



Pharmacologic Principles

Unit 3 Part 2

Radiologic Technologists need a basic understanding of pharmacology principles

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Current Practice Status

Professional Standards

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ASRT Scope of Practice

- Performing venipuncture as prescribed by a licensed practitioner.
- Starting, maintaining and/or removing intravenous access as prescribed by a licensed practitioner.
- Identifying, preparing and/or administering medications as prescribed by a licensed practitioner.



Radiography Scope of Practice accessed 6/15/21 asrt.org

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ASRT Practice Standard

- Radiographers prepare, administer and document activities related to medications and radiation exposure in accordance with federal and state laws, regulations or lawful institutional policy.
 - Standard 4 - Monitors the patient for reactions to medications.



Radiography Scope of Practice accessed 6/15/21 asrt.org

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Professional Liability

- The professional radiographer who administers drugs is expected to know the safe dosage, the safe route of administration, and the limitations of the drug to be administered. All potential hazards of any drug that is incorrectly or unsafely administered must also be known. If drug administration errors are made because of lack of knowledge, the person who administers the drug is legally liable.

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Negligence

- Court decisions against a health care provider may be centered on what another provider in your profession would have done under the same circumstance to determine if your actions were appropriate or inappropriate (negligent). Negligence of duty is malpractice.

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State Statutes and Employer Prerogative/Policy

- State Statutes: <http://www.pacodeandbulletin.gov/>
- Employer Prerogative:
 - Free will of management to conduct its own affairs to achieve its purpose.
 - However, the exercise of its management prerogative through policies, rules and regulations on work-related activities of the employees must always be fair and reasonable and the corresponding penalties, when prescribed, commensurate to the offense involved and to the degree of the infraction.

<https://definitions.uslegal.com/m/management-prerogative-law/>



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Basic Principles of Pharmacology



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- Drug – Any substance that, when taken into a living organism, may modify one or more of its functions
- Pharmacology – Study of drugs and their origin, nature, properties, and effects on living organisms

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Classifications

Nomenclature
Chemical group (Action)
Method of Legal Purchase
Mechanism and site of action
Primary effect

10

*Chapter 21 pg. 254

Nomenclature

(classified system of names)

- **Chemical Name:** N-acetyl-p-aminophenol, C₈H₉NO₂
- **Generic Name** (Nonproprietary name): *acetaminophen*
- **Brand Name** (Trademark, Trade name, Proprietary name): *Tylenol*

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*Chapter 21 pg. 255

Chemical Group

(Action or Function)

- Grouped into **FAMILIES** that have similar chemical actions
 - Family: Relieve Pain → analgesics
 - Family: Treat high BP → antihypertensives
 - Family: fight inflammation → anti-inflammatories

WARNING: one drug may be listed in more than one family

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Legal Purchase

Prescription vs. Non-prescription

FDA: "Caution: Federal law prohibits dispensing without prescription"

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Mechanism and site of action (MOA)

- a term used to describe how a drug or other substance produces an effect in the body

<https://www.cancer.gov/publications/dictionaries/cancer-terms/def/mechanism-of-action>

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Primary Effect

- Desired therapeutic effect of the drug

<https://www.cancer.gov/publications/dictionaries/cancer-terms/def/mechanism-of-action>

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General Pharmacologic Principles

Pharmacokinetics
Pharmacodynamics
Pharmacogenetics



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Pharmacokinetics

- Study of how a drug is absorbed into the body, circulates within they body, is changed by the body, and leaves the body
 - Absorption
 - Distribution
 - Metabolism
 - Excretion

Disintegration is thought to be the 1st step of the Pharmacokinetics process

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Absorption

- Drug movement from its site of administration into the blood.
- The drug must be absorbed and taken through the bloodstream to its intended site in order to act.
- Absorption also depends on the surface available

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Absorption

- The rate and extent of drug absorption depends on a number of factors...
 - Route of drug administration
 - Dosage form
 - Gastro-Intestinal motility
 - Interaction with food/other drugs
 - Absorption surface available
 - Blood flow
 - Age and present disease

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Distribution

- After absorption, the drug is *distributed* via circulation (bloodstream) to target tissues
 - If circulation is compromised, distribution of the drug is also compromised
 - Some drugs accumulate in specific tissues (fat) which can prevent the drug from reaching target site

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Metabolism (Biotransformation)

- Body alters the chemical structure of a drug or other foreign substance
- Most drugs are metabolized in the liver
- Many factors can alter drug metabolism

