**Pharmacology**

**Basics**

**Pharmacology** – how drugs interact with the body.

* Side effects, contraindications, effectiveness

**Pharmacokinetics** – how drugs move through the body.

* ADME (Absorption, Distribution, Metabolism, Excretion)

**Pharmaceutics** – how drugs are created.

* Tablet, capsule, suppository

Absorption

* Process by which drugs are absorbed into the bloodstream for them to produce an effect, typically in the GI tract.
* Some drugs have quick absorption times, such as liquid medications, because they are more easily able to pass into the blood stream.
* Other medications such as tablets or capsules may depend on the GI tract’s pH and movement to determine their absorption speed.

Distribution

* Process by which drugs are taken to their site of action.
* This portion of ADME pertains to how well the medication reaches its target location once absorbed.
* This primarily takes place in the blood stream.
* Factors that may affect distribution include a drug’s solubility, size, and protein binding.
* Prefer low protein binding.

Metabolism

* Process by which drugs are changed by enzymes to become active, inactive, or for elimination.
* Enzymes – complex proteins that speed up or slow down chemical reactions.
* Primarily done by the liver.
* An example includes the metabolism of codeine into morphine to be used as an analgesic and cough suppressant.
  + In this case, morphine would be a metabolite.
  + Metabolite – the substance resulting from the body’s transformation of an administered drug.

Excretion

* Process by which drugs are removed from the body.
* Can be renally excreted in urine or excreted in stool.

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**Equivalence**

Sometimes a medication may not be available for a patient and an alternative must be chosen.

There are three common types of alternatives a pharmacist may recommend:

1. Therapeutic Equivalent
2. Pharmaceutical Equivalent
3. Pharmaceutical Alternative

Therapeutic Equivalent

* When two medications contain the same active ingredient as well as the same pharmacokinetic principles as the reference drug.
* These are brand and generic medications.
* Ex. Brand name plain Tylenol 325mg and generic acetaminophen 325mg both contain acetaminophen as the active ingredient, in the same quantity, and they have the same pharmacokinetic profile, so they are therapeutic equivalents.
* Patients should be able to take therapeutically equivalent medications and experience no adverse effects from their current medications.

Pharmaceutical Equivalent

* These medications contain the same active ingredient; however, they may differ in inactive ingredients or their release properties.
* Ex. Tylenol 325mg vs. acetaminophen XR 325mg.
* In this case, both products share the same active ingredient, acetaminophen 325mg; however, one is extended released and on is not.
* These medications are NOT freely interchangeable, as it will change how the medication affects the patient.

Pharmaceutical Alternative

* These medications may be the same main active ingredient but may vary in their salt form or other characteristic.
* Ex. Metoprolol tartrate vs Metoprolol succinate.
* In this example, both active ingredients are metoprolol; however, they are different forms of metoprolol.
* These are NOT freely interchangeable, as the effects of the medications are not the same.

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**Dosage Forms**

* How the medication is made.
* Is a combination of active and inactive ingredients.
* Active ingredients – those that exhibit a therapeutic effect.
* Inactive ingredients – an ingredient holding little to no therapeutic value. These are basically fillers that make the active ingredient big enough to take in dosage form.
* Can be altered to change a medication’s absorption, distribution, metabolism, or excretion.
* Dosage forms include:
  + Solid
  + Semi-Solid
  + Liquid
  + Inhalation
  + Transdermal

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**Solid Dosage Forms**

* Solid dosage forms include tablets, capsules, lozenges, and powders.
* Some advantages of solid dosage forms include:
  + Precise dosing
  + Convenience
  + Easy packaging, storing, and dispensing.

Tablets

* Powdered active and inactive ingredients compressed into a small solid form.
* Can be modified to be extended or immediate release.
* May or may not be enteric or film coated.
* May or may not be scored for breaking.
* Some tablets come in flavored, chewable form.

Extended vs. Immediate Release

* Immediate release medications are available for the body to absorb as soon as the patient takes the medication.
* Extended-release medications are modified to only release some of the medication over a long period of time.
  + Enteric coating prevents aspirin from breaking down in the stomach by protecting the drug until it gets to the small intestines.
* Extended-release and enteric coated medications should never be cut or crushed unless the manufacturer explicitly says you can do so.

Capsules

* Medications in which the active ingredient is enveloped in a hard or soft gelatin shell.
* Can also be modified to be extended-released or immediate release.
* Some capsules may contain sprinkles inside of them.
  + Sprinkles are small bead-like formulations of medication that are meant to be sprinkled on food.

