EKG Course Manual

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Chapter 1: Introduction to EKG and Its Clinical Importance

Welcome to our EKG (electrocardiogram) class, where we will delve into the critical role that EKGs play in modern medicine. This foundational tool is essential for the assessment of cardiac health, providing invaluable insights into the electrical activity of the heart.

Understanding EKGs is not just about reading waves; it's about interpreting the information they convey regarding heart rhythm, rate, and potential abnormalities. In clinical practice, EKGs are pivotal for diagnosing various conditions, including arrhythmias, myocardial infarctions, and other heart diseases. By mastering EKG interpretation, healthcare professionals can make timely and informed decisions, leading to better patient outcomes. Throughout this course, we will explore the anatomy of EKGs, the significance of different waveforms, and practical applications in diverse clinical scenarios. This class will enhance your skills and deepen your knowledge.

We will cover several key areas to ensure a comprehensive understanding of electrocardiography.

Here's what you can expect:

1. Basic EKG Principles: We'll start with the fundamentals, including the electrical conduction system of the heart, how EKGs are generated, and the significance of the different waves, segments, and intervals.
2. Lead Placement and Types: Understanding how to properly place EKG leads and the significance of different lead types (e.g., limb leads, precordial leads) is crucial. We'll also discuss the 12-lead EKG and its role in providing a comprehensive view of cardiac activity.
3. Common EKG Patterns: We will examine normal EKG patterns, as well as variations that indicate potential cardiac issues. This includes recognizing atrial and ventricular arrhythmias, ST-segment changes, and signs of ischemia or infarction.
4. Clinical Applications: Real-world scenarios will be discussed, showcasing how EKGs are utilized in emergency settings, routine check-ups, and monitoring chronic conditions. Case studies will help bridge the gap between theory and practice.

5. Hands-On Practice: To reinforce learning, we'll include practical sessions where you can analyze EKG strips, identify abnormalities, and practice interpretation skills. This hands-on approach will boost your confidence in reading EKGs.
6. Integration with Other Diagnostic Tools: We'll explore how EKGs complement other diagnostic modalities, such as echocardiograms and stress tests, providing a more complete picture of heart health.
7. Updates in EKG Technology: As technology evolves, so do EKG tools. We will touch on advancements such as portable EKG devices and remote monitoring, discussing their implications in modern healthcare.

By the end of this class, you will be equipped with the knowledge and skills to interpret EKGs effectively, enhancing your ability to contribute to patient care and make informed clinical decisions. Whether you're aiming to improve your clinical practice or simply seeking to expand your knowledge, this course will be an invaluable resource for your professional development and understanding of cardiac care.

Chapter 2: Human Anatomy Overview

Understanding and using these anatomical terms correctly is crucial for clear communication in healthcare, biology, and related fields, especially when describing the location of symptoms, surgical procedures, or the movement of substances within the body.

Anatomical terms

- Help us describe different parts of the body clearly and accurately. They are especially important in biology, medicine, and anatomy. Many of these terms come from Latin or Greek and are used in a standard way to avoid confusion.

Anatomical Terms to know:

- *Bone:* Hard, dense organs that constitute part of the endoskeleton (e.g., femur, humerus).
- *Muscle*: Tissue that produces force and motion to move the body or produces movement in internal organs (e.g., biceps, heart muscle).
- *Tendon*: A flexible but inelastic cord of strong fibrous collagen tissue attaching a muscle to a bone.
- *Ligament*: A short band of tough, flexible, fibrous connective tissue that connects two bones or cartilages or holds together a joint.
- *Organ*: A group of tissues that perform a specific function or group of functions (e.g., heart, liver, kidney).

Tissues

- Tissues are groups of cells that work together to perform specific functions.
- In the human body, there are *four primary types of tissues*, each with unique structures and roles.

4 Types of Tissues:

1. Epithelial Tissue:
    a. Epithelial tissue covers the body surfaces, lines the cavities and organs, and forms glands.
    b. It serves as a barrier for protection, controls permeability to substances, provides sensation, and produces secretions through glandular structures.
    c. Examples:
        i. *Skin*: Protects against environmental damage.
        ii. *The lining of the stomach and intestines*: Absorbs nutrients and secretes digestive enzymes.
        iii. *Glandular epithelium*: Forms glands that produce hormones and other secretions.
2. Connective Tissue:
    a. *Primary Function*: Connective tissue supports, binds together, and protects tissues and organs.
    b. It also stores energy as fat, provides immunity, and transports substances within the body.
    c. Examples:
        i. *Bone*: Provides structural support and protection for organs and produces blood cells.
        ii. *Adipose (fat) tissue*: Stores energy, insulates, and cushions organs.
        iii. *Blood:* Transports oxygen, nutrients, and waste products; involved in immune responses.
        iv. *Cartilage*: Provides flexible support and reduces friction between bony surfaces.
        v. *Tendons and Ligaments*: Connect muscles to bones (tendons) and bones to bones (ligaments), providing stability and facilitating movement.
3. Muscle Tissue:
    a. *Primary Function*: Muscle tissue is responsible for producing movement, maintaining posture, and generating heat through contractions.
    b. *Myalgia* – muscle pain
    c. Examples:
        i. *Skeletal Muscle*: Facilitates voluntary movements by attaching to bones.

ii. *Cardiac Muscle*: Constitutes the heart's wall and pumps blood throughout the body.
iii. *Smooth Muscle*: Found in walls of internal organs (like the intestines, blood vessels, and bladder), controlling involuntary movements like the constriction and relaxation of blood vessels.

4. Nervous Tissue:
    a. *Primary Function*: Nervous tissue receives, transmits, and integrates information from internal and external environments to control the body's functions. It's the main component of the nervous system.
    b. Examples:
        i. *Neurons:* Conduct impulses and are the basic unit of the nervous system.
        ii. *Neuroglia (or Glial Cells):* Support and protect neurons, maintain homeostasis, form myelin, and provide support and protection for neurons.

Each tissue type has a distinct structure and function, and they work together to maintain the body's health, support its structure, and facilitate its movements and functions.

Organs

- A body system is made up of a few organs that perform interrelated functions.
- The organs are even more complex. A few tissue types compose an organ.
- For example- the *heart comprises cardiac muscle tissue covered by an epithelial lining supported by connective tissues.*
    - The *heart and blood vessels make up the circulatory* system.
    - The *urinary system eliminates waste and balances the body's pH*.
    - The *kidneys* filter the blood to remove waste and unnecessary ions concentrated in the urine. The urine passes from the kidneys to the *ureters*. The bladder stores *urine* until it is released through the urethra.

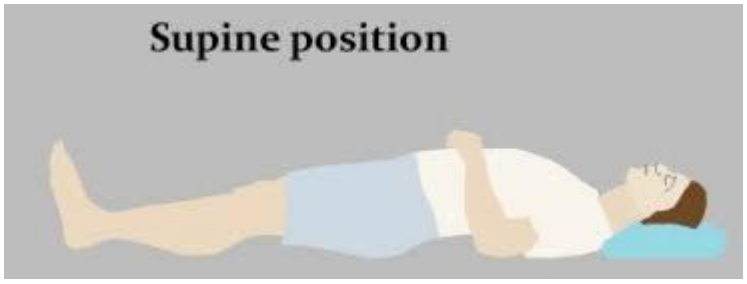
Body Positions

Understanding body positions is crucial in various fields, particularly in healthcare, physical therapy, and fitness. It helps in diagnosing conditions, planning treatments, or executing physical activities correctly.

Common body positions

Anatomical Position: This is the standard reference position for the body in the study of anatomy. The person stands erect, facing forward, with feet slightly apart and parallel, and arms at the sides with palms facing forward.

Supine Position: The person lies on their back with their face upward. This position is often used in surgical procedures and when examining the anterior (front) side of the body.

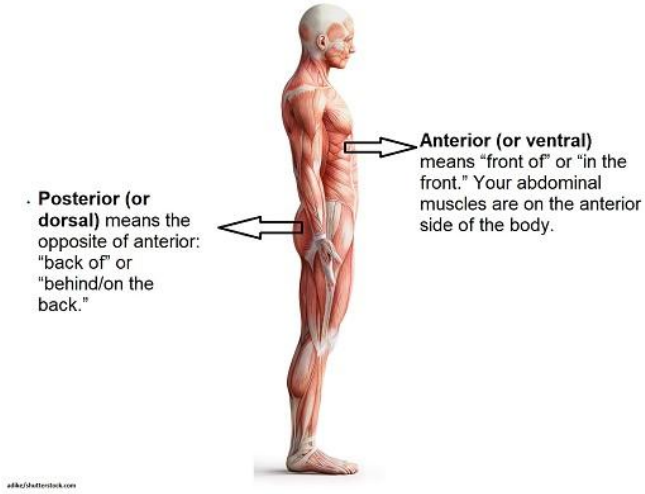


Anatomy Directional Terms

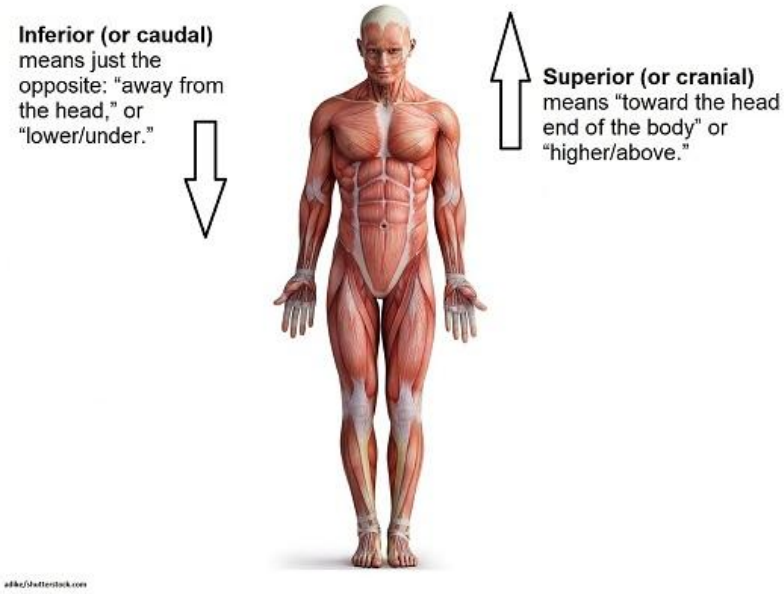
- *Directional terms* are used in anatomy to describe the locations of structures with other structures or locations within the body.
- These terms are essential for clear communication, especially in the fields of medicine, biology, and anatomy.

Important directional terms:

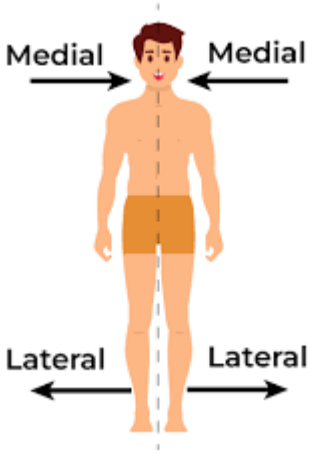
- *Anterior (Ventral):* Toward the front of the body.
- *Posterior (Dorsal):* Toward the back of the body.



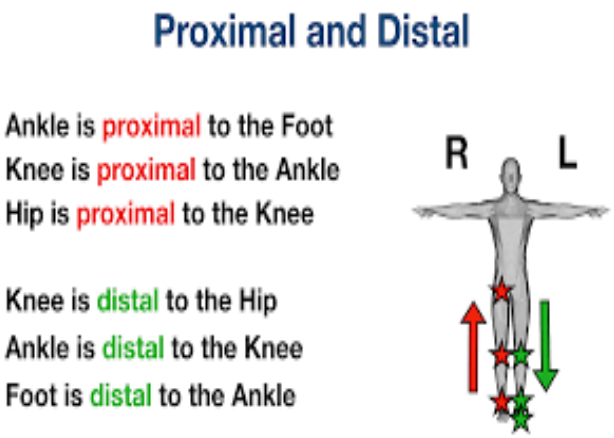
- *Superior (Cranial):* Toward the head or upper part of a structure.
- *Inferior (Caudal):* Away from the head, or toward the lower part of a structure.



- *Medial:* Nearer to the midline of the body.
- *Lateral:* Farther from the midline of the body.



- *Proximal*: Closer to the origin of the body part or the point of attachment of a limb to the body trunk.
- *Distal:* Farther from the origin of a body part or the point of attachment of a limb to the body trunk.



- *Superficial (External)*: Toward or at the body surface. The skin is superficial to the muscles.

Understanding and using these terms accurately can *help in identifying the precise location of structures and describing the position of surgical incisions, injuries, or diseases relative to body landmarks.*

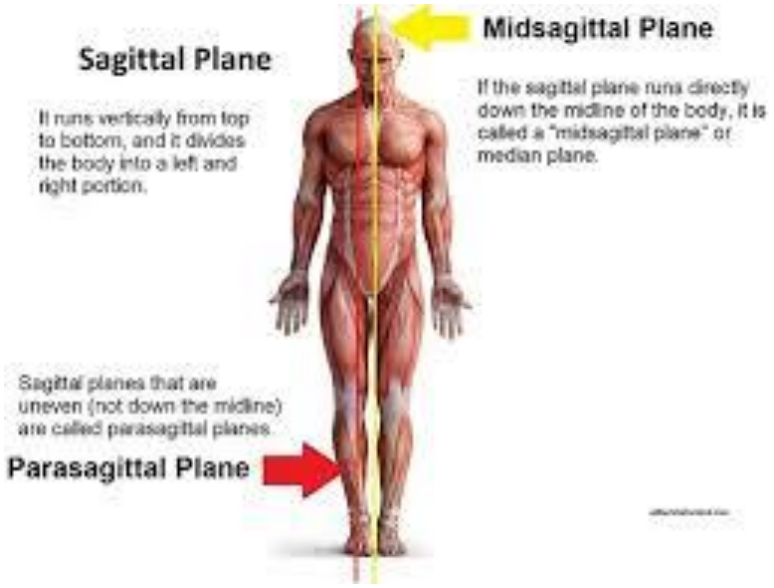
Anatomical Planes

Anatomical planes are *imaginary lines* used to divide the human body into sections. These planes are essential in medical and anatomical terminology for *describing the locations and movements of various parts of the body* with precision.

Main anatomical planes

Sagittal Plane: This vertical plane divides the body into left and right parts.

- When a sagittal plane runs directly *along the midline of the body*, it is referred to as the *midsagittal (or median) plane*, dividing the body into equal right and left halves.
- Planes parallel to the midsagittal plane are called *parasagittal planes*.



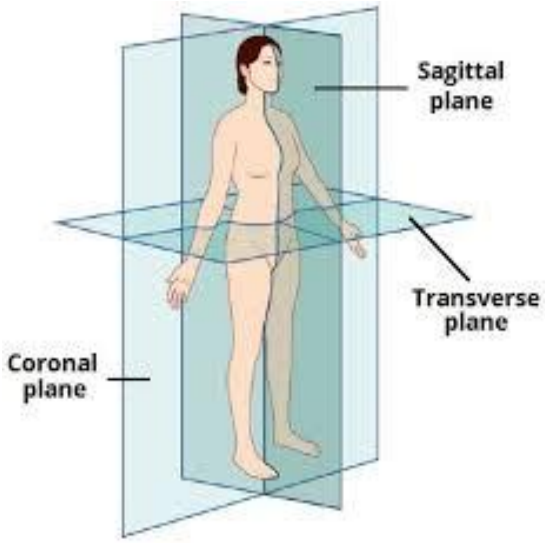
<u>*Frontal (Coronal) Plane*</u>: This is another type of vertical plane, but it divides the body into anterior (front) and posterior (back) sections.

- It runs *perpendicular to the sagittal plane and parallel* to the face, effectively splitting the body into front and back halves.

<u>*Transverse (Horizontal) Plane*</u>: This plane divides the body into *superior (upper) and inferior (lower) parts*. It runs perpendicular to both the sagittal and frontal planes, creating a cross-section that *separates the body into top and bottom halves*.

- This plane is also referred to as the cross-sectional or axial plane, especially in radiological contexts.

<u>*Midsagittal Plane*</u>: Cuts through vertically into equal right and left sections.