- Delay drug metabolism could cause an adverse reaction
- Rapid drug metabolism could interfere with intended effect

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Excretion

- Clearance Rate = Drug's removal from the body
- Primarily occurs in the kidneys
 - Other removal:
 - Intestines
 - Lungs
 - Breast milk

- Slow clearance rate and drug given too often = toxic level
- Contrast media is not metabolized = excretion in about 24 hours

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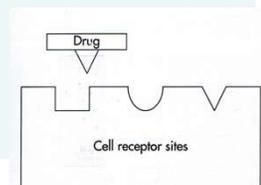
Excretion: Half-Life

- The time it takes for a 50% decrease in a drug's presence in the body
 - Ex: $100 \rightarrow 50 \rightarrow 25 \rightarrow 12.5 \rightarrow 6.25 \rightarrow 3.125 \rightarrow 1.56$ etc
- Short half-life = more frequent doses

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Pharmacodynamics

- Study of the method or mechanism of drug action on living tissues or the response of tissues to chemical agents at various sites in the body
- Drugs can alter physiologic effects in the body
- Receptor
 - The particular area for which a drug is intended and that receives the maximum effect
 - Agonist vs Antagonist



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Therapeutic Index/Range

Measures the safety of a drug

- The relation between dosage at which the intended effect of a drug is obtained and the amount that produces an unwanted effect

When a drug does not have the desired effect, it causes.....

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DRUG REACTIONS

Undesirable drug effects

- **Side Effect**
 - When a drug produces an effect that is mild, common, and/or non-toxic
 - Drug acts on unintended tissues
- **Adverse reaction**
 - When a drug produces a severe or more life-threatening reaction
 - **Toxic Reaction**
 - Unwanted effect that is an extension of the therapeutic effect otherwise known as Overdose
- **Drug Tolerance**
 - Occurs when a drug received continually for a length of time creates a change in the response to the drug

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Pharmacogenetics

- The study of how genes affect a person's response to drugs
- Combines field of pharmacology and genomics

Most drugs today are a "one size fits all" ---but not all drugs work the same for everyone.

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6 Rights of Drug Administration

- ✓ RIGHT medication
- ✓ RIGHT dose
- ✓ RIGHT patient
- ✓ RIGHT time
- ✓ RIGHT route
- ✓ RIGHT documentation

**Chapter 21 pg. 267
ASRT – states 6 RIGHTS versus Textbook*

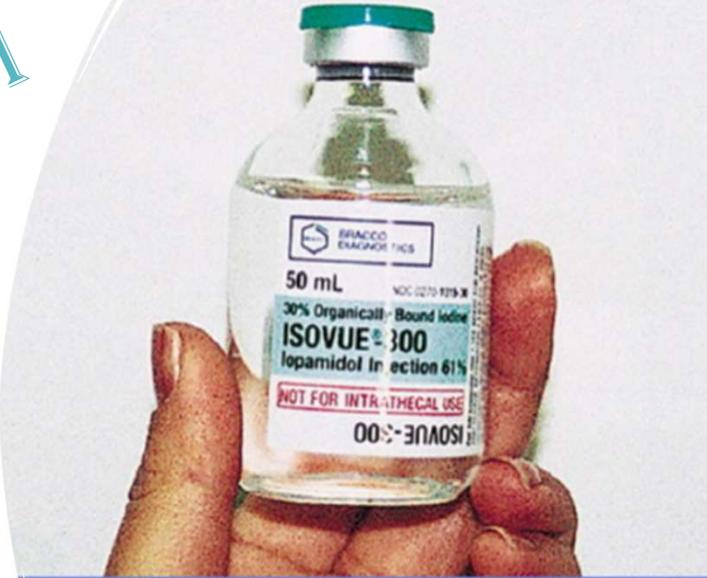
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Right: MEDICATION

(Drug)

Read the label **3** times— *Check Name Carefully!*

- When container removed from storage area/shelf
- When drug is removed from the container
- When container is replaced
- Never use an unlabeled drug/medication
- Check for expiration dates



Confirm contents and
expiration date

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Right: DOSE

(Amount)



Calculate/measure dose accurately

- Check Radiology Dept Protocols
- IF there are any questions with dosage – speak with the Radiologist Assistant or the Radiologist

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Right: PATIENT

Must receive the drug

#3

Follow institution/employers' protocol for patient identifiers

- Verify the patient's identification **each** time a medication is given
- Check
 - Name
 - MRN
 - DOB