Lozenges

* Sometimes called troches.
* Hard, sugary, candy-like dosage form.
* Think of these as cough drops with medication in them.

Powders

* Ground combinations of drug and inactive ingredient.
* Typically supplied in packets or with a measuring scoop to be mixed with a liquid and consumed.

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**Semi-Solids**

* Typically meant to be used topically.
* Are neither completely solid nor completely liquid.
* Includes:
  + Ointments
  + Creams
  + Lotions
  + Gels
  + Pastes
  + Suppositories

Ointments

* Topical dosage form that consists of a small amount of water in a large oily base.
* Is typically very thick and can be used for skin protection.
* Common ointments include:
  + Erythromycin ointment
  + Neosporin ointment

Creams

* Typically, a topical dosage form consists of a small amount of oil in a water base.
* Creams are typically lighter than ointments and can easily be rubbed into the skin.
* Creams may also be for vaginal or rectal use.

Lotions

* Like creams in that they are a small amount of oil in a water base.
* Are slightly thinner than creams.
* Are used to cover a larger surface area than creams.

Gels

* Gels are a thick liquid-like semi-solid that contain solid medication particles suspended within them.
* Gels can be rubbed into the skin cleanly.

Pastes

* Pastes are like ointments in that they are thick and contain a smaller amount of water.
* Pastes are a large amount of solid mixed with a small amount of liquid to form a stiff, thick, semi-solid.
* An example of a paste is zinc oxide ointment.

Suppositories

* Suppositories contain medication in an inactive base that will melt once inserted into the body.
* Suppositories are meant to be used by:
  + Vaginal
  + Rectal
  + Urethral
* Suppositories are helpful in situations in which oral medications may not be best.

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**Liquids**

* Typically have quicker onsets than solid dosage forms due to quicker absorption, or no need for absorption at all.
* Easy dose adjustments.
* Flavorings may be beneficial or detrimental to oral dosage forms.
* Ear and eye drops are liquid dosage forms.
* Include solutions, suspensions, and enemas.

Solutions

* An evenly distributed mixture of dissolved medications, or solutes, in a liquid base, or solvent (solvent is what the drug is dissolved in).
* This is like Kool-aid, you want the powder to be completely dissolved, no settling on the bottom.
* Aqueous solutions (water)
* Alcoholic solutions
* Hydroalcoholic solutions (alcohol and water)
* Solutions by contents and purpose
  + Aromatic water – water and oil or other volatile substance.
  + Elixir – dissolved medication in water and ethanol.
  + Syrup – a sugar-based solution.
  + Extract – powder derived from animal or plant after solvent is evaporated.
  + Tincture – alcoholic or hydroalcoholic liquid that contains plant extract.
  + Spirit – alcoholic or hydroalcoholic liquid with volatile, aromatic ingredients.
  + Irrigating solution – a liquid used for cleansing the body.
  + Parenteral solution – a sterile liquid with the intention of being administered by injection.

Suspensions

* A liquid in which the drug does not dissolve in the base, leaving the small solid particles floating in the liquid base.
* These medications may need to be reconstituted, or mixed with water, before dispensing.
  + Always shake suspensions well before dispensing them to ensure the medication is equally dispersed.
* Aqueous (water) suspensions will always need the auxiliary label “Shake Well”, as solid medication may settle at the bottom of the bottle.
* Injectable suspensions can be used for depot therapy.
  + Allows for drugs to be administered either to the muscle or the skin and to be released over a long duration of time.
  + Depo-Provera

Enemas

* Liquid medication used to deliver medication rectally to bypass the GI tract.
* Can be useful in situations when oral medications are not the best choice.

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**Inhalations**

* These medications gained their name after the literal term inhalation meaning to breathe in.
* These medications are used to reach the lungs rather than the GI tract for absorption.
* Include aerosols and sprays.

Aerosols

* A medication that is given as a very fine liquid or solid spray in a gas propellant.
* Container may be pressurized.
  + Advise patients to avoid heat.
* Rapid onset of action as it does not have to be absorbed in the GI tract, absorption takes place in the lungs.
* A common example is ProAir or albuterol.

Sprays

* A medication contained in a pump-type dispenser that when pushed dispenses a fine release of liquid, solid, or gas particles.
* Can be a variety of bases, including alcohol or water.
* Typically used more for upper respiratory such as a sore throat, rather than lower respiratory like aerosols.
* A common example is Flonase or fluticasone.