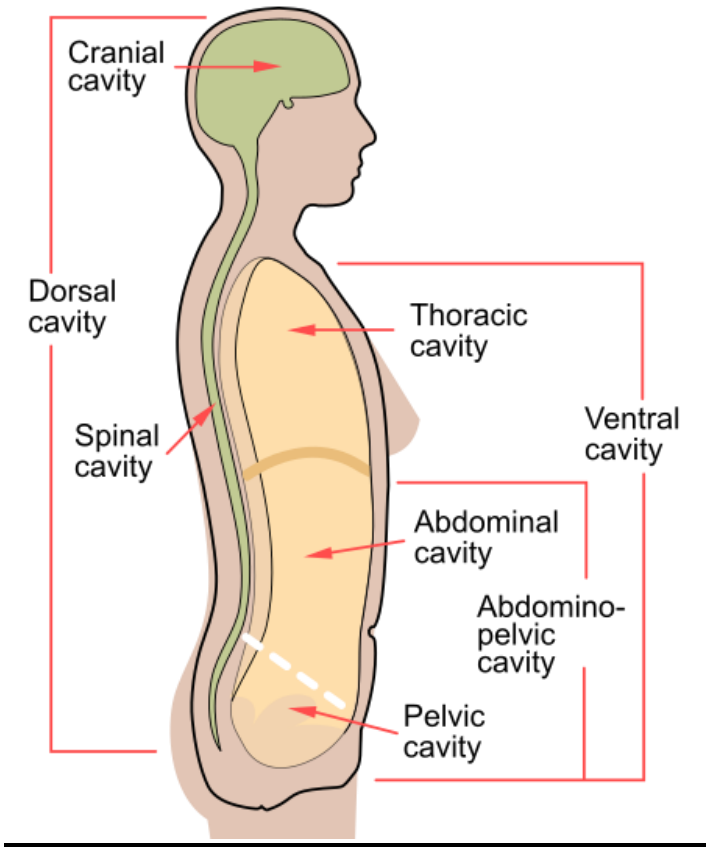


Understanding these planes is crucial for professionals in healthcare and related fields, as they provide a standardized way of describing the location or direction of movements relative to the body.

They are also fundamental in medical imaging techniques such as MRI and CT scans, which provide cross-sectional images along these planes to help diagnose conditions, plan treatments, or guide surgical procedures.

Body Cavities

Body cavities *are enclosed spaces within the body that house and protect vital organs.* In human anatomy, these cavities are distinct and organized, allowing for the separation and support of different organ systems.



- *Dorsal Body Cavity*: This cavity is on the posterior (back) side of the body and is divided into two subdivisions:
- *Ventral Body Cavity*: Located on the anterior (front) aspect of the body, it is larger than the dorsal cavity and is subdivided into two main parts, separated by the *diaphragm muscle*:
- *Cranial Cavity*: Encases the brain.
- *Spinal Cavity:* Encloses the spinal cord.
- *Thoracic Cavity*: Contains the heart and lungs, among other structures.
- *Abdominal Cavity*: Houses many digestive organs, the liver, and other organs.
- *Pelvic Cavity*: Contains the urinary bladder, some reproductive organs, and the rectum.

These cavities are *lined by membranes that not only protect the organs within them but also allow for the organs' movements and expansions*.

For example, the thoracic and abdominopelvic cavities are lined by the serous membrane, which is divided into the *parietal serosa* (lining the cavity walls) and the visceral serosa (covering the organs).

Understanding the organization of body cavities is crucial in anatomy, medicine, and related fields, as it helps in diagnosing diseases, planning medical procedures, and understanding the body's complex structure and functions.

Chapter 3: Human Body Systems

Integumentary System

The integumentary system is a complex set of organs that plays critical roles in protecting the body against:

- external threats,
- regulating body temperature,
- and providing sensory information.

It is comprised of the *skin and its associated structures, including hair, nails, sweat glands, and oil glands.*

Here's a detailed overview of the integumentary system's components and their primary functions:

Layers of the Skin

Epidermis: The outermost layer, providing a waterproof barrier and creating our skin tone.

- It contains several types of cells,
- *Keratinocytes* (producing keratin, a protein that strengthens the skin),
- *Melanocytes* (producing melanin, which gives skin its color),
- *Langerhans' cells* (involved in immune responses), and
- *Merkel cells* (involved in touch sensation).

Dermis: Beneath the epidermis, this layer contains tough *connective tissue, hair follicles, and sweat glands.*

It houses:

- blood vessels,
- lymph vessels,
- nerve fibers, and the bases of
- sweat and oil glands,

- provides skin nutrition, waste removal, temperature regulation, and sensation.

Dermal Papillae

- Connect the dermis to the epidermis. These are uneven projections or ridges. The patterns they produce create unique fingerprints and footprints in every individual.

Apocrine Glands

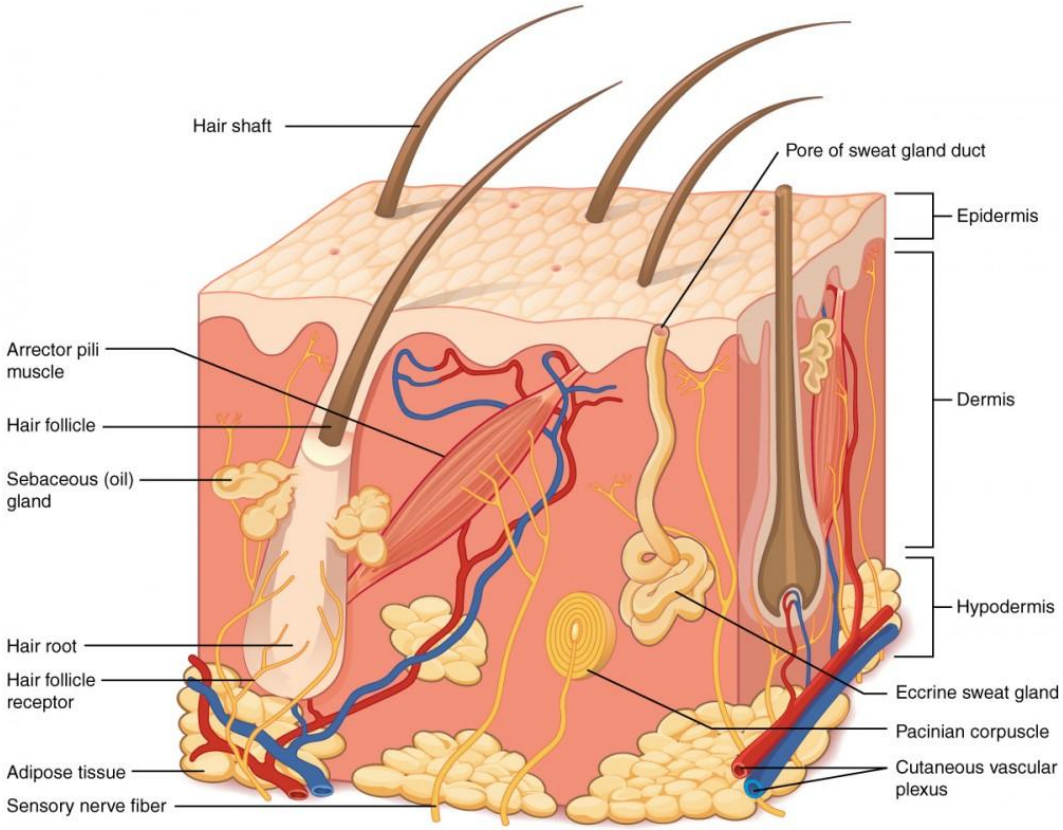
- Located within the dermis and extends up to the epidermis. They regulate body *temperature and eliminate waste from the pores through sweat*.

Sebaceous Glands

- Is a type of oil that keeps hair and skin moisturized.

Subcutaneous Layer

- Is made up of fat connecting the organs to the skin. It functions as a *shock absorber, an energy reserve, and insulation.*



Common Skin Disorders

Common skin disorders vary widely in symptoms and severity. They can be temporary or permanent and may be painless or painful.

Some have situational causes, while others may be genetic. *Phlebotomists must be aware of skin issues to avoid unsuitable venipuncture sites*

Contact Dermatitis - an allergic reaction to irritant substances, like soap, make-up, or plants

Eczema (Atopic Dermatitis): A condition that causes inflamed, itchy, cracked, and rash-type skin sore. It's more common in children but it can occur at any age. Eczema may be chronic and flare up periodically.

- It may also be accompanied by asthma or hay fever.

Impetigo: Is a form of an infection of Staphylococcus or Streptococcus bacteria or both. It presents as a pus-filled lesion that dries to become a yellowish crust.

Keloid: a type of hypertrophic scar resulting from excess collagen produced during skin healing.

Dermatologists - are specialists who can diagnose these conditions and recommend appropriate treatments.

Treatment for skin disorders varies depending on the condition and its severity and can range from topical treatments and medications to lifestyle changes and procedures.

Commonly Ordered Tests for Skin Diseases

Diagnosing skin diseases often requires a combination of clinical evaluation and specific tests. These tests help dermatologists and healthcare providers determine the exact nature of a skin condition and the most effective treatment plan.

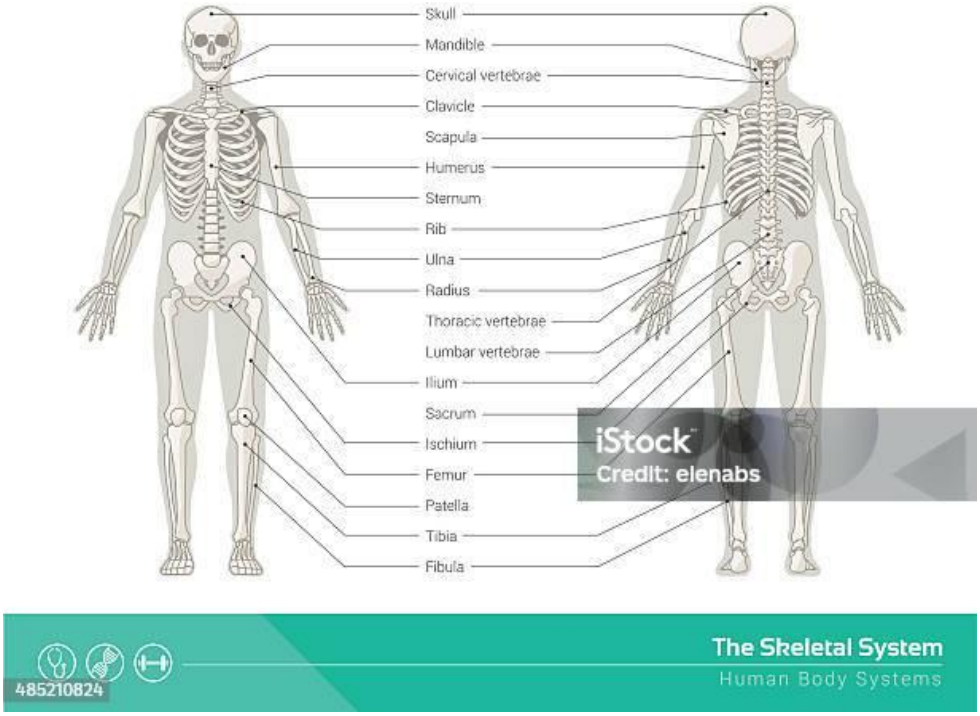
Commonly ordered tests for diagnosing skin diseases

- *Culture and sensitivity test*: Bacterial, fungal, or viral cultures may be taken from wounds, the skin, nails, or hair to identify the cause of an infection.
- This involves growing the organism in a lab to identify it and, often, to test its sensitivity to different antibiotics or antifungals.
- *Special staining*: Identifies pathogens.
- *Microscopy of the skin scrapings*: Fixed in potassium hydroxide to detect fungi.
- *Punch biopsies*: Distinguishes benign tumors from malignant tumors.

Skeletal System

The skeletal system is made up of *bones, joints, and ligaments*, which makes movement possible in conjunction with the muscles and nerves.

The skeletal system *provides support and protection*. It also *stores calcium and phosphorus.*



Common Conditions Affecting the Skeletal System

Osteoporosis: A condition characterized by weakened bones that are more prone to fracture.

- It occurs when the body loses too much bone, makes too little bone, or both, leading to porous and fragile bones.
- Osteoporosis is more common in older adults, especially postmenopausal women, due to lower estrogen levels.

Arthritis: This is a general term for conditions *affecting the joints and surrounding tissues, leading to pain, stiffness, and swelling.*

- The most common types are *osteoarthritis,* which results from *wear and tear of the cartilage in joints*, &
- *rheumatoid arthritis*, an *autoimmune condition* that attacks the lining of the joints

Fractures: Breaks in bones, often caused by trauma, falls, or conditions that weaken the bones, such as osteoporosis. The severity of fractures can vary from minor cracks to complete breaks.

- *Osteomyelitis* Is an *infection of the bone and its deeper layers*, including the marrow. An *improper heel puncture traumatizes the bone and can lead to osteomyelitis.*
- Early diagnosis and treatment are crucial for managing symptoms and preventing further damage.

Commonly Ordered Tests Involving the Skeletal System

- *Synovial fluid*: Normal sterile fluid lubricating the joint spaces, can be aspirated to investigate the presence of bacteria crystals for the diagnosis of joint inflammation or arthritis.
- *Wound culture*: Performed to identify causative agents in suspected osteomyelitis.

Muscular System

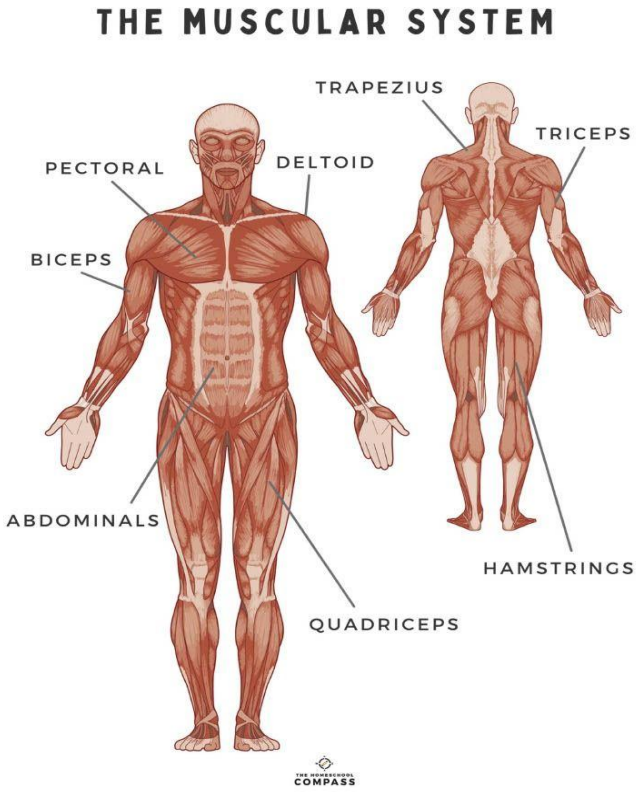
The muscular system is a complex network of *muscles and tissues that are vital for movement, stability, and overall bodily function.*

Skeletal Muscle

- *Functions*: Skeletal muscles are *striated*, attached to the bone, and responsible for voluntary movements, posture, and body support.

Smooth Muscle

- *Function:* Smooth muscle tissues are *found in the walls of internal organs and blood vessels.*
    - They control *involuntary movements such as the contraction and relaxation of blood vessels, movement of food through the digestive tract, and the regulation of airways in the lungs.*
- *Characteristics*: These muscles *are not striated*; they have a smooth appearance and operate *involuntarily*. Smooth muscles are *slower to contract* than skeletal muscles, but they can maintain contractions for a longer time without fatigue.



Common Conditions Affecting the Muscular System

The muscular system is crucial for movement, stability, and overall body function. However, it can be affected by a range of conditions that impair its performance, leading to discomfort, reduced mobility, or more serious health issues.

- *Atrophy*: The loss of muscle bulk from inactivity.
- *Myalgia:* A general medical term to refer to any caused by viral infections or accidents.
- *Poliomyelitis*: Results from a viral infection affecting the nerves that supply the muscles. It results in a progressive loss of strength and paralysis. Vaccines are available which confer lifelong immunity from the condition.

The Nervous System

The nervous *regulates and coordinates* body activities. It is divided into two main parts: the *central nervous system (CNS)* and the *peripheral nervous system (PNS).*

The Nervous system is composed of:

- *Neuron* – a cell body surrounded by dendrites and a single tail or axon
- *Dendrites* – receives information through electrical impulses, and then information is sent out through the *axon*.
- *Myelin sheath* – (produced by Schwann cells), wraps around the axon and dendrites to send information from electrical impulses more effectively.
- *Synapse* – where impulses in nerve cells are transmitted from axon to other
- Dendrites

<u>Central Nervous System (CNS)</u>

The CNS includes the *<u>brain and spinal cord</u>*. It is the *control center for the entire body, responsible for processing and sending signals and interpreting incoming sensory information.*

<u>Brain</u>:

- The brain is the body's *control center*. It's responsible for *processing sensory information, regulating blood pressure and breathing, and releasing hormones.*
- The brain is divided into several parts, including the *cerebrum, cerebellum, and brainstem, each with specific functions.*

The CNS is *encased in meningeal layers (shock absorbers) under the skull and vertebrae.*

Sensory (afferent) neurons receive information from sensory organs and relay it to the CNS.

Motor (efferent) neurons do the opposite; they *originate in the CNS and are relayed to the muscles to contract or glands to release secretions*

Spinal Cord

- The spinal cord is a *long, thin, tubular structure made of nervous tissue that extends from the medulla oblongata in the brainstem to the lumbar region of the vertebral column*.
- It *connects the brain to the body* and is responsible for *transmitting signals back and forth between the brain and the peripheral nervous system*.