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Right: TIME

#4

- Radiologic Technologist does not determine the time of administration
 - Follow facility protocols (Example: Fluoroscopy)
- Physician/Practitioner responsible for ordering drug and determining time of administration
- Once drug/medication administered—do not leave unattended.....Patient could have allergic reaction

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Right: ROUTE

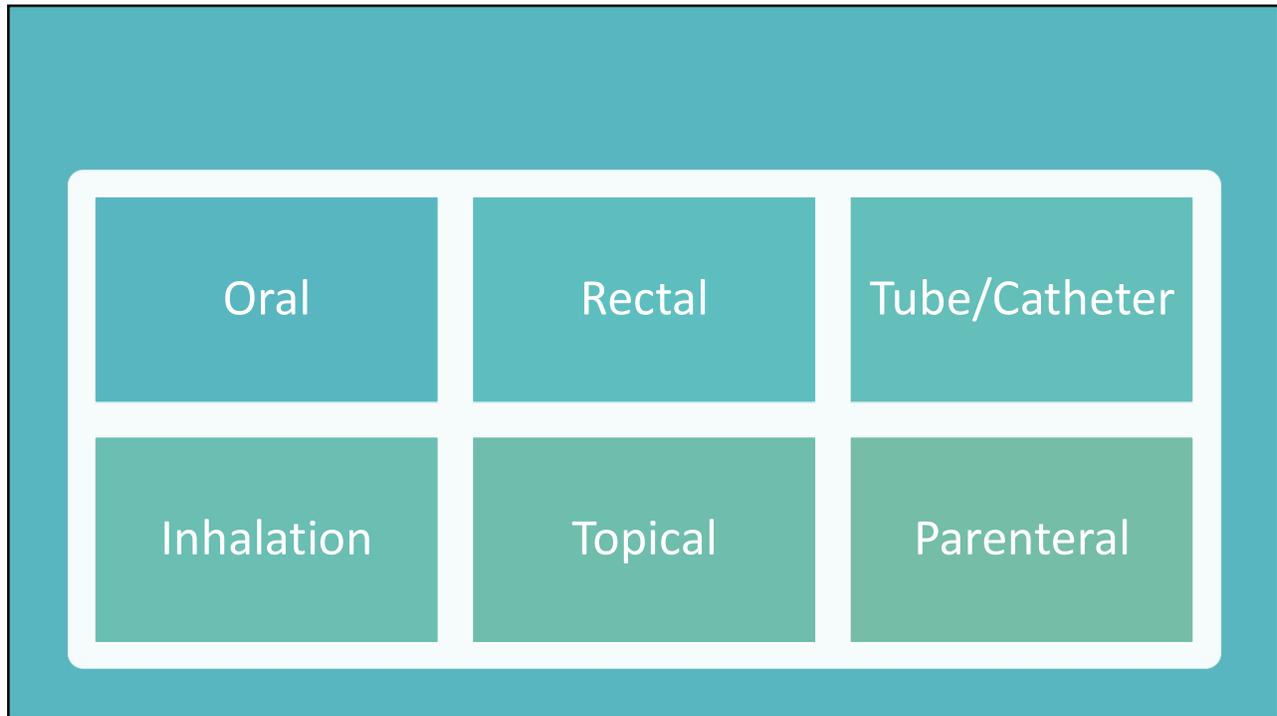
#5

- Physician/Protocol specifies route
- Radiology- Follow Protocols
- Most common routes:
 - Oral
 - Intravenous (IV)
 - Rectal
 - Intrathecal
- Things to consider:
 - Absorption
 - Conscious State
 - Ability to swallow

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Let's talk more about
ROUTES