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**Transdermal**

* Transdermal patch – medication is housed in a “reservoir” and slowly allowed to be released from the patch to the skin.
* Eliminate the need for frequent dosing.
* May be irritating to a patient’s skin.

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**Routes of Administration**

* This is how a medication is to be taken.
* All the things we’ve discussed so far, plus this, come together to determine how a medication affects a patient.
* Common routes of administration include:
  + Oral
  + Sublingual
  + Buccal
  + Rectal
  + Vaginal
  + Ocular
  + Otic
  + Nasal
  + Inhalation
  + Topical
  + Intramuscular
  + Subcutaneous
  + Intravenous
  + Intrathecal

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Oral Route

* Medications that are to be taken by mouth.
* Commonly abbreviated PO.
* Most common route of administration.
* Must pass through the GI tract to be absorbed typically.
* Relatively slow onset.
* May be metabolized before they can be distributed to the needed site due to the first pass effect.
* First pass effect – before drugs are transported to their site of action they pass through the wall of the intestines and are transported through the liver to the bloodstream; some drugs are completely metabolized in the liver before they can reach the bloodstream.
  + Other routes of administration such as injectables, inhalations, or transdermals do not undergo first pass effect because they do not have to go through the GI tract.

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Sublingual Route

* Should be placed under the tongue.
* Commonly abbreviated SL.
* Not always considered an oral route due to avoiding the GI tract.
* Do not under first pass effect.
* Have a quicker onset.
* Common formulations include nitroglycerin or Nitrostat for angina relief in heart failure.

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Buccal Route

* Placed between cheek and gums.
* Like SL that is does not go through GI tract.
* Does not undergo first pass metabolism.
* Faster onset of action than oral route.

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Rectal Route

* To be inserted into the rectum.
* May be abbreviated PR.
* May be suppository or enema.
* Avoids first pass effect.
* Quick onset of action.
* Convenient if oral route is unavailable.

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Vaginal Route

* To be inserted into the vagina.
* May be abbreviated PV.
* May be a cream, suppository, or vaginal ring.
* Typically, a slower route of administration through the vaginal wall.
* Avoids first pass effect.

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Ocular Route

* To be placed in the eye.
* May also be called ophthalmic.
* May be abbreviated OU for both eyes, OD for right eye, and OS for left eye.
* Avoids first pass effect.
* Almost always used locally.
* Typically, include drops or ointments.

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Otic Route

* To be placed in the ear.
* Commonly abbreviated AU for both ears, AD for right ear, and AS for left ear.
* “A” for “Auditory”.
* Avoids first pass metabolism.
* Exclusively used for local drugs.
* Eye drops can be used in the ear; however, ear drops cannot be used in the eye because they are not sterile.

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Nasal Route

* To be inhaled through the nose.
* This may be commonly abbreviated IEN for “In Each Nostril”.
* Commonly an aerosol or spray medication.
* Avoids first pass metabolism.
* Quick onset of action.
* A common example is Flonase, or fluticasone.

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Inhalation Route

* To be inhaled to the lungs.
* Avoids first pass metabolism.
* Quick onset of action.
* Commonly aerosolized or nebulized.
  + Aerosolized medications are those that are tiny droplets in a gas propellant canister, such as an inhaler.
  + Nebulized medications come as a liquid in a vial and are turned into a mist using pressure by a machine called a nebulizer.
    - Nebulizers require tubing and typically a face mask to inhale the medication, patients will commonly ask for these supplies.
* An example is albuterol, or Proair HFA.

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Topical Route

* To be applied externally, typically to the skin.
* A common abbreviation could be AAA for “Apply to Affected Area”.
* Common dosage forms include creams, gels, lotions, ointments, and pastes.
* Avoids first pass effect.
* Slower onset of action because it is absorbed through the skin.
* Mostly used for local effects.

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Transdermal Route

* To be diffused through the skin.
* These drugs are typically patches that contain a large amount of medication to be diffused across the skin to the blood supply, unlike topicals which are local typically.
* Avoids first pass effect.
* Slower onset with a longer duration.
* An example of a transdermal medication is fentanyl or Duragesic.

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Intramuscular Route

* To be injected into the muscle.
* Commonly abbreviated as IM.
* Used for larger volumes.
* Onset of action depends on blood supply to the muscle.
* Avoids first pass metabolism.
* An example of a drug using this route would be epinephrine or an Epipen.