Peripheral Nervous System (PNS)

- The PNS includes all the *nerves that branch out from the brain and spinal cord and extend to other parts of the body, including the limbs and organs*.
- The PNS is divided into the *somatic nervous system* and the *autonomic nervous system.*

Somatic Nervous System

Controls *voluntary movements of the skeletal muscles*. It also *receives sensory* information from the sensory organs and transmits it to the CNS.

Autonomic Nervous System (ANS)

Regulates *involuntary body functions*, such as blood flow, heartbeat, digestion, and breathing. The ANS is further divided into the:

- *Sympathetic nervous system* (prepares the body for "fight or flight")
    - e.g.: heart beats faster
- and the *parasympathetic nervous system* (restores the body to a state of calm).
    - e.g.: heart slows to its normal rate

Common Conditions Affecting the Nervous System

Parkinson's Disease –

- A progressive nervous system disorder that affects movement.
- It's characterized by tremors, stiffness, and slowness of movement. Tremors, muscle rigidity, slow movements, balance problems, and changes in speech and writing.

Bell's Palsy –

- paralysis and loss of sensation to one side of the face. Triggered by stress, diabetes, and viruses.
- Produces a characteristic paralysis and loss of sensation to one side of the face. It comes from compression or swelling of the facial nerve.
- Its exact cause is unknown, but the triggers include pregnancy, stress, diabetes mellitus, and viral infections.

Cerebrovascular accident or stroke –

- A *blockage of blood flow (from a thrombus or a hemorrhage) to the brain areas*, which results in less oxygen supply (or hypoxia).
- Resulting in sensory and motor deficits in the face and limbs and limbs supplied by the hypoxia area of the brain.
- Symptoms highly suggestive of stroke are facial asymmetry, slurring of speech, and sudden weakness.

ALS (Amyotrophic Lateral Sclerosis)

- is a disorder of the CNS that causes progressive musculoskeletal paralysis

Seizures

- Abnormal transmission of electrical impulses due to electrolyte imbalances, infections, fever (benign seizures of childhood), or traumatic injury to the brain. Recurring seizures are termed *Epilepsy.*

Meningitis

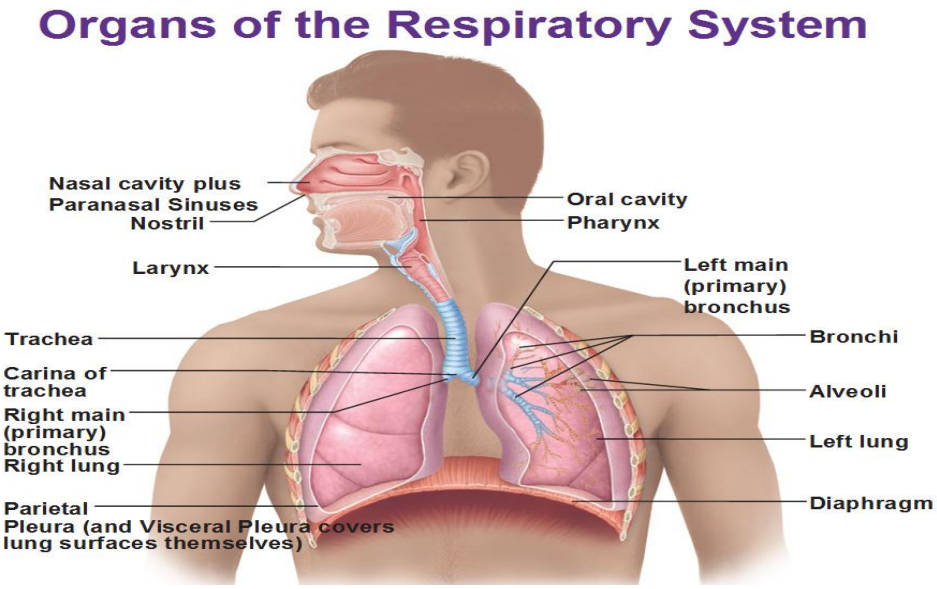
- Swelling of the meninges.

- Meningococcal Meningitis from Neisseria meningitides is highly contagious.

Varicella-Zoster

- a virus that often lies dormant within the peripheral nerves. During the period of immunosuppression, it can reactivate and cause a condition known as *shingles or herpes zoster*.
- This condition is marked by *painful blisters along a dermatome*, an area supplied by the nerve.
- This is contagious and causes unvaccinated individuals to develop chicken pox, not shingles.

The Respiratory System



The system that allows *for gas exchange (ventilation*).

- Its primary function is to supply the blood with oxygen so that the blood can deliver oxygen to all parts of the body through a process called *respiration*.

The respiratory system does this through *breathing: inhaling oxygen-rich air and exhaling air filled with carbon dioxide,* which is a waste product of metabolism.

The respiratory system includes the nose, airway, lungs, and alveoli.

The *Carina* separates the upper and lower tracts of the respiratory system.

Internal respiration – Occurs as gases are exchanged at the level of the *red blood cells and internal organs.*

- These gases circulate through the body through the red blood cells.
- They bind specifically to a molecule in these cells called *hemoglobin.*

Oxygenated blood carries oxyhemoglobin.

- Only about *20% of carbon dioxide* is carried as *carboxyhemoglobin*. The other 80% *combines with water* to form *bicarbonate ions* circulating through the plasma.

As these ions reach the lungs, a chemical reaction allows the carbon dioxide to separate from bicarbonate and bind to the red blood cells.

At the alveoli branches, in the lungs, the carbon dioxide is separated from the RBCs and is released during exhalation.

The level of *circulated oxygen (PO2*) and *carbon dioxide (PCO2*) are measured from *arterial blood as partial pressures*.

The *partial pressure* of oxygen should be *higher in arterial blood* as it functions as the outlet for oxygenated blood.

An analysis of arterial blood gases *also generates a measurement of the pH*.

Adequate respiration ensures the proper levels of gases in the body.

When *respiration is impeded*, carbon dioxide is inadequately released, the buildup of which results in a *decreased blood pH or respiratory acidosis*.

The body compensates by *increasing the rate of breathing*.

When this *hyperventilation* persists, *respiratory alkalosis* may occur as carbon dioxide is rapidly blown out.

Take note:

- During venipuncture, a patient may become anxious.
- Anxiety may produce a *sympathetic nervous response* observed as *increased heart rate and respiratory (or hyperventilation).*
- The respiratory system includes the *nose, airways, lungs, and alveoli*.
- It is separated into the *upper and lower tracts at the level of the carina*.

- Each component performs crucial functions for effective respiration, although ventilation primarily occurs at the alveoli level.

Common Conditions Affecting the Respiratory System

- The respiratory system, essential for gas exchange and oxygen delivery to tissues, can be affected by a range of conditions. These can range from acute infections to chronic diseases, affecting the airways, lung tissue, and the ability to breathe effectively.

Asthma

- A chronic inflammatory disease of the airways characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or early in the morning.
- These symptoms are usually associated with swelling of the small airways of the lungs and can be triggered by allergies, exercise, or smoke.

Chronic Obstructive Pulmonary Disease (COPD)

- A group of lung diseases that develop over time, that *block airflow making it difficult to breathe*.
- The two main types of COPD are *emphysema and chronic bronchitis*.

Emphysema

- involves *damage to the alveoli* (air sacs) in the lungs, while *chronic bronchitis is characterized by a long-term cough with mucus*.

Pneumonia

- An *infection* that inflames the alveoli in one or both lungs, which may fill with fluid or pus, causing cough with phlegm or pus, fever, chills, and difficulty breathing. This may cause *O2 saturation to decrease*.

Tuberculosis (TB)

- A *chronic lung infection caused by Mycobacterium tuberculosis bacteria.* The bacteria that cause TB are *spread from one person to another through tiny droplets released into the air via coughs and sneezes.*

Sleep Apnea

- A sleep disorder in which *breathing repeatedly stops and starts during sleep*. Common symptoms include snoring loudly and feeling tired even after a full night's sleep.
- *Obstructive sleep apnea* occurs in obese patients when the weight on their neck obstructs their upper respiratory tract.

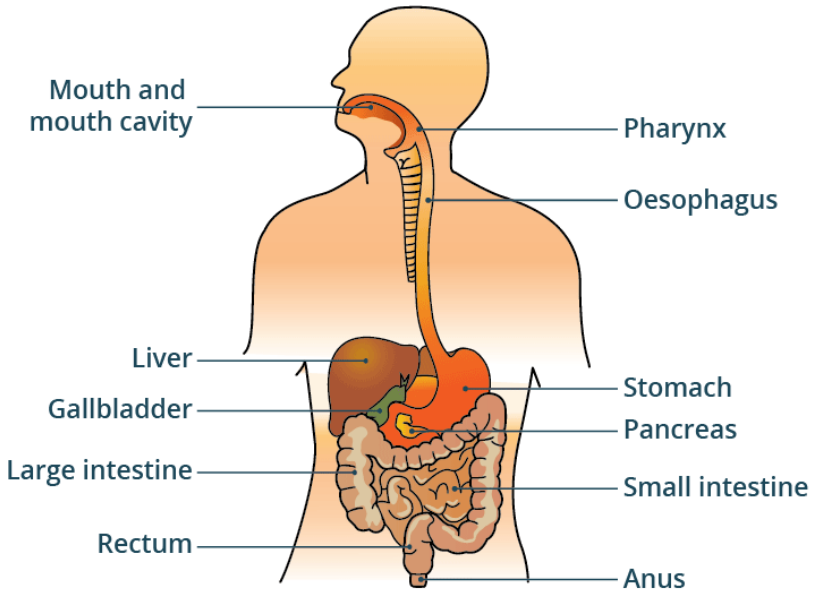
Pertussis

- Causes a characteristic *loud "whooping" cough*, fever, and colds in unvaccinated and susceptible individuals, especially *infants under six months old*. Its causative agent is *Bordetella pertussis bacteria*.
- *Immunization* of health care staff and those living and working around infants is highly recommended.

URTI

- Refers to an infection (either viral or bacterial) involving the organs of the upper respiratory tract. This includes the *common cold.*

The Gastrointestinal System



The gastrointestinal (GI) system, also known as the *digestive system*, is a group of organs and structures *responsible for the intake, breakdown, absorption of nutrients, and elimination of waste from the body.*

- Its role is to maintain overall health by ensuring that the *body receives the necessary nutrients from food and drinks.*

Components of the Gastrointestinal System

1. *Oral Cavity* – where digestion begins. By mastication (chewing) food is digested by the teeth and saliva.
2. *Pharynx:* A muscular tube that connects the mouth to the esophagus. It serves as a pathway for the movement of food and liquids.
3. *Esophagus:* A muscular tube that conveys food and liquids from the pharynx to the stomach through peristaltic movements.
4. *Stomach*: A hollow organ that holds food while it is being mixed with stomach enzymes and acids. These digestive fluids continue the chemical breakdown of food and destroy pathogenic organisms into a usable form *(chyme*).
    a. (*H-Pylori* stomach bacteria that can survive acids and cause ulcers or stomach cancers)
5. *Pancreas:* Produces *digestive enzymes* and bicarbonate, which are released into the small intestine to aid in the digestion and absorption of nutrients.
    a. The pancreas also has an *endocrine role because it releases insulin* into the bloodstream to regulate blood sugar levels
6. *Gallbladder*: Mixes the fat particles and emulsifies. Secretes *bile* for absorption into the liver.
7. *Small Intestine (Duodenum*): The first part of the small intestine where it mixes with pancreatic juices containing digestive enzymes.
    a. The second part of the small intestine includes the Jejunum and ileum. They transport chyme to the large intestines.
8. *Large Intestine (Colon):* Absorbs water, vitamins, and minerals from the material *that has not been digested* as food and is thus responsible for the formation of solid waste (feces).

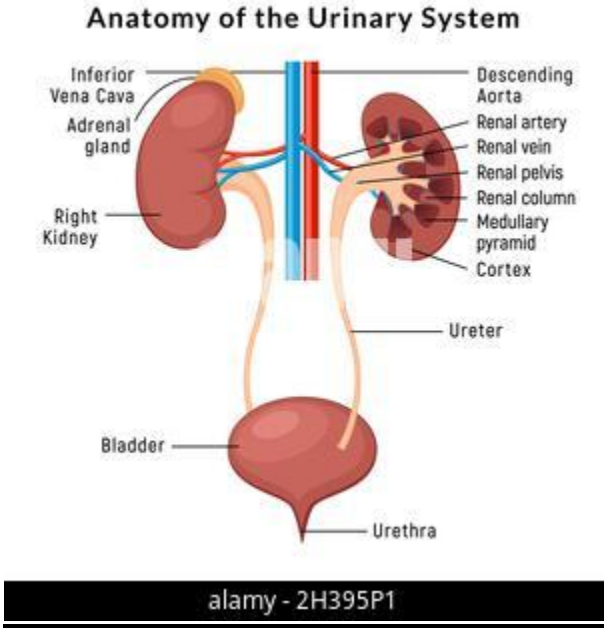
The gastrointestinal system is integral to the body's ability to maintain *homeostasis*, providing cells with nutrients and removing waste products.

Disorders of the GI system can range from common and mild (such as *heartburn and irritable bowel syndrome)* to severe and life-threatening (*such as gastrointestinal cancers and acute pancreatitis).*

Common Conditions Involving the Gastrointestinal System

1. *Peptic (Duodenal) Ulcers*: Open sores that develop on the inside lining of the stomach and the upper portion of the small intestine.
    a. The most common symptom is stomach pain.
    b. Primarily caused by *Helicobacter pylori* bacteria and *long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs*).
    c. Stress and spicy foods *do not cause peptic ulcers* but can worsen symptoms.
2. *Irritable Bowel Syndrome (IBS):* A common disorder that affects the large intestine, causing cramping, abdominal pain, bloating, gas, diarrhea, constipation, or both.
3. *Cholecystitis:* Swelling of *the gallbladder wall* commonly caused by gallbladder or bile duct stones, parasites *(worms, Ascaris, liver flukes*), or tumors.
    a. It may complicate the obstruction of the common *bile duct (cholangitis)* requiring urgent surgical attention.
4. *Cirrhosis*: Degeneration of hepatic cells, or attacks on the liver (hepatitis viruses, alcohol, toxins, or tumors).
5. *Gastroenteritis:* Inflammation of the gastrointestinal tract.
    a. Known as *diarrhea or loose stools*. Abdominal pain, nausea, and vomiting can also be associated with this. It can be caused by various microorganisms.
6. *Hernia:* Abnormal *protrusion of a part of an organ through the body cavity* that has lost its integrity, such as an inguinal hernia from the protrusion of the mesentery into the inguinal canal.
7. *Pancreatitis*: Excruciating pain from *inflammation of the pancreas*. This may be due to excessive alcohol intake, gallbladder stones, cancer, or surgical complications.

The Urinary System

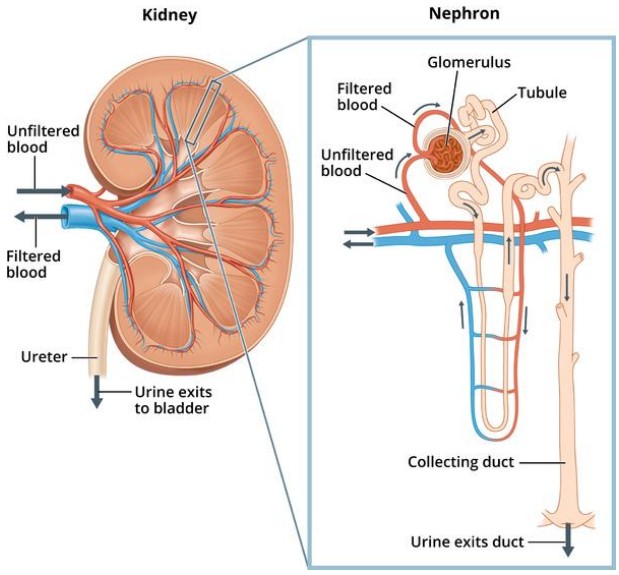


The urinary system, is also known as the *renal system*. Is responsible for the production, storage, and elimination of urine.

It is also important in maintaining the body's chemical balance, regulating blood pressure, and removing waste products and excess substances.

It is composed of the *kidneys, ureters and urethra*.

Parts of the Urinary System



1. *Kidneys:* A pair of *bean-shaped* organs located below the ribs toward the middle of the back; they contain over a million nephrons each.
2. *Nephrons* work to filter blood, keeping needed water, glucose, hydrogen, bicarbonate ions, and electrolytes creating a *homeostasis* environment.
    a. The nephrons then remove waste products and excess water, electrolytes, and toxins. Once the blood leaves the nephrons, it goes through a *bundle of capillaries called the glomerulus.*
3. *Glomerulus* filters out smaller substances while keeping larger ones like protein and RBCs., converting these to urine.
    a. This passes from each kidney to the paired *ureters.* It is stored in the *bladder* until the detrusor muscles contract to allow for *micturition* (or urination).
    b. Kidney function is estimated through the *glomerular filtration rate*, which should be 90 to 120 ml/min/1.73m2.
    c. This means all the blood travels through the kidney's filtration system about 40 times a day.
4. *Creatinine*: Is a substance that is excreted in the urine.
    a. The kidneys also have *endocrine functions*.
    b. They produce *renin*, which is involved in *blood pressure regulation*, and *erythropoietin,* which signals the bone marrow to produce red blood cells.
    c. The kidneys are also responsible for converting *exogenous vitamin D* (from the sun or diet) into its active bioavailable form.