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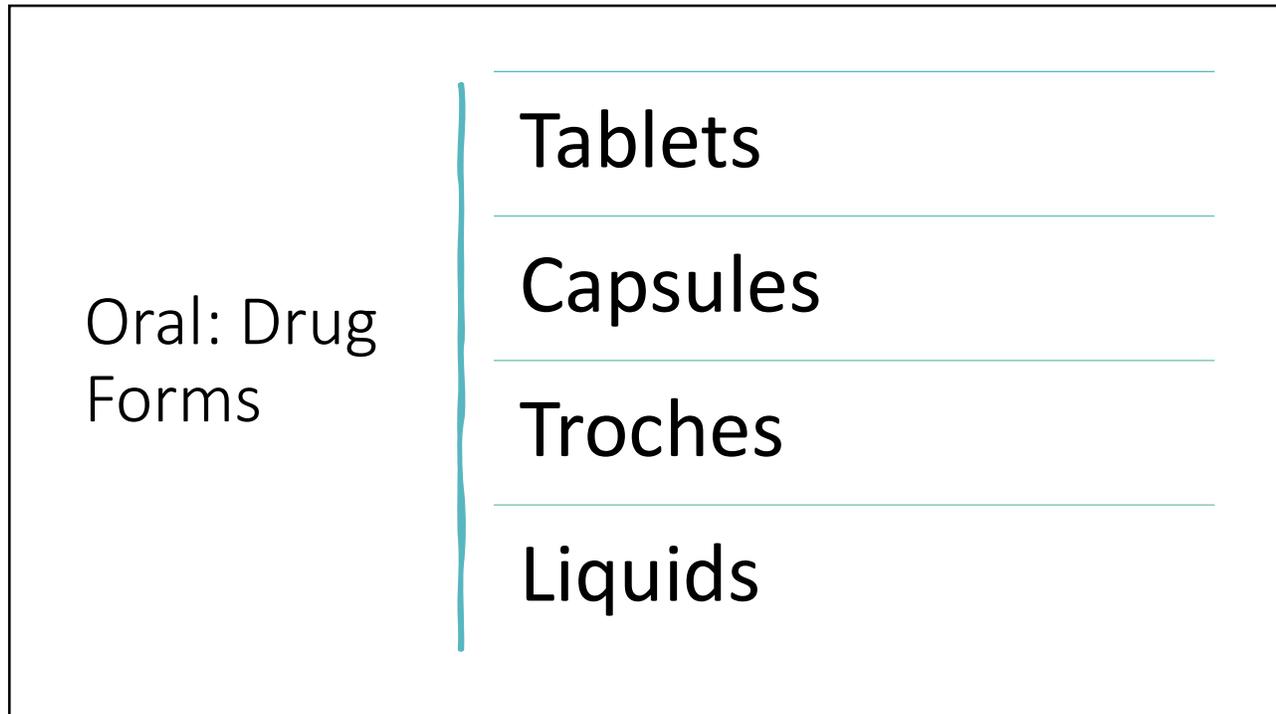
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Oral Route

- Most common method of drug administration
- Abbreviation: PO → means by mouth
- **ADVANTAGES:**
 - Safest, most economical, and most convenient way of giving medication
- **DISADVANTAGES:**
 - May have bad taste, odor, may be large
 - May irritate gastric mucosa – nausea and vomiting
 - Seriously ill or uncooperative person might aspirate
 - Digestive enzymes may destroy them



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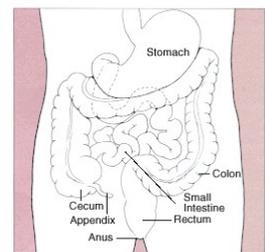


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Rectal Route

Reasonably convenient and safe when oral route cannot be used

- Advantages:
 - Medications can be given when stomach is traumatized or if digestive enzymes can destroy drug
 - Good method if drug has bad taste or odor
 - Avoids irritation of UGI tract
- Disadvantages:
 - Unpredictable retention of drug; absorption is erratic



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Tube or Catheter Route

- Drug introduced by tube or catheter in liquid form
- Examples:
 - PICC line - long, very thin, flexible tube (a catheter)
 - Nasogastric tube
- May need to flush the tube or catheter prior administration of medication or contrast

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**Chapter 21 pg. 256*

Inhalation

- High concentrations of a drug are deposited in the respiratory mucosa
- Produces bronchodilation or reduces inflammation
- Commonly used:
 - Oxygen therapy
 - Anesthesia
 - Aerosol inhalers



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Topical

WARNING: DO NOT APPLY WITH BARE HANDS!

- Drug applied directly to the skin
- Diffused through skin and absorbed into bloodstream
- Lotions, sprays and ointments
- Transdermal patch – supplies precise dose of drug released over a specified time



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Parenteral

Administered by injection or by a route other than the GI tract

- **Intravenous** – Administration directly into circulation (veins)
- **Intra-arterial** – Administration into or by entry of artery
- **Intrathecal** – Administration into the subarachnoid space within the brain or spinal cord
- **Intramuscular** – Administration into muscle tissue that lies under the subcutaneous tissue layer
- **Subcutaneous or Intradermal** – Administration below layer of skin but above muscle
- **Intraosseous** – Administration into a bone

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Right: DOCUMENTATION

#6

- Follow Employer policy
- Any time a drug is administered to a patient, relevant information must be recorded in patient's chart/EPIC
- INCLUDING:
 - Name and dose of medication/drug
 - Route of administration (if parenterally include site)
 - Date and time
 - If the patient refused
 - Adverse effects or errors must also be documented thoroughly

Many ERRORS can occur..... So, what can you do to prevent them.....