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Subcutaneous Route

* To be injected under the skin.
* Commonly abbreviated SC, SubQ, or SQ.
* Can be used for smaller volumes of injections.
* Avoids first pass effect.
* Quick onset of action because of capillaries.
* Insulin is injected by SubQ route.

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Intravenous Route

* To be injected directly into the veins.
* Commonly abbreviated IV.
* Quick onset of action as it goes straight to the blood stream.
* Avoids first pass effect.
* Ideal for when oral is not a good option, and medication is needed quickly.

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Intrathecal Route

* To be injected around the spinal cord in the spinal canal.
* This route is used to produce effects quickly on the brain and spinal cord.
* Avoids first pass metabolism.
* This route is typically used for anesthetics to numb the body as well as antibiotics to treat meningitis.

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**Common Side Effects**

* Side effects, sometimes called adverse effects, are unintended effects of a medication.
* Common oral medication side effects include GI discomfort.
* Common topical and transdermal side effects include skin irritation.
* Common injectable medications cause injection site pain.
* Some classes of medications contain important adverse effects.

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NSAIDs

* The stomach naturally produces fluid to protect it from stomach acid.
* NSAIDs disrupt the production of that fluid, which can lead to ulcers or stomach bleeding.
* NSAIDs can also cause serious kidney damage.
* NSAIDs increase a patient’s risk of having a blood clot.
* Other, less rare, more common side effects of NSAIDs include:
  + Heartburn
  + Gas
  + Stomach Pain
  + Constipation
  + Diarrhea

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Depressants/Sedatives

* These medications can cause respiratory depression or slowed breathing when overtaken.
* Other common but less severe side effects of depressants/sedatives include:
  + Forgetfulness or Amnesia
  + Drowsiness
  + Dizziness
* Signs of respiratory depression include slurred speech and blue lips or extremities.
* Common depressants and sedatives include:
  + Alcohol
  + Opioid
  + Analgesics
  + Barbiturates
  + Benzodiazepines

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Opioids

* Other common side effects of opioid analgesics include:
  + Constipation
  + Nausea
  + Vomiting
  + Itching
* Tolerance – When a patient’s body requires an increased dose of medication to achieve the same effect.
* Patients will gain tolerance to all effects of opioids except for constipation.

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Serotonin Agents

* These include SSRIs, SNRIs, tricyclic antidepressants, as well as any other agent that may affect serotonin levels.
* If the body has too much serotonin, the patient will experience serotonin syndrome.
* Symptoms of serotonin syndrome:
  + Changes in mood such as agitation or confusion.
  + Rapid heartbeat
  + High blood pressure
  + Twitching
  + Sweating
  + Rigid muscles
* More common symptoms of serotonin agents:
  + Nausea/Vomiting
  + Diarrhea
  + Headache

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Blood Thinners

* Blood thinners such as warfarin or aspirin help to prevent clots in high-risk patients.
* Sometimes these patients may fall or cut themselves and their blood may be too thin to clot.
* Common side effects of blood thinners include:
  + Bruising
  + Prolonged bleeding
* More serious side effects that warrant treatment include:
  + Bleeding that will not stop
  + Severe headache or stomachache
  + Bruising without an injury
  + Coughing up or vomiting up blood

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Anti-Histamines

* First generation vs. Second generation
  + First generation includes older anti-histamines such as diphenhydramine, meclizine, and promethazine.
  + Second generation includes once daily anti-histamines such as fexofenadine, loratadine, and cetirizine.
* First generation anti-histamines commonly have the following side effects:
  + Dry mouth
  + Drowsiness
  + Dizziness
  + Blurred vision
  + Confusion
  + Unable to urinate.
* First generation anti-histamines “dry you up”, which is why they work so well for that runny nose.

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HMG-CoA Reductase Inhibitors

* Commonly referred to as “statins”.
* Most common side effect that patients complain of is muscle pain.
* Not all statins are the same, some cause worse pain than others.
* If a patient is experiencing extreme muscle pain, it could be a condition called rhabdomyolysis, which is an emergency.
* Rhabdomyolysis – the breakdown of skeletal muscle.