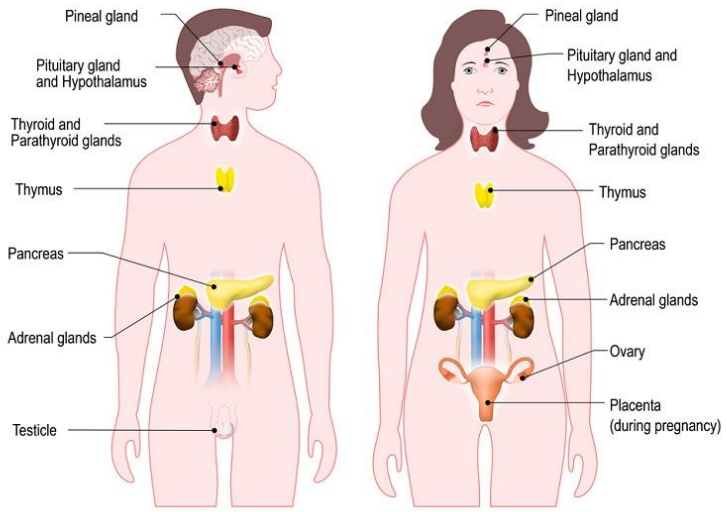
Common Conditions of the Urinary Tract

1. *Cystitis* – Inflamed urinary tract
2. *Pyelonephritis* – inflamed renal pelvis
3. *Urinary tract infection* - bacterial infection of the urinary tract
4. *Nephrolithiasis – Kidney stones*. Caused by an increase in uric acid or calcium in the blood, which impedes proper blood filtering in the kidneys. It can be painful and may need surgical intervention to treat.
5. *Renal failure* - loss of renal function to one or both kidneys. *Uremic* blood has too much urea and metabolic waste.

    a. The term for a permanent surgical connection between an artery and a vein is called an arteriovenous fistula, or AV. The fistula's blood flow avoids capillaries and moves directly from an artery into a vein.
6. Fistulas usually occur in legs, but they can develop most anywhere.
    a. With dialysis, people with severe kidney disease may have a fistula surgically created in their forearm.

The Endocrine System

ENDOCRINE SYSTEM



The endocrine system is a network of glands and organs that produce, store, and *secrete hormones* into the bloodstream. The endocrine system works in concert with the nervous system to control functions ranging from metabolism, sleep, stress, reproduction, and mood regulation.

- The *hypothalamus* produces and secretes hormones.
- The *feedback system* allows hormones to increase or decrease depending on the number of hormones the body needs.

The main glands of the Endocrine System

- *Anterior Pituitary Gland*: Often termed the "*master gland*," It's located at the base of the brain.
    - Signaled by the *hypothalamus*, secretes a stimulating hormone that helps other endocrine glands to secrete their hormones. This helps control functions such as growth, blood pressure, and reproduction.
- *Thyroid Gland*: Located in the neck, it produces *thyroxine and triiodothyronine*, hormones that regulate metabolism, energy production, and the body's sensitivity to other hormones.
- *Parathyroid Glands*: Small glands located on the posterior surface of the thyroid gland, regulate calcium and phosphate balance in the body.
- *Adrenal Glands*: Located on top of each kidney,

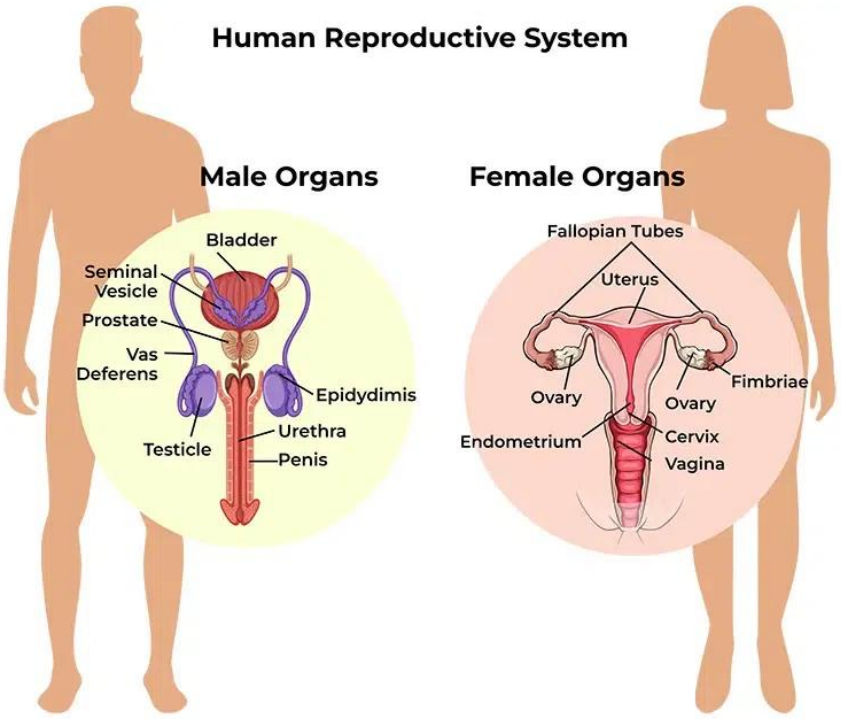
- *Adrenocortica*l - (*aldosterone*) affects blood pressure, and maintains calcium and potassium levels. (*cortisol*) response to stress, anti-inflammation, and metabolism.
- *Medullary* – (*epinephrine and norepinephrine*). Response to increased heart rate, activity, stress, responsible for vasoconstriction in increasing blood pressure.
- *Estrogen and androgens* responsible for sexual development
- *Pancreas:* An organ located in the abdomen; it has *both digestive and hormonal functions*. It produces *glucagon (Catabolic*), which regulates blood sugar levels, and *Insulin* which decreases blood sugar levels (*Anabolic)* and stores glucagon in blood cells
- *Testes:* In males, they produce sperm and testosterone, which regulate sperm production, libido, and secondary sexual characteristics.
- *Posterior pituitary gland*: (*antidiuretic hormone*) regulates kidneys to reabsorb water and maintain hydration. (*Oxytocin*) stimulates the uterus to contract and mammary glands to secrete milk.
- *Thymus*: Stimulates the maturation of *T cells*; responsible for developing the immune system; atrophies in adults.
- *Pineal gland*: Regulates the circadian rhythm; stimulated by darkness and allows sleep to occur.

Common Conditions Affecting the Endocrine System

- *Type 1 Diabetes*: An autoimmune condition where the pancreas produces little or no insulin.
- *Type 2 Diabetes*: More common, resulting from the body's ineffective use of insulin, often associated with obesity and lifestyle factors.
- *Hyperthyroidism*: Caused by excessive thyroid hormone production, resulting in weight loss, rapid heartbeat, and heat intolerance.
- *Goiter*: Enlargement of the thyroid gland, which can result from iodine deficiency or thyroid disease.
- *Acromegaly*: A condition resulting from the excessive secretion of growth hormones. Progressive and noticeable enlargement of extremities like hands and feet.
- *Diabetes insipidus*: Inadequate levels of antidiuretic hormones.
- *Dwarfism*: Lack of growth hormone during development.

- *Congenital hypothyroidism*: Observed in infants with impaired thyroid function due to a genetic disorder or maternal iodine deficiency.
- *Diabetes mellitus*: Increased blood sugar due to insulin deficiency or the inability of cell membrane receptors to recognize insulin.
- *Addison's disease*: (adrenal insufficiency) Glands do not secret sufficient cortisol and aldosterone.
- *Cushing disease*: Excessive secretion of adrenocorticotropic hormone, which results in excessive cortisol levels.

The Human Reproductive System



The reproductive system is essential for human reproduction and consists of both external and internal organs that work together for procreation.

The system is divided into two main parts: the *male reproductive system* and the *female reproductive system*, each with specific functions and structures.

The Male Reproductive System

- The male reproductive system is designed to produce, maintain, and transport sperm — the male reproductive cells, and protective fluid (semen).
- It also discharges sperm into the female reproductive tract during sex.

Main parts of the Male Reproductive System

- *Testes (Testicles*): Produce sperm and testosterone, the male sex hormone.
- *Scrotum:* A pouch of skin containing the testes, regulating their temperature.
- *Epididymis*: Stores sperm cells and is where they mature.
- *Vas Deferens*: Tubes that transport mature sperm to the urethra in preparation for ejaculation.
- *Prostate Gland*, *Seminal Vesicles, and Bulbourethral Glands*: Produce fluids that nourish and transport sperm (semen).
- *Penis*: Delivers semen into the female reproductive tract.

The Female Reproductive System

- The female reproductive system is designed to produce eggs (ova) for fertilization and to provide a place to support the development of offspring.

Main parts of the Female Reproductive System

- *Ovaries*: Produce eggs and hormones including estrogen and progesterone.
- *Fallopian Tubes*: Transport the eggs from the ovaries to the uterus. Fertilization of an egg by sperm typically occurs here.
- *Uterus (Womb):* A hollow organ where a fertilized egg can develop into a fetus.
- Cervix: The lower part of the uterus that opens into the vagina.
- *Vagina (Birth Canal):* A canal that connects the cervix to the external body, serving as the passageway for menstrual blood, sexual intercourse, and childbirth.

Common Conditions Affecting the Reproductive System

Sexually Transmitted Infections (STIs)

- Chlamydia trachomatis (chlamydia)

- Trichomonas vaginalis (trichomoniasis)
- Treponema (syphilis)
- Herpes simplex virus (Herpes genitalis)
- Neisseria gonorrhea (gonorrhea)
- *Pelvic inflammatory disease*: An infection that affects the organs of reproduction and may cause infertility or septicemia.
- *Endometriosis:* Abnormal implantation of endometrial tissue outside the uterus.

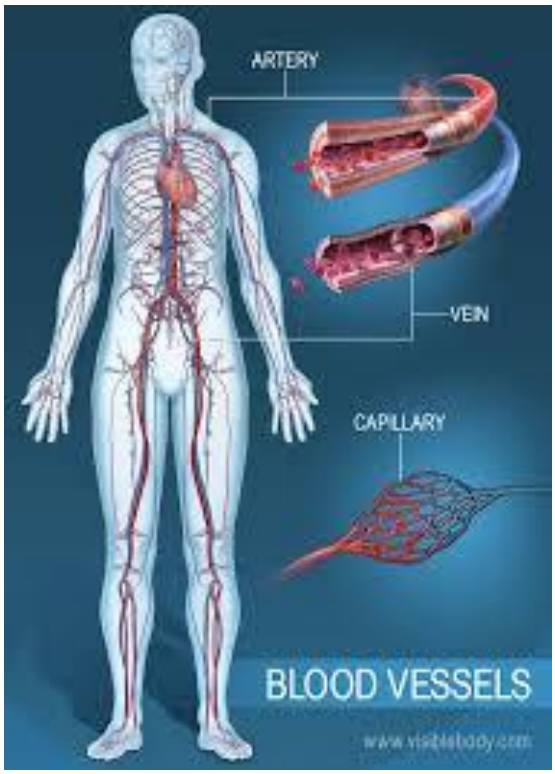
To diagnose, evaluate, and manage conditions affecting the reproductive system, healthcare providers may order a variety of tests. These tests help assess the function and integrity of the reproductive organs, hormone levels, and identify any abnormalities.

The Circulatory System

The circulatory system, also known as the cardiovascular system, is a complex network that plays a vital role in maintaining homeostasis and supporting life. It consists of the heart, blood vessels, and blood, and it functions to transport oxygen, nutrients, hormones, and waste products throughout the body.

The Vasculature

These are the blood vessels that act as highways for blood cells.



Arteries

- Carry oxygen-rich blood away from the heart to the body's tissues, except for the pulmonary arteries, which carry oxygen-poor blood to the lungs.
- Arteries are typically oxygenated (*an exception is the pulmonary artery*).
- They branch to form *microscopic-sized arteries called arterioles*.
- *Both arteries and arterioles carry and distribute oxygen*.

Veins

- Return oxygen-poor blood to the heart, except for the pulmonary veins, which carry oxygen-rich blood from the lungs to the heart.

Capillaries

- Tiny blood vessels that form a network between arteries and veins, facilitating the exchange of oxygen, nutrients, and waste products between blood and tissues.
- *Petechiae* - Ruptured capillaries, are tiny red spots that can appear on the skin, conjunctiva (the inside of eyelids), retina, and mucous membranes.

Blood

- A fluid that circulates through the heart, arteries, veins, and capillaries. It comprises plasma (the liquid component), red blood cells (carry oxygen), white blood cells (part of the immune system), and platelets (involved in clotting).

The 3 layers of Blood vessel walls

1. Tunica adventitious – made up of connective tissue, outer layer
2. Tunica media – muscular and elastic, middle layer
3. Tunica intima- made of endothelium, inner layer (endocardium)

Functions of the Circulatory System

1. Transportation: *Carries oxygen* from the lungs to the body's cells and transports carbon dioxide from the cells to the lungs for exhalation.
    a. It also *moves nutrients* from the digestive system to the cells, *carries waste products* to the kidneys for excretion, and transports hormones from the endocrine glands to their target organs.
2. Regulation: Helps regulate *body temperature* by distributing heat produced in the muscles and other areas to the skin, where it can be dissipated.
    a. It also helps maintain the pH balance and electrolyte composition of body fluids.
3. Protection: Blood *contains cells and antibodies* of the immune system that protect the body against pathogens.
    a. Platelets and certain plasma proteins form clots to seal wounds and prevent blood loss.

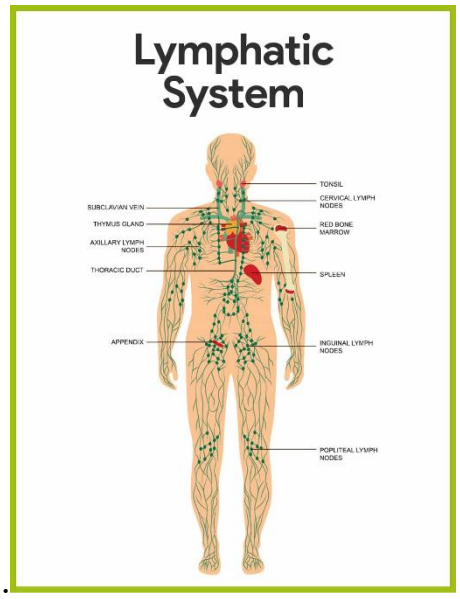
Common Conditions Affecting the Circulatory System

- Hypertension (High Blood Pressure): A condition where the force of the blood against the artery walls is too high, increasing the risk of heart disease and stroke.
- Coronary Artery Disease (CAD): is characterized by the buildup of plaque in the coronary arteries, reducing blood flow to the heart muscle.
- Heart Attack (Myocardial Infarction): Occurs when blood flow to a part of the heart is blocked for a long enough time that part of the heart muscle is damaged or dies.

- Stroke: Happens when the blood supply to part of the brain is interrupted or reduced, preventing brain tissue from getting oxygen and nutrients.
- Heart Failure: A chronic condition where the heart doesn't pump blood as well as it should.
- Arrhythmias: Irregular heartbeats that can affect how effectively the heart pumps blood.
- Peripheral Artery Disease (PAD): A circulatory condition where narrowed blood vessels reduce blood flow to the limbs.

The health of the circulatory system is essential for overall wellness, and maintaining a healthy lifestyle can help prevent many circulatory system disorders. Regular exercise, a balanced diet, avoiding tobacco use, and managing stress are critical steps in supporting cardiovascular health.

The Lymphatic System



Lymphatic tissues — the spleen, thymus, lymph nodes, and other organs — produce lymphocytes.

Platelets(thrombocytes), contributes to blood clotting, preventing excessive bleeding.

Plasma, comprising water, electrolytes, proteins, hormones, and waste products, acts as a medium for the transportation of nutrients and metabolic by-products.

Chapter 4: The Heart & Blood

The Heart

The heart is a muscular organ located in the thoracic cavity. Its primary function is to pump blood throughout the body, delivering essential oxygen and nutrients to tissues and organs while removing waste products.