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Right: DOCUMENTATION (cont.)

Medication errors associated with drug administration is among the most common legal problems which RTs are involved

- Follow Policies
- Knowledgeable of Policies
- Documentation is essential
- Do not rush through medication administration
- Avoid interruptions
- Write legibly (if paper chart)
- Use approved abbreviations, if in doubt spell it out

• <https://trh.ellucid.com/documents/view/6573>



****Note: Patient may refuse medication (or other treatments) at any time**

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Let's Review the RIGHTS again

RIGHT
medication

RIGHT dose

RIGHT patient

RIGHT time

RIGHT route

RIGHT
documentation

When will an RT use the 6 RIGHTS?

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Contrast Administration

IV

Oral

Rectal

Intrathecal

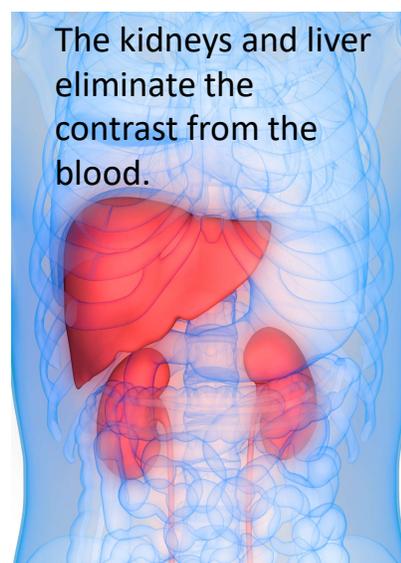
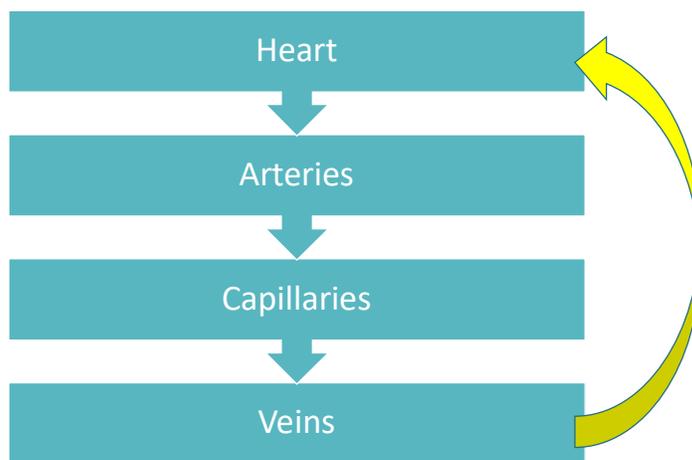
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IV Contrast Administration

- Introduce contrast directly into the blood stream
- Seen in CT, MRI, AIR etc.
- Contrast is clear and packaged in a glass bottle or vial
- Highlights the vessels/organs
- Ensure protocols and policies are followed precisely

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How does contrast circulate once in the blood?



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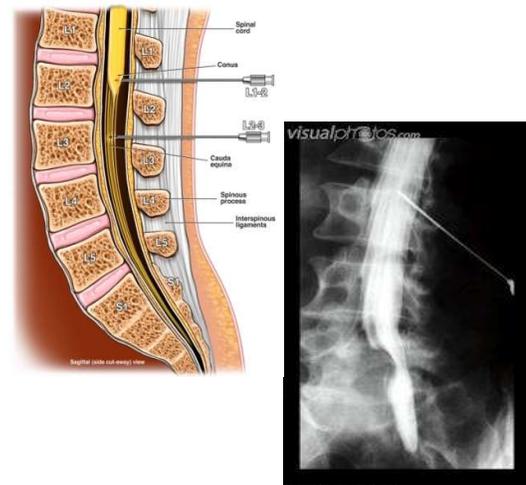
Oral, Rectal, Tube Contrast Administration

- Procedures in which you would see Oral Administration:
 - Esophagus
 - UGI
 - Small Bowel
- Procedures in which you would see Rectal Administration:
 - Barium Enema
- Procedures in which you would see Tube/Catheter Administration:
 - Fistulagram
 - Loopogram
 - T-tube cholangiogram

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Intrathecal Contrast Administration

- Myelograms
- CT
- MRI
- Injection into the subarachnoid space (spinal canal)



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Chemical Group

Classifications



The ASRT advocates that preparation, identification, and administration of contrast media, radiopharmaceuticals, and/or medications are within the scope of practice of radiologic technologists with appropriate clinical and didactic education and where federal or state law and/or institutional policy permit."

