drugs

Interactions between a drug and biological system are divided into two classes

- Pharmacokinetic interactions (how body handles the drug)
- Pharmacodynamic interaction (drug effect on the body)

Once administered, drugs go through four stages

- Absorption
- Distribution
- Metabolism
- Excretion
Mechanisms of Drug Actions

Concentration of the drug at its site of action is influenced by various processes, which are divided into three phases of drug activity:

- **Pharmaceutical**
  - Disintegration of dosage form
  - Dissolution of drug

- **Pharmacokinetic**
  - Absorption, distribution, metabolism, excretion

- **Pharmacodynamic**
  - Drug-receptor interaction
Pharmacokinetics

Definition

- Study of the basic processes that determine the duration and intensity of a drug’s effect
- How drugs enter the body, reach their site of action, and how they are eliminated
- Includes: Absorption, distribution, metabolism, and elimination
Pharmacokinetics

Physiology of transport

- Pharmacokinetics is dependent upon the body’s physiological mechanisms that move substances across the body’s compartments
  - Active transport
    - Requires the use of energy to move substances
    - ATP is broken down into ADP liberating a considerable amount of biochemical energy
    - Example: Na - K pump
  - Facilitated diffusion
    - Process in which carrier proteins transport large molecules across the cell membrane
    - Example: Insulin - glucose relationship
Physiology of transport

- Passive transport
  - Movement of a substance without the use of energy
  - Requires the presence of concentration gradients
  - Most drugs travel through the body by means of passive transport
Pharmacokinetics

Types of passive transport

● Diffusion
  ● Movement of solute in a solution from an area of higher concentration to an area of lower concentration

● Osmosis
  ● Movement of solvent in a solution from an area of lower solute concentration to an area of higher solute concentration

● Filtration
  ● Movement of molecules across a membrane from an area of higher pressure to an area of lower pressure
Absorption

- Process involved in transferring drug molecules from the place where they are deposited in the body to the circulating fluids
- Drugs enter bloodstream and are transported to their sites of action
- Examples
  - Direct injection into bloodstream
  - Injection into a muscle
  - Injection into the subcutaneous tissue
  - Oral administration
  - Rectal administration
  - Respiratory administration
Pharmacokinetics

Absorption

- Variables that affect drug absorption
  - Nature of absorbing surface
  - Blood flow to the site of administration
  - Solubility of the drug
  - pH
  - Drug concentration
  - Dosage form
  - Routes of drug administration
  - Bioavailability
Pharmacokinetics

Distribution

- Transport of a drug through the bloodstream to various tissues of the body and ultimately to its site of action
- Drug reservoirs
- Plasma protein binding
  - Albumin
- Tissue binding
Pharmacokinetics

Distribution
- Barriers to drug distribution
  - Some organs exclude drugs from distribution
- Blood brain barrier
  - Tight junction of capillary endothelial cells in the central nervous system vasculature through which only non-protein bound, highly lipid-soluble drugs can pass into CNS
- Placental barrier
  - Biochemical barrier at the maternal/fetal interface that restricts certain molecules
Pharmacokinetics

Metabolism and Biotransformation

- Metabolism is the body’s breakdown of chemicals to different chemicals
- Biotransformation is the special name given to the metabolism of drugs
- Biotransformation has one of two effects
  - Can transform a drug into a more or less active metabolite
  - Can make the drug more water soluble (or less lipid soluble) to facilitate elimination
  - Active and inactive metabolites
Pharmacokinetics

Metabolism

- Majority occurs in liver (endoplasmic reticulum)
- Hepatic portal system
- First-pass effect
  - Liver’s partial or complete inactivation of a drug before it reaches the systemic circulation
- Drug microsomal metabolizing system
  - Phase I: oxidation of drugs to make them more water soluble to ease excretion
  - Phase II: combines prodrug with endogenous chemicals to make the drugs more polar and easier to excrete
Pharmacokinetics

Elimination

- Organs of excretion
  - Kidneys
  - Intestines
  - Lungs
  - Sweat and salivary glands
  - Mammary glands
Pharmacodynamics

Effect of a drug on the body (drug action)

Types of drug actions

- Drug receptor interaction
- Changing the physical properties of cell
- Chemically combining with other chemicals
- Altering a normal metabolic pathway
Pharmacodynamics

Drug receptor interaction
- Most drug actions are thought to result from a chemical interaction between drug and various receptors throughout the body
- Receptor
  - Protein complex on cell membrane that combines with a drug resulting in a biological effect
  - Analogy: Key and lock mechanism
- Affinity
  - Force of attraction between a drug and a receptor
- Efficacy
  - A drug’s ability to cause the expected response
Pharmacodynamics

Types of receptors and locations (ANS)

- Beta 1: Heart
- Beta 2: Lungs
- Alpha 1: Vascular
- Alpha 2: Vascular
- Dopaminergic
  - Renal, mesenteric, and coronary vessels
Pharmacodynamics

Drug receptor interaction
- Second messenger
  - Chemical that participates in complex cascading reaction that eventually cause a drug’s desired effect
- Down regulation
  - Binding of a drug or hormone to a target cell receptor that causes the number of receptors to decrease
- Up regulation
  - A drug causes the formation of more receptors than normal
Pharmacodynamics