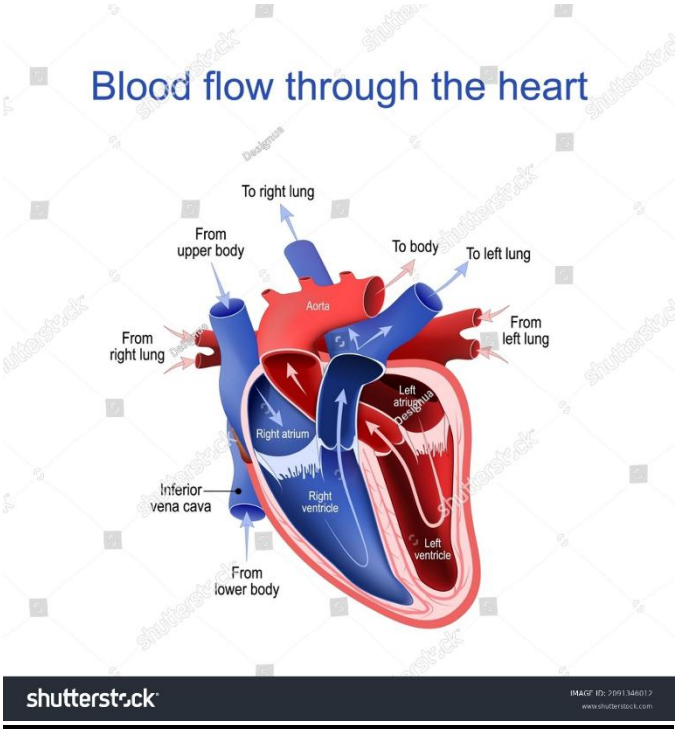
Anatomy of the Heart

The heart is about the size of a closed fist and is divided into four chambers: two atria and two ventricles.

The ***right atrium*** receives deoxygenated blood from the body and pumps it into the ***right ventricle***, which then sends the blood to the lungs for oxygenation. The oxygenated blood returns to the ***left atrium*** and passes through the ***left ventricle***, and is pumped to the rest of the body.

The *pulmonic valve* belongs to the type called "*outflow*" valves.

Separates the *right ventricle* from the *pulmonary artery*, the pulmonic valve opens so that blood from the right ventricle can be pumped to the lungs, here it picks up oxygen. To prevent blood back-flow from the pulmonary artery, the pulmonic valve has three flaps (cusps) that close (or contract) before repeating the process.



Physiology of the Heart

The heart's rhythmic contractions are known as the *cardiac cycle*.

The SA node, often referred to as the "natural pacemaker," initiates the heartbeat, causing the atria to contract. The electrical signal then travels to the AV node, which delays the impulse briefly before transmitting it to the ventricles, ensuring a coordinated contraction sequence.

The cardiac cycle involves two main phases: systole and diastole.

During systole, the heart contracts, pumping blood into the arteries.

Diastole, on the other hand, is the relaxation phase, allowing the chambers to fill with blood before the next contraction.

The heart's ability to adjust its rate and force of contraction based on the body's demands is regulated by the autonomic nervous system, specifically through the sympathetic and parasympathetic branches.

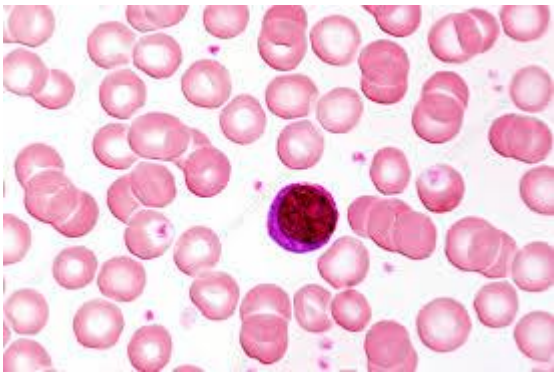
Blood

serves as a lifeline, delivering essential nutrients, oxygen, and hormones to various organs and tissues. Comprising red and white blood cells, platelets, and plasma, blood is a dynamic and complex substance with a plethora of functions.

Composition of Blood

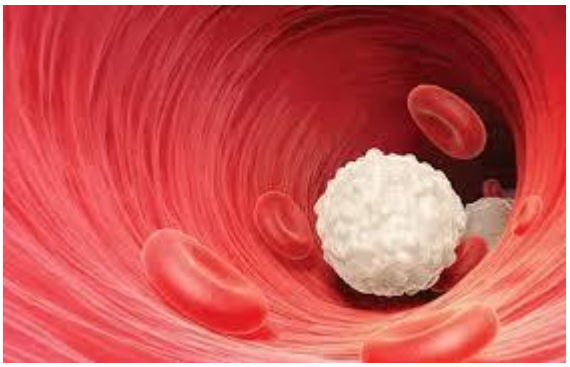
Blood is a specialized connective tissue that consists of various cellular and non-cellular components. The cellular components include red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes), while plasma, a straw-colored liquid, constitutes the non-cellular portion.

Each component plays a unique role in maintaining the equilibrium of the internal environment.



Red blood cells (erythrocytes), predominantly composed of hemoglobin, facilitate the transport of oxygen and carbon dioxide.

- RBCs pass through the spleen and liver prior to their death — at *about 120 days* — at which time the liver's macrophages "undergo a process called phagocytosis" and digest the spent cells.



White blood cells(leukocytes), are crucial components of the immune system, defending the body against infections and foreign invaders.

- White blood cells make up about one percent of total blood volume. A high volume of leukocytes often indicates the body is fighting disease or infection.
- Approximately 20–40% of WBC are lymphocytes. The lymphocytes consist of *T cells and B cells.*
- *Bone marrow* stores approximately 80–90% of WBC, but they are released when an inflammatory condition or an infection occurs.
- White blood cells work to recognize and protect the body against infections by producing *proteins (antibodies*) to fight infections.

Basophils are small cells that recognize an allergic reaction, at which time they secrete antihistamine.

Functions of Blood

Blood performs a myriad of vital functions that are essential for the survival of the human body.

Oxygen transport is one of its primary functions, facilitated by red blood cells. These cells bind with oxygen in the lungs and release it in tissues, ensuring cellular respiration.

Nutrient transport, delivering nutrients absorbed from the digestive system to cells throughout the body.

White blood cells, the immune system relies on blood to detect, and eliminate pathogens, viruses, and abnormal cells.

Blood clotting is another critical function, preventing excessive bleeding in response to injuries.

Blood acts as a regulator of *body temperature, pH levels, and fluid balance*, contributing to the overall homeostasis of the internal environment.

Hemostasis, the process in which the body repairs a damaged blood vessel to prevent further loss of blood, begins with the vascular stage.

Fibrinolysis is the process that removes clots following hemostasis.

The normal body process of breaking down and removing a clot is *primary fibrinolysis*. *Secondary fibrinolysis* occurs with medication, a medical disorder, or another cause.

Common blood-related conditions

Anemia

- occurs when there is a decrease in the number of red blood cells or a low concentration of hemoglobin in the blood. This can result from nutritional deficiencies (such as iron, vitamin B12, or folic acid), chronic diseases, or genetic conditions.
- Symptoms may include fatigue, weakness, and paleness.

Hemophilia

- is a genetic disorder that affects blood clotting. People with hemophilia have a deficiency or absence of clotting factors, leading to prolonged bleeding after injuries or surgeries.
- There are different types of hemophilia, and the severity varies.

Leukemia

- is a type of cancer that affects the blood-forming tissues, primarily the bone marrow and lymphatic system. It leads to the overproduction of abnormal white blood cells, interfering with the normal functioning of the immune system.
- Symptoms include fatigue, frequent infections, and unexplained weight loss.

Thrombocytopenia

- is a low platelet count, leading to an increased risk of bleeding and bruising.
- It can be caused by various factors, such as autoimmune disorders, medications, infections, or bone marrow disorders.

Polycythemia vera

- is a rare blood disorder caused by the overproduction of red blood cells in the bone marrow.
- This can lead to an increased risk of blood clots, strokes, and other cardiovascular complications.

Sickle cell disease

- is a genetic disorder that causes red blood cells to become misshapen and break down more easily.
- This can lead to anemia, pain, and organ damage. Individuals with sickle cell disease may experience episodes of pain (crises) and have a shortened lifespan for their red blood cells.

Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)

- occurs when a blood clot forms in a deep vein, usually in the legs.
- If a part of the clot breaks off and travels to the lungs, it can cause a pulmonary embolism.
- Both conditions can be life-threatening and require prompt medical attention.

Hypertension (High Blood Pressure)

- can have significant effects on the blood vessels.
- Chronic high blood pressure can damage blood vessels, increasing the risk of heart disease, stroke, and other cardiovascular complications.

Hemochromatosis

- is a genetic disorder that leads to excessive iron absorption by the body.
- Over time, this can result in iron overload, affecting various organs and tissues and causing complications such as liver damage, diabetes, and heart problems.

Idiopathic Thrombocytopenic Purpura (ITP)

- is an autoimmune disorder in which the immune system mistakenly attacks and destroys platelets.
- This can result in a low platelet count and an increased risk of bleeding.

Coagulation

Coagulation is the process by which blood forms clots to stop bleeding. It is a complex and highly regulated sequence of events that involves the interaction of various proteins in the blood known as clotting factors. The coagulation process is crucial for preventing excessive bleeding when blood vessels are injured.

The primary components involved in coagulation are platelets and clotting factors.

- Platelets are small cell fragments in the blood that play a key role in forming the initial plug at the site of injury.
- Clotting factors are proteins, including fibrinogen, prothrombin, and various others, which interact to form a stable blood clot.

3 main phases of the coagulation process:

1. Vasoconstriction and Formation of the Platelet Plug:
    a. When a blood vessel is injured, vasoconstriction occurs to reduce blood flow to the affected area. Platelets adhere to the exposed collagen at the site of injury, become activated, and release chemicals that attract more platelets. This forms a temporary plug to stop immediate bleeding.
2. Coagulation Cascade:
    a. Involves a series of enzymatic reactions that lead to the activation of clotting factors. This change results in the conversion of fibrinogen into fibrin, which forms a mesh that stabilizes the platelet plug, creating a more robust blood clot.
3. Clot Retraction and Repair:
    a. After the stable blood clot is formed, the clot retracts to reduce its size. This process is crucial for tissue repair. Eventually, the clot is dissolved through a process called fibrinolysis, ensuring that blood vessels are not unnecessarily occluded.

Hemostasis

Hemostasis refers to the overall process of preventing and stopping bleeding. It includes three main components: vascular spasm, platelet plug formation, and coagulation. *Hemostasis* is a dynamic and intricate system that maintains the delicate balance between preventing excessive bleeding and avoiding unnecessary clot formation.

Vascular Spasm:

- -When a blood vessel is injured, the immediate response is vasoconstriction or a narrowing of the vessel. This reduces blood flow to the affected area, minimizing blood loss. A vascular spasm is a rapid, temporary constriction that provides the initial response to vessel injury.

Platelet Plug Formation:

- Platelets play a crucial role in the formation of a temporary plug at the site of injury. They adhere to the exposed collagen, become activated, and release chemicals that attract more platelets. This leads to the formation of a platelet plug that seals small breaks in the blood vessel wall.

Coagulation:

- Coagulation is the final stage of hemostasis, where the formation of a stable blood clot occurs. The coagulation cascade involves a series of sequential steps that lead to the conversion of fibrinogen into fibrin, reinforcing the platelet plug and creating a more durable clot.

The regulation of hemostasis is essential to prevent both excessive bleeding and inappropriate clotting. Imbalances in hemostasis can lead to conditions such as bleeding disorders (hemorrhagic disorders) or thrombosis (excessive clot formation), both of which pose significant health risks.

Chapter 5: The Cardiac Cycle

The cardiac cycle can also be explained by how the pressure changes inside the heart as it beats.

The **cardiac cycle** has two main parts: systole and diastole.

Systole is when the ventricles (the lower chambers of the heart) squeeze and pump blood out to the body and lungs. Even though the right ventricle is not as strong as the left, both sides pump out the same amount of blood. This balance is important so that blood flows properly and does not get backed up in the body or lungs

Diastole is when the ventricles relax and fill with blood. During this time, the mitral and tricuspid valves open so blood can move from the atria (the upper chambers) into the ventricles.
In the last part of diastole, the atria contract to give an extra push of blood into the ventricles. This extra push is called the "*atrial kick*" and adds about 20% more blood before the next heartbeat.

When the ventricle (the lower part of the heart) squeezes to pump blood, it doesn't do it the same way the whole time. The pressure inside the ventricle changes during four main phases.

Four Phases of Diastolic Pressure inside the Ventricle:

1. *Isovolumic Relaxation Phase*, both the aortic valve and the mitral valve are closed. The ventricle is relaxing but not filling with blood yet.

2. *Ventricular Filling Phase*. Because the pressure in the ventricle is so low, the mitral valve opens, and blood flows from the atrium (upper part of the heart) into the ventricle.

3. *Isovolumic Contraction Phase*. The ventricle starts to squeeze (contract), but both the mitral and aortic valves are still closed at this time.

4. *Ventricular Ejection Phase*, Lastly, the aortic valve opens, and blood is pushed out of the heart to the rest of the body.

Normal Heart Pressure ranges:

- Left Ventricle: 15 to 120 mm Hg
- Right Ventricle: 5 to 25 mm Hg
- Right Atrium: 4 to 5 mm Hg
- Pulmonary Arteries & Left Atrium: 10 to 25 mm Hg
- Aorta: 80 to 120 mm Hg

Preload and Afterload

Preload describes how much the heart muscle is stretched when the lower part of the heart (the left ventricle) is full of blood — right before it squeezes to pump the blood out.

Another name for preload is LVEDP, which stands for *Left Ventricular End-Diastolic Pressure.*

Stroke volume describes how much blood the heart pumps out with each beat or how much blood the heart pumps out in one minute.
When preload (or pressure) increases, the heart muscle stretches more. In a healthy heart, this helps the heart squeeze and pump normally.

In heart failure, if the left ventricle fills with too much blood, the heart muscle gets weak and stretched out like a worn-out rubber band
This makes it harder for the heart to squeeze well, so it pumps out less blood than normal.

Afterload. pressure the heart has to push against to pump blood out to the body. It happens right before the heart squeezes.

Afterload can affect how much blood stays in the heart after it squeezes, the pressure in the heart when it's full, and how much blood is pumped out with each heartbeat.

With continuous poor afterload, cardiac output would fail because not enough blood is pushing out of the heart with each beat.

How Electricity is Transmitted in the Body

The body's electric signals comes from tiny charged particles called *ions (*sodium, potassium, chloride, and calcium) *that* move in and out of cells.
Calcium is very important for the heart because it helps the heart muscle squeeze and pump blood.

Refractory Periods

During this time, the heart cell cannot send another electrical signal. This keeps the heart from beating too fast or out of control, preventing dangerous heart problems called *arrhythmias*.

The *absolute refractory period* - the heart pauses because the cell's sodium and calcium channels are closed and not working yet.

There are two types of refractory periods to remember.

The *absolute refractory period* means it is impossible for the cell to start another heartbeat.

The *relative refractory period* happens right after that, the heart might be able to beat again, but it would take a much stronger signal than normal.

Hyperpolarization - when the heart cell is trying to get back to normal, potassium leaves the cell. If too much potassium leaves, this makes the inside of the cell extra negative. The cell can still start a new beat during this time, but it would need a stronger signal.
Once the cell returns to its normal resting state, the relative refractory period is over.

How the Heart Gets Nerve Signals (Innervation of the Heart)

In the lower part of the brain, called the medulla oblongata, there are special nerve centers that help control heart rate. These nerves are part of the *autonomic nervous system*, which works without us having to think about it.

Autonomic Nervous System

Determines the heart's ability to adjust its rate and force of contraction based on the body's demands. The ANS works specifically through the *sympathetic and parasympathetic* branches.

Sympathetic Nervous System

This speeds up the heart. It's also called the "fight or flight" system because it helps your body get ready to respond to danger or stress.

Parasympathetic Nervous System

This slows the heart down. The main nerve that does this is called the vagus nerve *(cranial nerve X*). When this nerve slows the heart, it's sometimes called putting a "vagal brake" on the heart.

Even though the heart can beat on its own, your thoughts and emotions can also affect your heart rate. For example, if you think of something scary, signals from the brain travel down to the medulla oblongata to either speed up or slow down the heart, depending on the situation.

Your body can also adjust your heart rate without you thinking about it. For example, special sensors in your body (*baroreceptors*) check your blood pressure. If your blood pressure is too high, your brain will send signals to slow your heart down.

Two important areas in the brainstem help with this:

- *Nucleus Tractus Solitarius (NTS)*: This area gets information from the sensors in your body.

- *Dorsal Vagal Nucleus and Nucleus Ambiguus:* These areas send signals through the vagus nerve to slow the heart rate.

Normally, your heart rate is lower than 100 beats per minute because of the constant "vagal brake" slowing it down.

The *hypothalamus*, another part of the brain, also helps control heart rate, especially during exercise, stress, or sickness

- *Chronotropy* - anything that changes the heart rate.
- *Positive chronotropy* - speeds up the heart
- *Negative chronotropy* - slows down the heart
- *Inotropy* -describes the strength of the heart's beat (how hard it squeezes).

- Some medicines can make the heart beat stronger (increase inotropy) or weaker (decrease inotropy).

Dromotropy - how fast electrical signals travel through the heart. These electrical signals help control the heartbeat.

The body has two systems that can affect dromotropy — the *sympathetic nervous system* and the *parasympathetic nervous system*.