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Analgesics

**Chapter 21 pg. 259*

Relieve pain without causing loss of consciousness

Two Groups

- **Opioid (narcotic)** - Treat moderate to severe pain
 - Morphine; oxycodone (OxyContin)
 - Side Effects: nausea, vomiting, constipation; can be very harsh to the GI system
 - Overdose of opioid = naloxone (Narcan) parenterally or intranasally administered
- **Nonopioid (non-narcotic)** - Treat mild to moderate pain
 - acetaminophen (Tylenol)

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Anesthetics

Reversibly depress neuronal function, producing loss of ability to perceive pain and/or other sensations

Two Types

- **General** - Produce muscle relaxation and loss of consciousness
 - Inhalation : sevoflurane (Ultane)
 - IV : propofol (Diprivan)
- **Local** - Block nerve conduction from an area of the body to the central nervous system
 - mepivacaine (Carbocaine); lidocaine (Xylocaine); procaine hydrochloride (Novocain)
- **Side Effects:** irregular heartbeat, seizures, breathing issues, death

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Antianxiety (Anxiolytics)

Treatment of anxiety; Act on the Central Nervous System to calm/relax anxiousness

Benzodiazepines

- used often as a pre-operative drug for procedures (anxiety), relieves muscle spasm, and seizures
 - diazepam (Valium)
 - lorazepam (Ativan)
 - alprazolam (Xanax)
 - midazolam (Versed)

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*Chapter 21 pg. 260

Anticholinergics

Reduce smooth muscle tone, motility of the GI tract, and secretions from respiratory tract and secretory glands

Oxybutynin (Ditropan XL) & tolterodine (Detrol LA) - Use for the treatment of overactive bladder

Atropine – used preoperatively to inhibit the secretions that can be stimulated by general anesthetics and to prevent bradycardia

Side effects

- Dry mouth
- Delirium (high doses)

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*Chapter 21 pg. 259-260



Antiarrhythmics

- Treat (arrhythmias) variations from normal rhythm of the heartbeat
- Depends on type of arrhythmia
 - Amiodarone (Cordarone) –used for ventricular arrhythmias
- Side Effects: Could cause adverse effects such as hypothyroidism and pulmonary fibrosis

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*Chapter 21 pg. 259-260



divalproex (Depakote)
Phenytoin (Dilantin)

Anticonvulsants (antiepileptic)

- Used to prevent or control the occurrence of seizures
- DO NOT treat the CAUSE of seizures
- Some types are available as oral or parenteral
- Not only treats seizures, but certain types can help with bipolar disease and fibromyalgia
- Side Effects: Liver toxicity, thrombocytopenia, pancreatitis

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*Chapter 21 pg. 260



Antidiabetic

- INSULIN
 - only treatment used to treat Type 1 but also used for Type 2
- Type 2 medications: Micronase, Glucotrol, Amaryl, Glucophage (metformin), Actos, Januvia, Victoza, Invokana
- Complications: hypoglycemic reactions
- Recommended to temporarily discontinue metformin before x-ray contrast used to prevent renal function issues

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Anticoagulants

**Chapter 21 pg. 260*

Inhibit clotting of the blood (increase coagulation time)

Prevent/treat thromboembolic disorders

- Patients undergoing IR procedures receive anticoagulants
 - IV: Heparin; enoxaparin (Lovenox)
 - Oral: Warfarin (Coumadin)

Coagulants

Control hemorrhage or speed up coagulation

Oral and IV: Phytonadione (Mephyton)

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Antidepressant

**Chapter 21 pg. 260*

Treatment of depression; panic disorder; OCD; and depressive state of bipolar disorder

- fluoxetine (Prozac)
- sertraline (Zoloft)
- paroxetine (Paxil)
- duloxetine (Cymbalta)
- bupropion (Wellbutrin)

Treatment of 6-12 weeks for maximum effect

Drug interactions can occur if receiving drugs in combination with antidepressants