- Drug receptor interaction
  - Agonist
    - Drug that binds to a receptor and causes it to initiate the desired response
  - Antagonist
    - Drug that binds to a receptor but does not cause it to initiate the expected response
  - Partial agonist (agonist-antagonist)
    - Drug that binds to a receptor and stimulates some of its effects, but blocks others
  - Competitive antagonism
    - One drug binds to a receptor and causes the expected effect while blocking another drug from triggering the same receptor
Pharmacodynamics

- Drugs that act by changing physical properties
  - Changing physical properties of the body
    - Example: osmotic diuretics change osmotic balance increasing urine output
  - Drugs that act by chemically combining with other substances
    - Example: denaturing of substances (antibiotics, sodium bicarbonate)
  - Drugs that act by altering a normal metabolic pathway
    - Example: anticancer and antiviral medications
Drug-Response Relationship

To have optimal desired or therapeutic effects, a drug must reach appropriate concentrations at its site of action.

The magnitude of the response depends on dosage and the drug’s course through the body over time.

In the field, response to drug therapy is usually assessed by observing the pharmacological effect of the drug on easily measured physiological parameters such as blood pressure and pain relief.
Drug-Response Relationship

Plasma level profiles

- Describes the length of onset, duration, and termination of action, as well as the drug’s minimum effective concentration and toxic level
- Majority of information needed to describe drug response relationships comes from plasma profiles

- Onset of action
  - Time from administration until a medication reaches its minimum effective concentration

- Minimum effective concentration
  - Minimum level of drug needed to cause a given effect
Drug-Response Relationship

- Plasma level profiles
  - Duration of action
    - Length of time that amount of drug remains above its minimum effective concentration
  - Termination of action
    - Time from when the drug’s level drops below its minimum effective concentration until it is eliminated from the body
Drug-Response Relationship

- **Therapeutic index**
  - Ratio of a drug’s lethal dose for 50 percent of the population to its effective dose for 50 percent of the population
  - Represents the drug’s margin of safety

- **Biological half life**
  - Time body takes to clear one half of a drug
  - Rate of biotransformation and excretion of a drug determines its half life
Responses to Drug Administration

- **Predictable responses**
  - Desired action
  - Side effects

- **Iatrogenic responses**
  - Adverse effects produced unintentionally

- **Unpredictable adverse responses**
  - Drug allergy (medications frequently implicated in allergic reactions)
  - Anaphylactic reaction
  - Delayed reaction (serum sickness)
  - Hypersensitivity
  - Idiosyncracy
Responses to Drug Administration

- Side Effect—unintended response to a drug.
- Allergic Reaction—hypersensitivity.
- Idiosyncrasy—drug effect unique to an individual.
Responses to Drug Administration

- **Tolerance**—decreased response to the same amount.
- **Cross Tolerance**—tolerance for a drug that develops after administration of a different drug.
- **Tachyphylaxis**—rapidly occurring tolerance to a drug.
Responses to Drug Administration

- **Cumulative effect**—increased effectiveness when a drug is given in several doses.
- **Drug dependence**—the patient becomes accustomed to the drug’s presence in his body.
- **Drug interaction**—the effects of one drug alter the response to another drug.
- **Drug antagonism**—the effects of one drug block the response to another drug.
Responses to Drug Administration

- **Summation**—also known as additive effect, two drugs with the same effect are given together — similar to $1+1=2$.
- **Synergism**—two drugs with the same effect are given together and produce a response greater than the sum of their individual responses — similar to $1+2=3$. 
Responses to Drug Administration

- **Potentiation**—one drug enhances the effect of another.
- **Interference**—the direct biochemical interaction between two drugs; one drug affects the pharmacology of another drug.
Factors Altering Drug Response

- Individuals may have different responses to the same drug
- Factors that alter standard drug-response relationship include
  - Age
    - Liver and kidney functions of infants are not fully developed
    - Elderly liver and kidney functions decline
  - Body mass
    - The more body mass a person has, the more fluid is available to dilute a drug
    - Drug will cause a higher concentration in a person with little versus large body mass
Factors Altering Drug Response

- **Sex**
  - Most differences in drug reactions due to sex are based on body mass and fluid composition

- **Environmental milieu**
  - Various environmental stimuli affect drug response
    - Stress
    - Vasodilation

- **Time of administration**
  - Before eating versus after eating

- **Pathologic state**
  - Disease states alter the drug-response relationship
    - Renal and hepatic dysfunction
    - Acid base disturbances

- **Genetic factors**

- **Psychological factors**
Drug Interactions

Variables influencing drug interaction include:

- Intestinal absorption
- Competition for plasma protein binding
- Drug metabolism or biotransformation
- Action at the receptor site
- Renal excretion
- Alteration of electrolyte balance
Drug Interactions

Other drug interactions

- Drug induced malabsorption of food and nutrients
- Food induced malabsorption of drugs
- Alteration of enzymes
- Alcohol consumption
- Cigarette smoking
- Food-initiated alteration of drug excretion
Drug Storage

- Certain precepts should guide the manner in which drugs are secured, stored, distributed, and accounted for.

- Drug potency can be affected by:
  - Temperature
  - Light
  - Moisture
  - Shelf life
  - Applies also to diluents

- Security of controlled medications
Thank you!