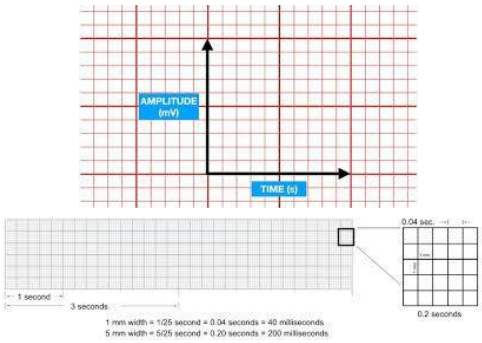
- *Sympathetic* system - speeds up the electrical signals in the heart
- *Parasympathetic* system - slows down electrical signals
- Certain medicines can also make the electrical signals go faster or slower.

Phrenic nerve - sends messages to the heart. This nerve comes from the neck area, between the third and fifth bones in the spine (called cervical vertebrae).

The *phrenic nerve* controls parts of the diaphragm (which helps you breathe) and the pericardium (the sac around the heart).

Sometimes, pain from the phrenic nerve can feel like chest pain coming from the heart, even though the heart isn't the real problem. This is called *referred pain.* Pg 36

Chapter 6: EKG Paper



The paper used for an EKG (electrocardiogram) has small boxes that help measure time and electricity in the heart.
Each *tiny box across (1 mm wide) shows 0.04 seconds.*
Each tiny box going up (*1 mm tall) shows 0.1 millivolts of electricity*.
The EKG prints the heart's activity at a speed of 25 millimeters per second.
Ten boxes across (1 cm) equal 1 millivolt.

Paper speed: 25mm/sec
Horizontally -1 small box = 0.04 sec
1 mm/25 seconds =0.04 mm/second
Horizontally - 1 big box
1 big box = 5mm or 5 small boxes
5 small boxes x 0.04 sec=0.2 seconds

Standard vs. Increased Paper Speed

Increasing the paper speed on an ECG machine during tachycardia helps to improve clarity and diagnostic accuracy of the tracing.
Standard speed: 25 mm/sec (most commonly used)
Increased speed: 50 mm/sec

Why Increase Paper Speed in Tachycardia

- Better visualization of P waves
- In fast heart rates (e.g., >150 bpm), the P waves may merge into T waves or QRS complexes.
- Increasing the paper speed spreads out the waveform so you can see atrial activity more clearly (important to distinguish types of tachycardia like SVT vs. atrial flutter).
- Improved measurement accuracy

Spreads out each cardiac cycle, making it easier to:

- Measure PR, QRS, and QT intervals
- Identify rate, rhythm, and morphology (describes the shape, amplitude, duration, and contour of the waves and complexes in an ECG tracing).
- Enhanced rhythm analysis
- Helpful in diagnosing narrow-complex tachycardias or wide-complex rhythms where timing is critical.
- Easier to identify AV dissociation, flutter waves, or ectopic beats.

Example Use Case

A patient has a heart rate of 180 bpm. At 25 mm/sec, QRS complexes appear very close together. Switching to 50 mm/sec doubles the spacing, so you can better tell if P waves are present and whether the rhythm is regular or not.

When increasing the paper speed:

- Make sure to label the tracing clearly.
- Be aware that intervals and distances will appear longer but do not represent longer actual time—you must adjust your interpretation accordingly.

Thermal-sensitive graph paper is the special paper used in ECG machines (and some other medical devices) to record tracings of the heart's electrical activity. It is

coated with a chemical that reacts to heat, allowing the ECG machine's thermal printer to "burn" or print the ECG waveform onto the paper without ink.

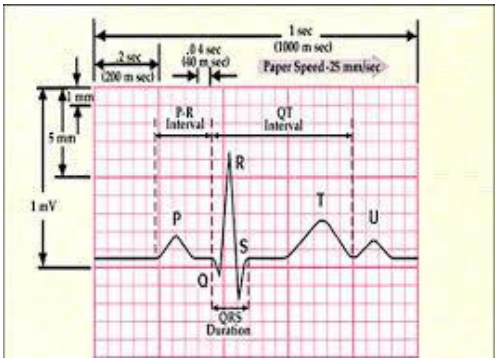
How It Works

- The ECG machine uses a thermal print head that heats specific areas on the paper.
- The heat-sensitive coating darkens when exposed to heat, creating lines and waveforms.
- No ink or toner is needed.

Advantages

- Instant, clean printing
- No ink maintenance
- Precise for medical readings
- Standardized format for interpretation

Chapter 7: Sinus Rhythm



A heartbeat starts with the *P wave*. This shows the electrical activity when the top chambers of the heart (atria) begin to contract.

The space between the start of *the P wave and the start of the R wave is called the PR interval*.

This shows the time it takes for the electrical signal to move from the atria to the bottom chambers (ventricles).

- The *PR segment is the space between the end of the P wave and the start of the R wave.*
- The *QRS complex is the part where the ventricles contract. It starts with a small dip down (Q wave), then a large spike up (R wave), then a sharp drop down (S wave), and finally returns to the normal line.*
- The *width of the QRS complex is important because it tells us if the AV node (a part of the heart's electrical system) is working correctly*. It should be narrow, meaning the signal is moving fast through the ventricles.
- There is also a small electrical signal from the atria returning to rest during the QRS complex, but it is hidden and cannot be seen because the QRS is so big.
- The *ST segment is the flat line between the S wave and the T wave. The T wave shows when the ventricles are returning to their resting state.*
- Some people may have a U wave, which is a small wave after the T wave. It doesn't always happen, and it may be a sign of a heart problem. It is thought to show when a special part of the heart's electrical system, called the Purkinje fibers, resets.

The heartbeat cycle begins when both the atria and ventricles are relaxed (called diastole).

The *P wave marks the electrical start of a heartbeat.*

- The atria contract first, then the ventricles contract after the QRS complex. The heart muscle needs this electrical signal before it can squeeze and pump blood.
- You can't add vectors the same way you add regular numbers because the direction they point in is important.

Determining Heart Rate

Large Box Method (300 Method)

The Large Block Method is a quick and easy way to estimate heart rate using a 12-lead ECG strip. It works best when the rhythm is **regular** (i.e., the R-R intervals are consistent).

On ECG paper:

- Each **large block** = **5 small boxes** = **0.20 seconds**
- **300 large blocks** = **1 minute** of heart time (since 1 small box = 0.04 sec)
- **Find two R waves** (the tall spikes in the QRS complex).
- **Count the number of large boxes** between those tQuick wo R waves.

Reference Guide:

# of Large Boxes	**Estimated Heart Rate (bpm)**
1	300
2	150
3	100
4	75
5	60
6	50

Maximum heart rate formula

The maximum heart rate (MHR) formula is a simple way to estimate the highest number of beats per minute your heart should reach during maximum physical exertion, especially in the context of stress testing with an ECG.

Standard Formula

Maximum Heart Rate (MHR)} = 220 - {age}

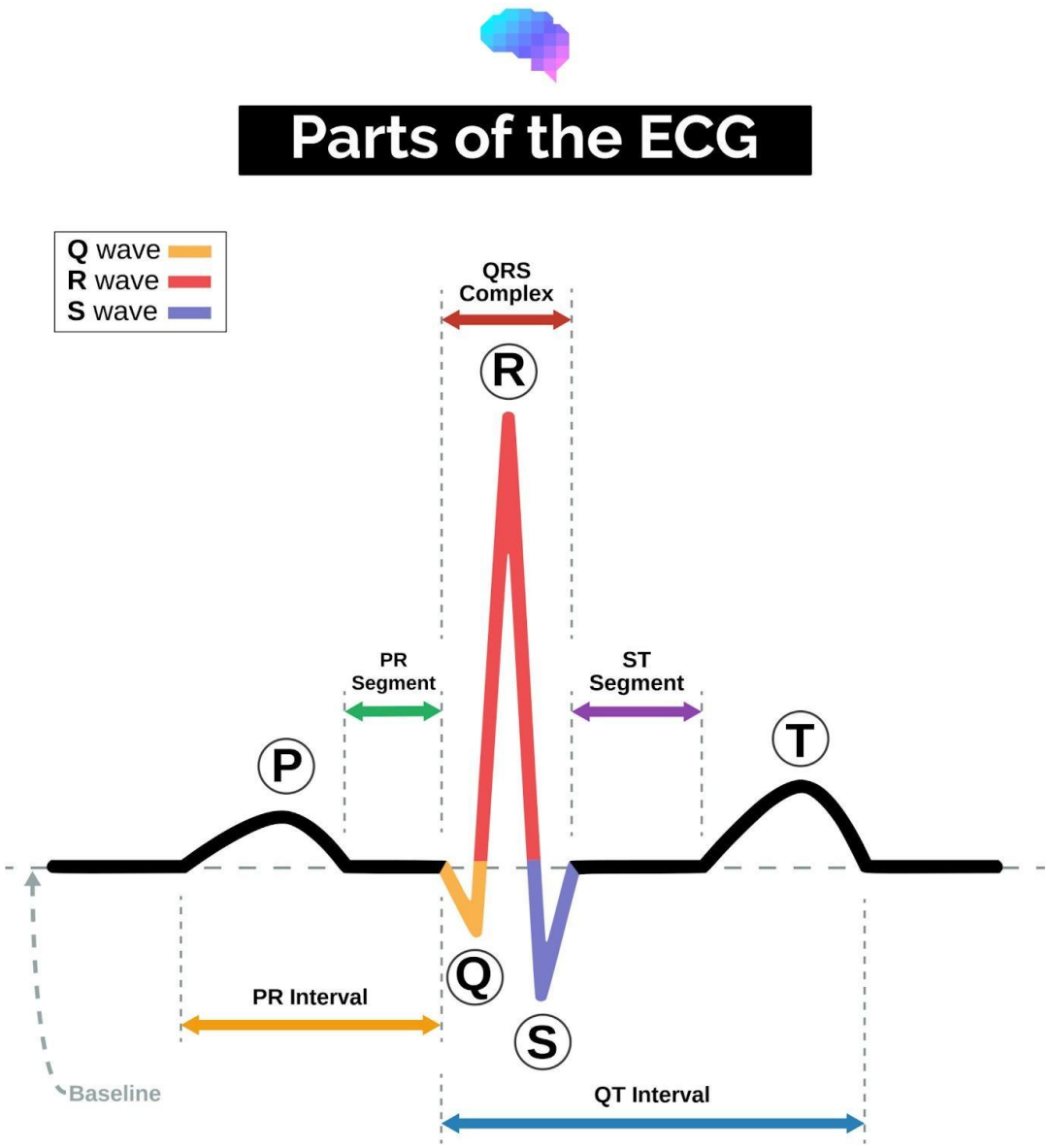
Example:

If a patient is 40 years old:

220 - 40 = {180 bpm}

Littmann Sign

Refers to the double counting of the heart rate by ECG software or monitors, often indicating severe *hyperkalemia* (high potassium blood level). This can cause characteristic changes on an ECG, including tall, peaked T-waves, which can become so prominent that some ECG software mistakenly identifies them as QRS complexes, thus doubling the apparent heart rate



The *P wave marks the electrical start of a heartbeat.*

- The atria contract first, then the ventricles contract after the QRS complex. The heart muscle needs this electrical signal before it can squeeze and pump blood.

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Chapter 8: Vectors & Axis Determination

When you look at an EKG (electrocardiogram), the picture you see on the paper looks flat, like it's only two-dimensional. But what it shows is really happening in three dimensions inside the body.

Vectors have two parts:

- *Voltage* - Amount of electricity
- *Volts or Millivolts* - Direction it is moving
- *Isoelectric line* - means zero millivolts. The waves you see go above or below this line, depending on how the electricity is moving.

You can think of the direction of the electricity in three ways:

- *Positive (above the line)*
- *Negative (below the line), or*
- *Zero (right on the line).*

If the electricity moves toward the positive electrode, the EKG will show a wave going up. If it moves toward the negative electrode, the wave will go down.
If the electricity moves at a 90-degree angle (sideways to the electrode), the EKG will show little or no wave because the electricity isn't moving toward or away from the electrode.

The heart's cells send out tiny electrical signals one by one. When all the cells in the heart send signals together, it makes a large electrical change that the EKG can pick up and show as waves on the screen or paper.

Conductivity of Electricity

Our bodies can carry electricity because we are made mostly of water and salt. *Saltwater* is a good conductor of electricity.

These electrical signals can be picked up by small stickers called *electrodes* that are placed on the skin.

The electrodes can sense tiny changes in the heart's electrical activity as it moves through the salty water in our body.

If the electricity moves toward the positive electrode, the ECG will show a wave going up. If
If it moves toward the negative electrode, the wave will go down.

If the electricity moves at a 90-degree angle (sideways to the electrode), the ECG will show little or no wave because the electricity isn't moving toward or away from the electrode.

The electrical *axis* is the average direction of all the electrical activity during ventricular depolarization (QRS complex).

The electrical axis points in the general direction the electricity is flowing. It's usually described in degrees on a circle (*Hexaxial Reference System*, like a compass).

<u>Axis Determination</u> will coincide with some medical conditions

Wandering baseline is a type of artifact seen on an ECG where the baseline (the flat, isoelectric line between waves) appears to drift up and down slowly, rather than staying steady.
It's when the ECG tracing appears to "wander" or shift gradually above and below the baseline, making it harder to accurately measure or interpret the electrical activity.

Causes

- Patient movement
- Breathing (deep or irregular respirations)
- Talking or shifting
- Loose or poorly attached electrodes
- Poor skin-electrode contact
- Oily, sweaty, or hairy skin
- Tension or pulling on the lead wires
- Improper placement of limb leads

What It Looks Like

- The P, QRS, and T waves may still be present and identifiable.
- The baseline (isoelectric line) slowly shifts up and down, especially in longer rhythm strips.
- Most noticeable in limb leads.

How to correct

- Reposition and secure the electrodes.
- Clean the skin (alcohol wipes) and shave hair if necessary.
- Instruct the patient to lie still and breathe normally.
- Check and untangle lead wires.
- Ensure proper placement and firm adhesion of electrodes.
- Wandering baseline doesn't come from the heart—it's external interference. But it can:
- Mimic ischemia or arrhythmia
- Interfere with rhythm interpretation
- Lead to misdiagnosis if not corrected

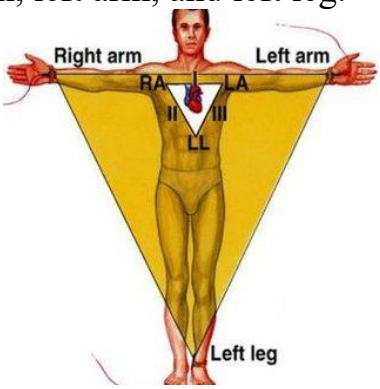
Chapter 9: Leads

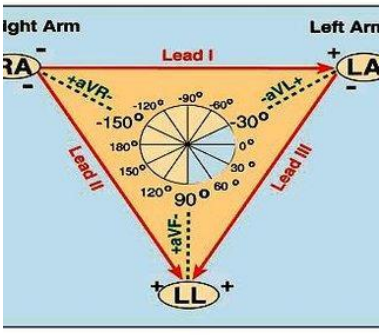
Leads are “views” or “angles” from which the ECG machine looks at the electrical activity of the heart. Each lead doesn’t send electricity—it receives signals.
Think of them like cameras placed around the heart, capturing electrical movement from different directions.

The electrodes connect to wires called “*leads*.” Leads help show the heart’s activity by comparing the electrical signals picked up from different places on the body.

Bipolar leads compare the signals between two body parts.
In a standard 12-lead EKG, you also use other leads. The first three leads are called I, II, and III.

Einthoven’s Triangle - Even though most people have four limbs, the EKG looks at three of them: the right arm, left arm, and left leg.





There are three main bipolar leads on an EKG: Lead I, Lead II, and Lead III.

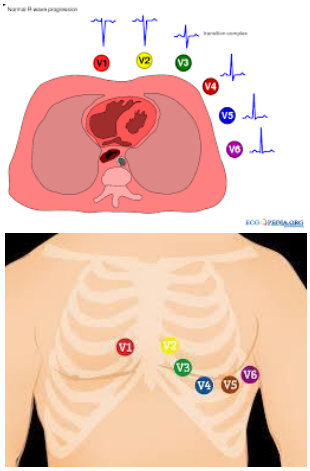
The *left leg is called the “ground*” because it gives us a starting point or baseline to compare the other signals.

Lead I - looks at the electrical signal from the right arm to the left arm.

Lead II - looks from the right arm to the left leg.

Lead III - looks from the left arm to the left leg.

V (Voltage) leads - help show what is happening in the heart from different angles, almost like seeing the heart in 3D.



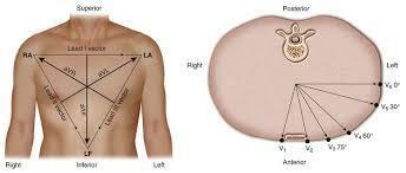
There are six V leads, and they are placed across the front of the chest. They are named V1, V2, V3, V4, V5, and V6. Gives a clear picture of the heart's electrical activity from the front and sides.

The first few chest leads (V1 through V3) help show what's happening in the front part of the heart. The last few chest leads (V4 through V6) help show what's happening on the left side of the heart.