Side effects – nausea, vomiting, diarrhea

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Antiviral

**Chapter 21 pg. 260-261*

DO NOT DESTROY their target pathogen; instead they inhibit its developments

Treat: herpes simplex, chicken pox, shingles, flu, hepatitis, and infection from HIV

Zovirax – available as oral, topical and parenteral forms

Side effects – Nausea, vomiting, diarrhea, and headache



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**Chapter 21 pg. 260*

Antiemetic

Prevent/treat nausea and vomiting

- Most effective in prevention versus after the symptoms have started
 - - Oral and IV: prochlorperazine (Compazine); ondansetron (Zofran)
- Reduces motion sickness
 - metoclopramide (Reglan); prochlorperazine (Compazine); dimenhydratate (Dramamine)

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*Chapter 21 pg. 261

Antihistamine (Antiallergic)



Treat acute/chronic allergic disorders

- Treat symptoms (runny nose); upper respiratory infections; common cold (viral infections)
 - *Sedating*
 - Moderate/severe allergic reactions
 - Severe reactions injected intramuscularly
 - Oral and IV: diphenhydramine (Benadryl)
 - *Non-sedating*
 - Oral: loratadine (Claratin); fexofenadine (Allegra)

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*Chapter 21 pg. 261

Antihypertensives



- Treat high blood pressure (hypertension)
- Hypertension caused by many factors = many different drugs used as treatment
- Commonly used in combination with other drugs
 - lisinopril (Zestril)
 - metoprolol (Lopressor, Toporol XL)
- Side Effect- persistent cough

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Antibacterial (Antimicrobial)

Used to destroy or inhibit growth of microorganisms

- Antibiotics
 - *Broad spectrum*: Effective against large number of microorganisms
 - oxytetracycline (Terramycin); ciprofloxacin (Cipro)
 - *Narrow spectrum*: Effective against a smaller number of microorganisms
 - erythromycin (Erythrocin); penicillin

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Antibacterial (Antimicrobial) cont.

- *Antiseptics* – Destroy microorganisms on living tissue
 - Alcohol, Betadines (skin preps) – cidastat, choraprep
- *Disinfectants* – Substances that are applied to non-living objects to destroy microorganisms that are living on the objects
 - Bleach

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Anti-Inflammatory

Treat inflammation



- Effective and widely used for mild/moderate pain
 - *NSAIDS* – Nonsteroidal Anti-Inflammatory analgesic drugs
 - ibuprofen (Advil, Motrin)
 - acetaminophen (Tylenol)
- Side Effects: May increase risk of: GI irritation, bleeding, and acute renal failure can occur with all NSAIDS with increased duration of use

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Corticosteroids

- Used to reduce symptoms associated with chronic inflammatory disorders or short-term treatment of acute inflammatory conditions
- Dexamethasone and hydrocortisone – used systemically
- Depo- Medrol – injected
- Flovent – inhalation
- Prolong use can cause adverse effects – osteoporosis and cataracts

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*Chapter 21 pg. 262

Bronchodilators

Treat asthma and COPD; Relax bronchial muscles and dilate respiratory passages

- Inhalation and Oral:
 - albuterol (Proventil) fast acting bronchodilator
 - tiotropium (Spiriva) long acting bronchodilator

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Antidiarrheal

Helps to relieve diarrhea by slowing down the movement of the bowel

- May not be taken with certain medical conditions (bowel obstructions) or with certain medications
- Usually 2 day use maximum*
 - Pepto-Bismol
 - Imodium
 - Atropine
 - Diphenoxylate
- ***Common Side Effects:*** Constipation, bloating, feeling of fullness, drowsiness, nausea, vomiting, and pain in the abdomen.



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Cathartics

Helps to empty bowels and stimulate intestinal motility

- Not to be used for extended periods of time
- May interact with other drugs causing improper absorption of that drug
 - MiraLAX
 - bisacodyl (Dulcolax)
- Side Effects: Abdominal cramps

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Laxatives

*Chapter 21 pg. 262

- Act to promote the passing and elimination of feces from the large intestines
- Frequently used in radiology to prep patients for GI procedures
- Dulcolax and magnesium citrate
 - Eliminate fecal matter to see clear view of intestinal walls
- Miralax – powder to mix in cold or hot beverages – stimulates bowel movement
- Side effects – skin rash, irregular heartbeat, weakness and tiredness