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Ace Inhibitors

* Include the drugs lisinopril and ramipril.
* May cause low blood pressure.
* Most common side effect that patients will complain of is a non-life-threatening cough.
* In rare instances, ACE inhibitors can induce angioedema, which is an emergency.
  + Angioedema – extreme swelling of the deep tissues.
* Since ACE inhibitors work in the kidneys, they also put patients at risk for electrolyte changes such as high potassium.
* All blood pressure medications can also cause a patient to have low blood pressure.
* Symptoms of low blood pressure include:
  + Dizziness upon standing.
  + Changes in vision

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Anti-Cholinergics

* Medications such as oxybutynin or benztropine.
* Very similar side effect profile to first-generation anti-histamines:
  + Dizziness
  + Drowsiness
  + Dry Eyes
  + Decreased urination
  + Changes in mood/agitation

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Acetaminophen

* Relatively safe in lower doses.
* Maximum daily dose of 3000mg(3g) over the counter due to risk of liver injury.

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Electrolytes/Vitamins

* Magnesium
  + Diarhhea
  + Think of milk of magnesia or magnesium citrate.
* Aluminum
  + Constipation
* Iron
  + Constipation
  + Gas/Bloating
* Niacin
  + Flushing

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**Common Medication Allergies**

* Penicillin antibiotics
  + Cross-sensitivity to cephalosporins is controversial.
* Sulfa drugs
  + Bactrim
  + Glyburide
* Anticonvulsants
  + Carbamazepine
  + Phenytoin
* NSAIDs
  + Aspirin specifically
* Chemotherapy medications

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Symptoms of Allergic Reactions

* Can range from mild to life threatening.
  + Mild – Itching, hives, swelling.
  + Life threatening – anaphylaxis (patient cannot breathe because of swelling around the throat)
* Allergies that are mild such as those that produce itching or hives can be treated with first-generation antihistamine such as diphenhydramine.
* Allergies that are life threatening, such as some penicillin allergies, should be avoided at all cost, and require emergent medical treatment if exposed.

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What can you do as a pharmacy technician?

* Always ask for patients’ allergy information when they are dropping off prescriptions to ensure you have the most recent information.
* Recognize high-risk drugs and ensure your patient is not allergic to that medication.
* Clean your counting tray and work area before and after counting any medication that is a high-risk for an allergic reaction.
  + This is especially important for medications that commonly cause anaphylactic reactions, such as penicillin or sulfa drugs.

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**Common Drug Interactions**

* As drugs travel through the body, they are exposed to anything else in our blood stream.
* Common interactions with drugs include other drugs, diseases, supplements, nutrients, and can even affect laboratory tests.
* Interactions vary in severity and are important to tell your pharmacist if you catch them.

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Drug-Drug

* Medications may interact with one another to cause an additive or detrimental effect.
* As a pharmacy technician, if you believe a patient may be taking medications that are interacting, always tell the pharmacist.

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Oral Contraceptives

* Certain medications cause oral contraceptives to be less effective.
* Medications include:
  + Carbamazepine
  + Lamotrigine
  + Oxcarbazepine
  + Phenobarbital
  + Phenytoin
  + Primidone
  + Rifampin
  + Topiramate

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HMG-CoA Reductase Inhibitors

* Taking certain medications with statins can increase a patient's risk for muscle damage or myopathy.
* Some of these medications include:
  + Amiodarone
  + Digoxin
  + Ranolazine
  + Cyclosporine
  + Tacrolimus
  + Diltiazem
  + Gemfibrozil
  + Ticagrelor
  + Itraconazole
  + Ketoconazole

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Fluoroquinolones, Tetracyclines, and Levothyroxine

* Taking these medications around the same time as element containing vitamins can result in the medications not working.
* Do not take these medications within 2 hours of taking any multivitamins, or any calcium, magnesium, iron, or aluminum.

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Warfarin

* Warfarin interacts with many drugs, ultimately causing the blood to either be too thin or too thick.
* A common PTCB interaction is that of aspirin and warfarin.
  + If a patient is taking aspirin and warfarin, their blood could be even further thinned, and they are at an increased bleeding risk.
* Other medications that effect warfarin include:
  + Rifampin
  + Azithromycin
  + Ciprofloxacin
  + Doxycycline
  + Tramadol
  + Amiodarone
  + Metronidazole
  + Bactrim (trimethoprim/sulfamethoxazole)

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Hypertension Medications

* Hypertension medications from different classes can interact with each other to cause an additive blood pressure lowering effect or cause electrolyte imbalances.
* An example of a detrimental interaction would be between a potassium sparing diuretic, like spironolactone and an ACE inhibitor, like lisinopril.
* Since both of these medications work in the kidneys and affect potassium, they could together cause high potassium levels.
* An example of a beneficial interaction would be between lisinopril and HCTZ.
* These medications come formulated as a combination pill as they can be used together to provide extra blood pressure lowering for a patient in one pill.