Augmented or "virtual leads. - They are named aVR, aVL, and aVF.

Each of these looks at the heart from a different direction
aVR looks to the right side of the body.
aVL looks to the left side of the body.
aVF looks straight down toward the feet.

- They help show what the heart looks like from a horizontal view (side to side). These leads give smaller but very important details that help doctors understand the heart's shape and how it works in 3D.



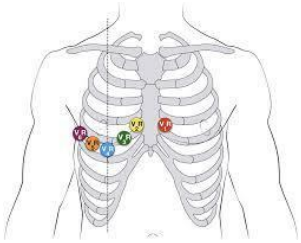
These leads are created using a point called Wilson's central terminal (VW lead), which is like an average of the other electrodes already placed on the body (RA - right arm, LA - left arm, and LL - left leg)

There are 6 limb leads and 6 chest("precordial") leads, which are all used together for a standard 12 lead EKG.

Limb leads
I, II, III, aVL, aVR, aVF

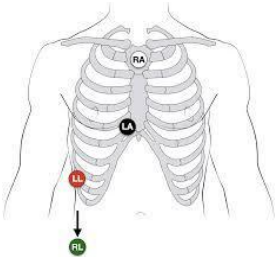
Chest or Precordial leads
V1, V2, V3, V4, V5, V6

Special Lead Types

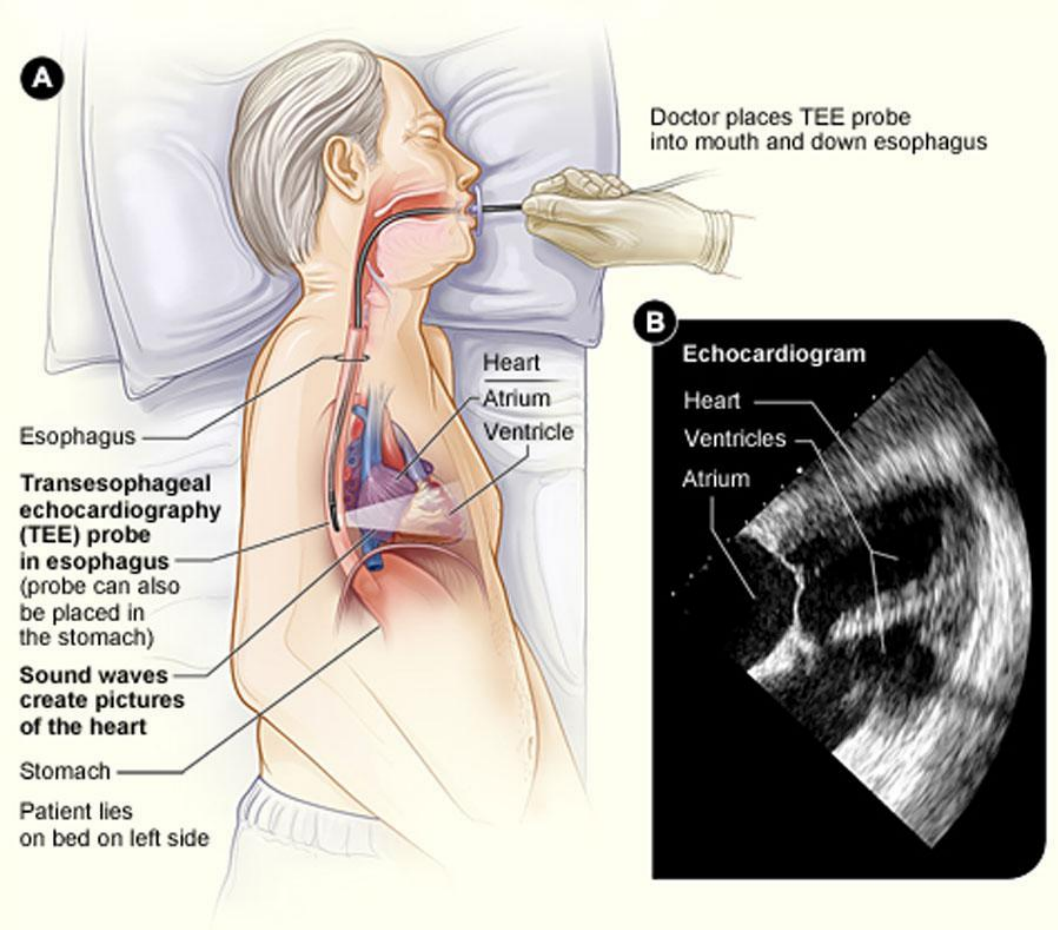


Right-sided leads are used to check the right side of the heart or to check people who have *dextrocardia* — a condition where the heart is flipped and points to the right instead of the left.

Lewis lead - Used to study certain types of heart rhythm problems. In this case, one of the electrodes is placed along the right side of the breastbone, near the second rib.



Other special tests - a small electrode can be placed inside the esophagus (the tube that carries food to your stomach) to get a clearer picture of the heart's rhythm.



Intracardiac EKG - in rare cases, doctors can use a small tube (catheter) to place electrodes directly inside the heart to record its activity from the inside.

Chapter 10: Electrodes

Electrodes are small sticky pads that help pick up the heart's electrical signals. They usually have a water-based gel on them to help them work better.

Electrodes are placed on the skin to measure the electrical activity of the heart as it travels through the body. They measure the difference in electrical energy between two points on the body.

There are two main types of electrodes.

1) One type is round with sticky edges and gel in the middle. These are good for long-term use because they stay on the skin longer, like with a portable heart monitor (ambulatory EKG).
2) The other type is flat and shaped like a square or rectangle. These are used for short tests because they stick well for a short time.

The gel in the electrodes helps conduct electricity from the skin to the wires connected to the EKG machine.

This gel often contains *silver and silver chloride* to help the electrical signals travel easily.

The leads on an EKG machine compare the electrical activity between the different electrodes placed on the body. There are six leads that come from electrodes placed across the chest (called *Precordial* or *Pericardial electrodes*). There are also electrodes placed on the arms and legs.

***Some of the leads are not from physical electrodes but are created by averaging the electrical signals from the electrodes that are already in place.

Electrodes measure the difference in electrical signals between two points on the body. You don't have to place the limb electrodes on the farthest part of the arms or legs (like the wrists or ankles). You can place them higher up, like near the shoulders or upper legs, and still get the same results.

The most important thing is to be consistent — place all the electrodes in the same way every time, either closer to the center of the body (proximal) or farther out (distal).

A total of ten electrodes,*color-coded in standard ways by the American Heart Association* so you can visualize where you should put them

Limb Electrodes
Left am (LA): black
Right arm (RA): white·
Left foot or leg (F): red·
Right foot or leg (N for neutral"):green

Chest or Precordial Electrodes
V1-in the fourth intercostal space on the right side of the sternum (red)
V2-in the fourth intercostal space on the left side of the sternum (yellow)
V3-in the space midway through V2 and V4 (green)
V4-in the fifth intercostal space along the midclavicular line (blue or brown)
V5-along the anterior axillary line at the same level as V4 (orange or black)
V6-along the midaxillary line at the same level as V5 or in the axilla (purple)
For people with pronounced breasts (such as most women, for example), you should place the chest electrodes beneath the breasts and not on top of them.

Left Lateral Tilt

Tilting a patient's body 15–30 degrees to the left by placing a wedge or pillow under the right hip or lower back.

In ECG, the left lateral tilt is not a specific ECG lead or measurement—rather, it refers to a body positioning technique, particularly used in pregnant women.

- Purpose: To shift the uterus off the inferior vena cava and aorta (especially in late pregnancy).
- In pregnant patients, particularly in the third trimester, lying flat (supine) can compress the inferior vena cava, reducing venous return and cardiac output.
- This can result in:
    Hypotension
    Dizziness
    Fetal distress

ECGs or fetal monitoring performed in the supine position may yield abnormal results due to reduced perfusion.

Helps improve blood flow and reduce artifact or misinterpretation in:

- Stress testing
- Rhythm monitoring
- Maternal/fetal assessments

It's not about changing lead positions—lead placement stays the same, but body positioning helps ensure accurate results and patient safety.

Special Positioning

Patients with certain conditions, such as COPD may have a difficult time laying flat for electrotrode placement. In this case the patient can sit in an upright position making such electrodes are placed correctly.

Patient with excessive hair should have their chest shaved with medical razor

ECG Electrode Placement in Children Standard 12-Lead Placement:

Limb Electrodes
RA (Right Arm): Right shoulder or upper arm
LA (Left Arm): Left shoulder or upper arm
RL (Right Leg): Right lower leg or thigh
LL (Left Leg): Left lower leg or thigh
(For infants/toddlers, place limb electrodes on the torso instead to reduce movement artifacts.)

Chest (Precordial) Leads

V1: 4th intercostal space (ICS), right sternal border
V2: 4th ICS, left sternal border
V3: Midway between V2 and V4
V4: 5th ICS, midclavicular line (left side)
V5: Horizontal with V4, anterior axillary line
V6: Horizontal with V4 and V5, midaxillary line

Placement of electrodes for Obese Patient Chest Leads

V1 & V2: May need to be placed **slightly higher** or more **lateral** if the chest wall is thick or if there is breast tissue.
V3–V6: Carefully lift breast tissue (if present) and place electrodes on the chest wall, not on top of fat or muscle folds.
V4 still goes at the 5th intercostal space at the midclavicular line. Use anatomical landmarks rather than visual landmarks.
Ensure good skin contact: Shave chest hair if needed and wipe skin to reduce oil/sweat.
Use larger electrodes with stronger adhesive.
Position the patient in a semi-recumbent or upright position to better access the chest.
Double-check lead position against anatomical landmarks, not visual ones.

Chapter 11: Types of EKGs

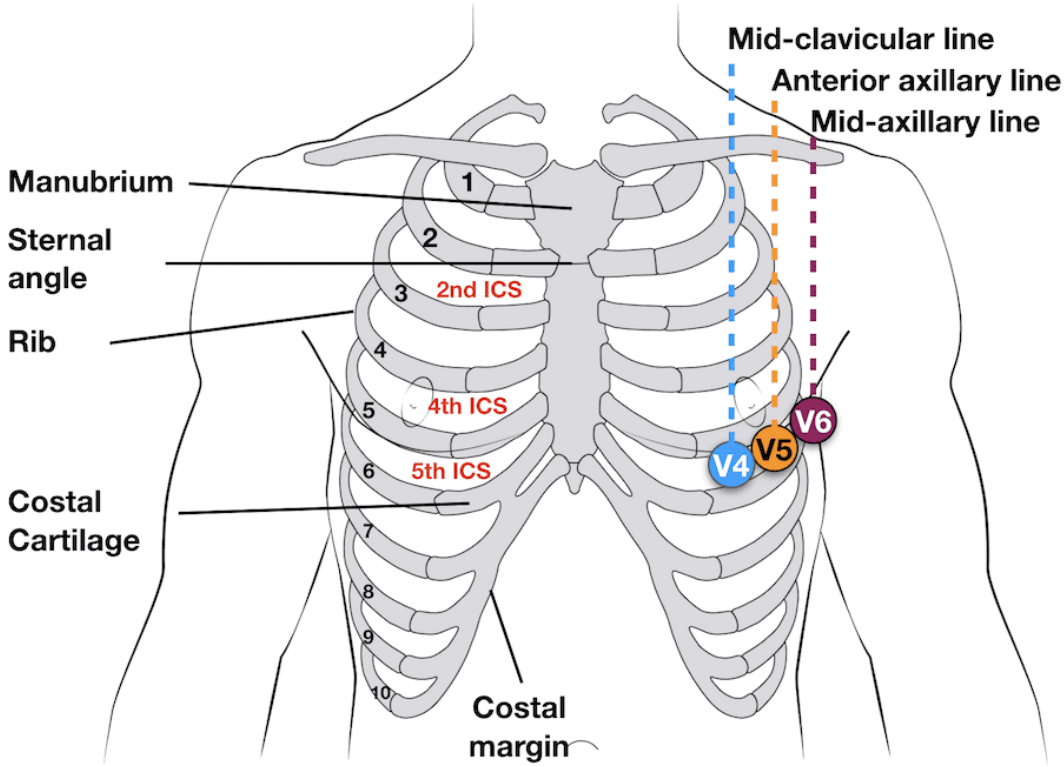
Resting EKG
A Resting EKG is the most common type of electrocardiogram performed. It is done while the patient is lying down calmly and not moving. The standard Resting EKG uses 12 leads (electrodes) attached to the body, but there are also simpler versions that use 1, 3, or 5 leads. This test helps healthcare providers determine the patient's heart rate, heart rhythm, and the shape or pattern of the heart's electrical activity. It can also show signs of heart problems like reduced blood flow (ischemia) or heart damage from a past heart attack (infarction).

Stress EKG
A Stress EKG, also known as an Exercise EKG, is performed while the patient exercises, usually on a treadmill or stationary bicycle. Electrodes are placed on the chest, and the test checks how the heart responds to physical activity. This helps doctors look for signs of reduced blood flow to the heart (ischemia) that may not appear when the patient is at rest.

Ambulatory EKG
An Ambulatory EKG is a test where a few electrodes are attached to the patient's chest, allowing them to go about their normal daily activities. The test can last from 24 hours to a week, depending on what the doctor is looking for. It is mainly used to detect irregular heartbeats (ectopy) that might not occur during a short, in-office test. However, this type of EKG is not the best way to check for reduced blood flow (ischemia) to the heart.
Often telemetry, used hospital set to track the patient's heart rate and rhythm remotely.

Chapter 12: Wire Systems

5-Lead Wire System



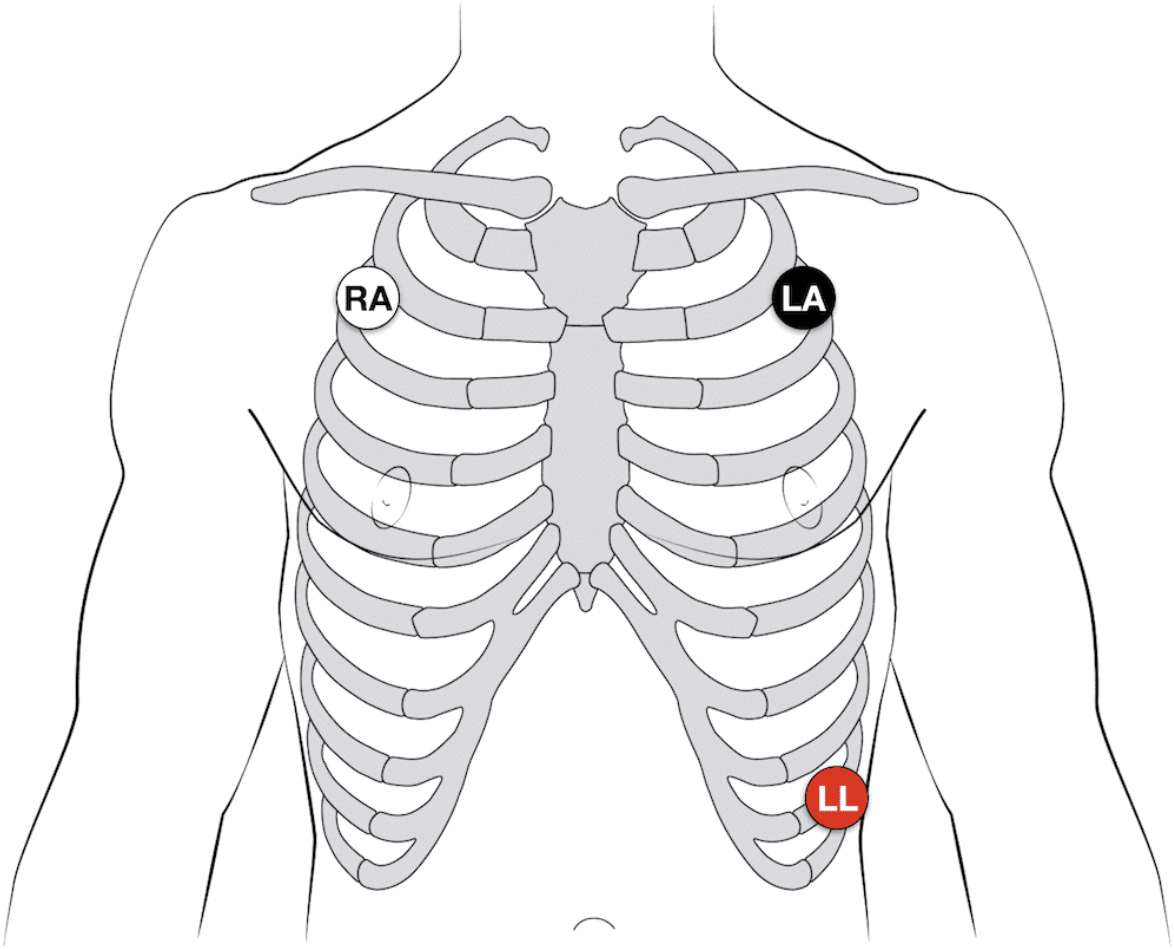
The 5-lead wire system is often used when a patient needs to be placed on a heart monitor or connected to a telemetry system. This system helps healthcare workers check the heart's rhythm and also look for signs of heart problems, like reduced blood flow (ischemia).