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*Chapter 21 pg. 262

Diuretics

Increase the amount of urine excreted by the kidneys
(removes sodium and water from the body)

- Aids in treatment of edema (associated with congestive heart failure)
- Used in conjunction often times with treatment of high blood pressure
- Patients are monitored closely for excessive fluid loss
 - furosemide (Lasix)
 - hydrochlorothiazide



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Sedatives (Hypnotics)



Depress the Central Nervous System; effect ranges from mild sedation to inducing sleep

- Treats anxiety related to painful or anxiety-provoking procedures; induces sleep for insomnia
- Extended use can lead to addiction
 - zolpidem (Ambian)
 - midazolam (Versed)
 - Valium
- Common Side Effects: Daytime fatigue and cognitive impairment

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*Chapter 21 pg. 263

Vasodilators

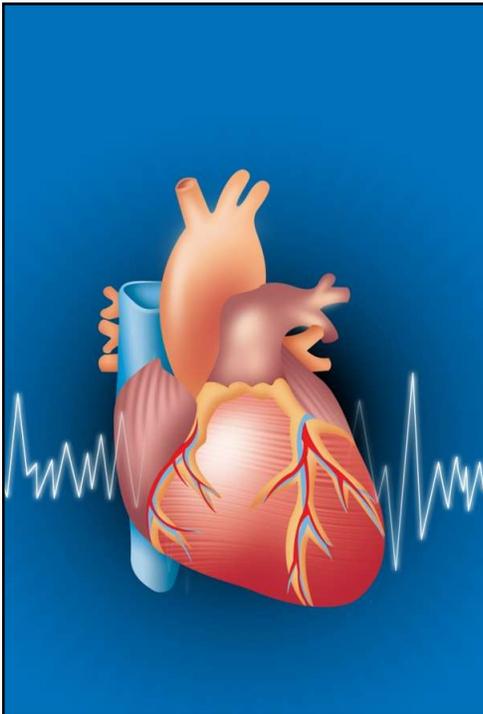


Causes blood vessels to dilate and useful in treating vascular diseases (angina)

- IV, Oral, Topically
 - nitroglycerin (Nitrogard) – coronary vasodilator
- nitroprusside (Nitropress)– treats hypertensive crisis or heart failure

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*Chapter 21 pg. 263



Vasoconstrictors

Cause blood vessels to constrict- increasing heart action and raising blood pressure

- Can treat shock symptoms
 - dopamine (Intropin)
 - norepinephrine (Levophed)
 - epinephrine (Adrenalin)
- Common Side Effects: Pain, burning, irritation, discoloration, sudden numbness, weakness, or cold feeling, slow or uneven heart rate, blue lips or fingernails, urinating less than usual or not at all, trouble breathing, high blood pressure

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*Chapter 21 pg. 262

Hormones

- Affect the endocrine system
- Used in replacement therapy:
 - hypothyroidism – Synthroid
 - Severe menopause symptoms – Premarin
- Side effects:
 - headache
 - upset stomach
 - vomiting
 - stomach cramps or bloating
 - diarrhea
 - appetite and weight changes
 - changes in sex drive or ability
 - nervousness



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Antiseptic and Disinfectant agents

Essential part of infection control practices and aid in the prevention of nosocomial

- Kill microorganisms such as bacteria, viruses, and fungi using chemicals called biocides
- **Disinfectants** are used to kill germs on nonliving surfaces
 - Hydrogen peroxide
 - Alcohol
 - Chlorine
- **Antiseptics** kill microorganisms on your skin.
 - Chlorhexidine and other biguanides - These are used on open wounds and for bladder irrigation.
 - Antibacterial dye - These help to treat wounds and burns.
 - Peroxide and permanganate - These are often used in antiseptic mouthwashes and on open wounds.
 - Halogenated phenol derivative - This is used in medical-grade soaps and cleaning solutions.
- Side effects: nose/sinus irritation, skin irritation, eye irritation, and dizziness

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Patient Monitoring/Safety

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- *Pharmacokinetics, Pharmacodynamics, Pharmacogenetics*
- *Continuous Monitoring*
 - *ED/In-Patient – Question –Have you had any pain medications?*
 - *Standing Precautions – Vertigo, Syncope, Nausea/Vomiting, Pain Medications*
- *Diagnostic Imaging*
 - *After Contrast administration – patient should not be left alone*
 - *Take note of patient's behavior or vital signs at the start of the exam, during the exam, with contrast administration, after contrast administration*

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