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Serotonin Agents

* When taking more than one agent that affects serotonin, it can increase a patient's risk of serotonin syndrome.
* Common medications that can interact with serotonin agents to cause serotonin syndrome:
* Buspirone
* Fentanyl
* Ondansetron
* Tramadol
* Sumatriptan

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Depressants/Sedatives

* If a patient takes more than one depressant or sedative at a time, they may be at an increased risk of respiratory depression.
* Common fatal combinations of medications that cause increased risk of respiratory depression are:
  + Alcohol and opioids
  + Alcohol and benzodiazepines
  + Benzodiazepines and opioids

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Beneficial Interactions

* Some drug interactions are beneficial and help the drug to work better.
* Examples of these include:
  + Amoxicillin and clavulanate potassium
    - Clavulanate potassium helps to protect amoxicillin in the body.
  + Ritonavir and other HIV medications
    - Helps to boost the effectiveness of other HIV medications.

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Drug-Disease

* Medications can interact with a patient’s disease state causing it to be better or worse.
* Examples:
  + NSAIDs and hypertension
    - NSAIDs can raise blood pressure making hypertension worse.
  + NSAIDs and GERD
    - NSAIDs can increase the risk of stomach bleeding, making GERD worse.
  + Beta-blockers and asthma
    - Since beta receptors are used to treat asthma, beta blockers can cause asthma medications to not work.

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Drug-Nutrient

* Drugs can interact with the food we eat changing how the drugs works in our body.
* The most important drug-nutrient interaction is that of warfarin and vitamin K.
* Warfarin works by keeping vitamin K from being activated to start clotting in the body.
* If a patient starts to eat more vitamin K from leafy greens, their warfarin may not work as well.
* Another example of a drug-nutrient interaction is loop diuretics and potassium.
* As a pharmacy technician, you can notify your pharmacist if your patient mentions changes in their diet to you.

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Drug-Supplement

* Some patients may take over-the-counter supplements to aid in their health.
* These supplements can also interact with patients’ prescription.
* The most common drug-supplement interaction is that St. John’s Wort with other medications.
* St. John’s Wort
  + Herbal supplement that can be used for anxiety and depression.
  + Can increase a patient’s risk of serotonin syndrome when taken with other serotonin agents.
  + Belongs to a group of CYP enzyme inducers discussed earlier which can lower the effectiveness of other popular drugs.

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Drug-Laboratory

* Some medications can affect the results of laboratory tests.
* Common drug-laboratory interactions include:
  + Antibiotics
  + Psychotropics
  + Contrast media
  + PPIs
  + Biotin
  + Acetaminophen
  + Propranolol
  + Niacin
  + NSAIDs
* Effects range from:
  + Elevated glucose levels
  + Changes in protein urine tests
  + False positive drug screens
  + False pregnancy tests.

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**High Alert Medications**

* Medications that are considered safe when taken as prescribed but could potentially be dangerous if taken incorrectly.
* High Alert Medications and Narrow Therapeutic Index medications are important to recognize to ensure accurate data entry.

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Narrow Therapeutic Index

* Therapeutic Index – A comparison of the amount of a drug causes the desired effect vs the amount that causes toxicity.
  + In an ideal situation, this will be a large gap.
  + You want 100% of the doses to cause a positive effect and 0% of the doses to cause toxicity.
* Narrow Therapeutic Index - the window between the positive effect and toxic effect may be small.
  + Forgetting that you took a 10mg medication then taking another 10mg may be toxic.
* Narrow therapeutic index drugs include:
  + Warfarin
  + Levothyroxine
  + Digoxin
  + Lithium
  + Phenytoin

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ISMP High Alert Medications

* Institute for Safe Medication Practices
* List of high alert medications based on practice setting.
* Review PDFs of these medications located in this chapter.

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**Summary**

* Pharmacology, pharmaceutics, and pharmacokinetics come together to produce a drug’s effect on our body.
* While the active ingredient may be the same, therapeutic equivalents, pharmaceutical equivalents, and pharmaceutical alternatives vary in their release properties and inactive ingredients sometimes.
* Absorption, distribution, metabolism, and excretion are the main processes by which the body handles medications.
* There are many different dosage forms available that range in purpose and characteristics.
* Routes of administration help to deliver drugs to the site needed and vary in both onset of action and first pass metabolism.
* Pharmacy technicians can assist pharmacists by:
  + Recognizing common medication side effects.
  + Allergies
  + Interactions
  + High-Alert Medications

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