In this system, a small telemetry box is usually connected to the patient by wires that attach to sticky pads (electrodes) placed on the chest.
Here is where the electrodes go:

- White electrode – On the right side, near the middle of the collarbone.
- Black electrode – On the left side, just below the collarbone.
- Brown electrode – On the right side of the chest, in the 4th space between the ribs, next to the breastbone.
- Green electrode – On the right side, on the lower part of the ribcage.
- Red electrode – On the left side, on the lower part of the ribcage.

The four outer electrodes create what are called limb leads, while the brown electrode in the center creates a chest (precordial) lead.

3-Lead Wire System



The 3-lead wire system uses three electrodes that create three heart monitor leads called RA (right arm), LA (left arm), and LL (left leg).
This system is often used for patients who are moving around (ambulatory monitoring). It helps look for irregular heartbeats (ectopy) or episodes of fast (tachycardia) or slow (bradycardia) heart rhythms that may not show up in a short test.

Electrode Placement for a 3-Lead EKG

- RA (Red) electrode is placed below the right collarbone near the right shoulder, inside the rib cage area.
- LA (Yellow) electrode is placed below the left collarbone near the left shoulder, inside the rib cage area.
- LL (Green) electrode is placed on the left side of the chest, just below the chest muscles and along the lower edge of the left rib cage.

The 3-lead EKG is good for watching the heart's rhythm and detecting irregular heartbeats (arrhythmias). However, it is not the best choice for finding signs of heart damage caused by low blood flow (ischemia).

This is because the 3-lead EKG does not have chest leads (precordial leads) that give a full view of the heart's front wall. It only shows the heart's activity in two directions (side to side and up and down), which limits what you can see.

If you notice any changes in the ST segment (a part of the heart's electrical pattern), you should follow up with a 12-lead EKG to get a more complete view.

Chapter 13: Dysrhythmias

Sinus Dysrhythmias (Irregular Heart Rhythms from the Sinus Node)

Sinus Arrhythmia

- This is when the heart beats in an irregular pattern. The heart rate speeds up when you breathe in and slows down when you breathe out. The P waves (which show the start of a heartbeat) look normal and come before each QRS complex (which shows the heartbeat on an ECG).

Sinus Bradycardia

- This means the heart is beating slower than normal—usually under 60 beats per minute. Even though it's slow, the rhythm is steady, and the P, QRS, and T waves all look normal.

Sinus Tachycardia

- This means the heart is beating faster than normal—over 100 beats per minute. Like bradycardia, the rhythm is still regular and the waves on the ECG look normal.

Atrial Dysrhythmias (Irregular Rhythms Starting in the Atria)

Premature Atrial Contractions (PACs)

- These are extra early heartbeats that start in the atria. The P waves look different from normal ones but are still followed by QRS complexes.

Atrial Fibrillation (AFib)

- The heartbeat is very irregular and there are no clear P waves. Instead, the baseline may look wavy or flat. The rhythm is unpredictable and disorganized. This is known as a "F wave" or fibrillatory wave. This reflects chaotic atrial electrical activity.

Atrial Flutter

- This has a pattern that looks like a "sawtooth" on the ECG, seen best in leads II, III, and aVF. The atria beat regularly and very fast, but the ventricles may not follow in a regular pattern.

Supraventricular Tachycardia (SVT)

- A fast but regular rhythm that starts above the ventricles. The QRS complexes are narrow. The P waves may be hard to see or may show up before, after, or inside the QRS complexes.

Ventricular Dysrhythmias (Irregular Rhythms Starting in the Ventricles)

Premature Ventricular Contractions (PVCs)

- These are early beats that start in the ventricles. They look wide and strange on the ECG. Sometimes they are followed by a P wave, sometimes not.

Ventricular Tachycardia (VT)

- A fast heart rhythm—between 150 and 250 beats per minute—with wide, unusual-looking QRS complexes. P waves might not be seen or might not match with the QRS complexes.

Ventricular Fibrillation (VFib)

- The heart’s electrical signals are very disorganized. There are no clear P waves, QRS complexes, or T waves. The heart quivers instead of pumping blood.

Torsades de Pointes

- A special kind of VT that looks like the QRS complexes are twisting around the ECG baseline. It’s often linked to a long QT interval and can be dangerous.

Heart Blocks (Problems with Electrical Signals Between the Atria and Ventricles)

First-Degree AV Block

- The signal from the atria to the ventricles is slowed down, so the PR interval is longer than normal. However, every P wave is still followed by a QRS complex.

Second-Degree AV Block Type I (Wenckebach)

- The PR interval gets longer and longer until a beat (QRS complex) is skipped.

Second-Degree AV Block Type II

- The PR interval stays the same, but sometimes a QRS complex doesn't follow a P wave—so some beats are missed.

Third-Degree (Complete) Heart Block

- The atria and ventricles beat separately and don't work together. The P waves and QRS complexes both occur regularly but aren't connected.

Other Dysrhythmias

Asystole

- This is a flat line on the ECG—there's no electrical activity and no heartbeat.

Pulseless Electrical Activity (PEA)

- The ECG shows electrical activity, but the heart isn't pumping, so there's no pulse.

STEMI in ECG stands for ST-Elevation Myocardial Infarction — a serious type of heart attack.

- ST: Refers to the ST segment on the ECG tracing or the flat line between the QRS complex and the T wave.
- The ST segment is abnormally higher than baseline (usually ≥1 mm in limb leads or ≥2 mm in chest leads).

- Myocardial Infarction: Means heart muscle death due to complete blockage of a coronary artery
- A STEMI usually occurs when a blood clot completely blocks a coronary artery.
  preventing Blood and oxygen from reaching part of the heart muscle.
- Without treatment, that part of the muscle starts to die.

ECG signs

- ST-segment elevation in two or more contiguous leads (leads next to each other on ECG that view the same heart region).
- Possible reciprocal ST depression in opposite leads.
- Later, pathological Q waves may appear.

Symptoms in the patient:

- Severe chest pain or pressure (lasting >20 minutes)
- Sweating
- Shortness of breath
- Nausea or vomiting
- Pain radiating to arm, jaw, or back

A STEMI is a medical emergency — it means “time is muscle

The patient needs immediate reperfusion therapy, such as:

- Primary Percutaneous Coronary Intervention (PCI) (angioplasty with stent)
- Thrombolytics (“clot busters” - if PCI isn’t available quickly)

NSTEMI stands for Non–Non-ST-Elevation Myocardial Infarction — another type of heart attack, but without the classic ST elevation on an ECG.

- Myocardial Infarction: Still means actual heart muscle injury due to reduced or blocked blood flow, confirmed by elevated cardiac enzymes (like troponin).
- Usually caused by a ***partial*** blockage of a coronary artery (vs. complete blockage in STEMI).
- Reduced blood supply damages heart muscle but doesn't cause full-thickness injury immediately.
- ECG will show ST-segment depression in some leads
- T-wave inversion
- Sometimes the ECG can look almost normal — the diagnosis depends on symptoms + cardiac enzyme tests.

Symptoms are similar to STEMI:

- Chest pain or pressure (often less intense than STEMI, but can still be severe)
- Shortness of breath
- Sweating, nausea, lightheadedness

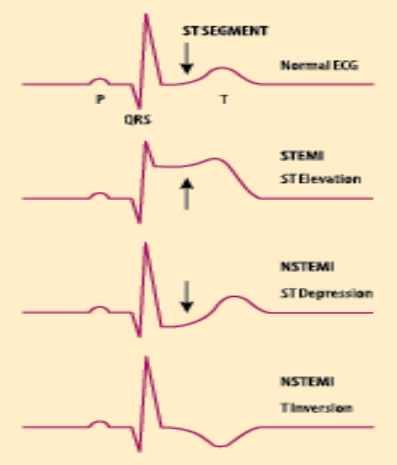
An NSTEMI is still a medical emergency — it can progress to a STEMI if untreated.

Treatment often involves:

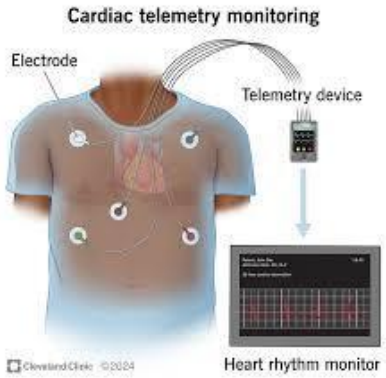
- Oxygen (if low saturation)
- Anti-clot medications (aspirin, heparin)
- Possible angioplasty/stenting
- Close hospital monitoring

Examples on ECG:

FIGURE B: EKG READINGS FOR STEMI AND NSTEMI



Chapter 14: Telemetry Systems



Telemetry is commonly used in hospitals to check a patient's heart rhythm over time, especially if the patient is walking around (ambulatory).

The patient wears a small device, usually clipped to a pocket, connected to 3 to 5 leads attached to their chest. This device sends heart rhythm data wirelessly to a monitor, allowing medical staff to check the heart's activity in real time from a distance.

Telemetry provides a beat-by-beat record of the heart's electrical activity. If the patient goes out of range, the device will store the information and send it when the patient is back in range.

Some will record arrhythmias such as atrial fibrillation, bradycardia or tachycardia. Some telemetry devices also let the patient press a button to record any symptoms or events they feel, like chest pain or dizziness.

Telemetry

Telemetry Technicians (Tele Techs) are responsible for continuously monitoring the cardiac rhythms of patients on the telemetry floor. They play a critical role in the early detection of potentially life-threatening cardiac events.

Key Responsibilities

1. Continuous ECG Monitoring:

- Detecting abnormal rhythms like bradycardia, tachycardia, atrial fibrillation, ventricular tachycardia/fibrillation, and heart blocks.

- Watching for ST segment changes that may indicate ischemia or infarction.

2. Alarm Response:

- Responding to alarms for sudden heart rate changes or loss of signal.

- Alerting nursing staff of critical arrhythmias like asystole or V-fib.

3. Documentation:

- Recording rhythm strips every shift or per hospital policy.

- Labeling and reporting abnormal rhythms.

4. Lead Placement Verification:

- Ensuring proper electrode placement.

- Identifying and reducing artifacts that may obscure readings.

5. Communication:

- Working closely with nurses and physicians to report changes.

6. Multi-Patient Monitoring:

- Monitoring 20-40 patients from a centralized station in real-time.

Role of a Telemetry Technician on a Hospital Telemetry Floor

- Telemetry Techs serve as the hospital's 'eyes on the monitor'-vigilantly observing and interpreting cardiac activity to ensure prompt intervention and patient safety.

Role Boundaries: Telemetry Technician vs RN vs Provider

Telemetry Technician

- Continuously monitor heart rhythms
- Recognize and report abnormal rhythms
- Print and label ECG strips
- Notify nursing staff of critical changes
- Ensure lead placement and signal quality
- Do not administer medications
- Do not make clinical diagnoses

Registered Nurse (RN)

- Interpret ECG rhythms alongside patient symptoms
- Administer prescribed medications for dysrhythmias
- Initiate emergency protocols (e.g., ACLS)
- Communicate findings to provider
- Document interventions and patient response
- Educate patients on cardiac care

Provider (MD, NP, PA)

- Diagnose type of arrhythmia
- Order labs, imaging, or additional cardiac testing
- Prescribe medications or interventions
- Determine treatment plans (e.g., cardioversion, pacing)
- Monitor effectiveness of treatments

Chapter 15: Machines that Read Electric Signals

Types and Examples of ECG Machines

Portable 6-/12-Lead Resting ECG

- Rayman Portable 6-Channel ECG Machine. Used in clinics for standard resting 12-lead ECG.

Wearable Holter Monitor

- LEPU Rechargeable 12-channel Holter device. Worn by patients for continuous rhythm monitoring over 24-48 hours.

3-Channel Portable / Stress Test ECG

- Portable 3-channel ECG used for stress or ambulatory testing. Lightweight and easy to carry.

Standard Holter Monitor

- Traditional Holter monitor with multiple electrodes, used for 24-hour or longer continuous recording.

Detailed Review of Key ECG Machine Settings

1. Filters: ECG filters are designed to minimize unwanted electrical noise and artifacts without distorting the heart's true signals:
    a. AC (Notch) Filter: Removes 50/60 Hz interference from nearby electrical devices or power lines.
    b. Muscle Tremor (High-frequency) Filter: Reduces noise caused by patient shivering or muscle movement.
    c. Baseline Wander (Low-frequency) Filter: Corrects slow shifts in the baseline caused by breathing or poor electrode contact.
2. Gain (Amplitude) Gain controls the vertical size of the ECG waveform:
    a. Standard calibration is 10 mm = 1 mV.

b. Increasing gain (e.g., 20 mm/mV) makes small waves easier to analyze.
c. Decreasing gain (e.g., 5mm/mV) prevents tall R waves from overlapping on the tracing.

3. Mode Selection: Most ECG machines have multiple recording modes:
   a. Automatic Mode: Records all 12 leads at once for a standard printout.
   b. Manual Mode: Operator controls which leads are recorded, useful for repeating specific leads.
   c. Rhythm Strip Mode: Provides a continuous recording from one or two leads (commonly Lead II or V1) for arrhythmia analysis.
4. Calibration: Calibration ensures that the ECG machine is accurately recording electrical activity:
   a. Standard calibration mark: 1 mV signal should produce a 10 mm tall square wave at the start of the tracing.
   b. If calibration is set incorrectly, all waveforms will appear larger or smaller than they truly are.
   c. Some machines allow adjustment between 0.5, 1, or 2 mV/cm.

ECG Machine Settings

1. Paper Speed: Default is 25 mm/sec. Determines how quickly the paper moves under the stylus/print head. Faster speeds (50 mm/sec) stretch out the tracing for detailed analysis. Slower speeds compress the tracing.
2. Gain (Amplitude)**:** Controls the height of the ECG waves. Standard is 10 mm = 1 mV. Adjusting gain can help when tracings are too small (increase) or too tall (decrease).
3. Filters: Modern ECGs have filters to reduce artifacts:
   • AC filter – reduces electrical interference,
   • Muscle filter, reduces tremor artifact,
   • Low-frequency filter – reduces baseline wander. Use cautiously to avoid altering true ECG signals.
4. Lead Selection: Allows viewing of different lead tracings individually or simultaneously. The operator can choose which leads to display or print.
5. Mode Selection: ECG machines may have modes such as:
   • Automatic 12-lead recording,

• Rhythm strip recording (continuous tracing from one lead, usually lead II or V1),
• Manual mode for operator-controlled recording.

6. Patient Data Entry: Settings allow entry of patient demographics such as name, age, sex, ID number, and sometimes clinical notes. This ensures the ECG record is correctly matched to the patient.
7. Print Format: User can select full-page 12-lead format, rhythm strips, or customized reports. Some machines allow multiple copies or electronic storage.
8. Calibration: Standard calibration is 1 mV = 10 mm. A calibration mark should be visible at the start of each tracing. Used to verify the accuracy of ECG measurements.
9. Power/Battery Check: Machine settings include battery monitoring and power status. Important to check before the patient uses.

EKG (electrocardiogram) - shows the electrical activity of the heart.

EMG (electromyogram) shows the electricity in muscles.

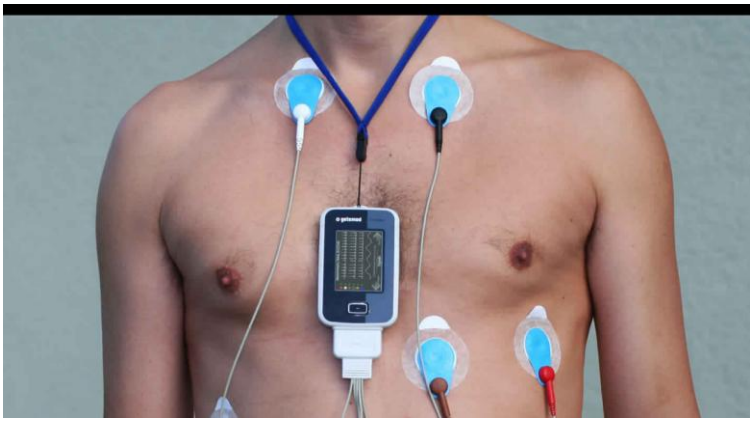
EEG (electroencephalogram) measures the electrical signals in brain

<u>EMG (electromyogram)</u> shows the electricity in muscles.

EEG (electroencephalogram) measures the electrical signals in brain

Isopropyl alcohol is the preferred method for cleaning machines.

Traditional Holter Monitor - with multiple electrodes connected to a small recorder worn on the waist or carried in a pouch.



It tracks heart rhythms over time to detect:

- Irregular heartbeats (arrhythmias)
- Unexplained dizziness or fainting

- Palpitations or fluttering
- Silent ischemia
- It can detect problems that a standard ECG might miss because a regular
- ECG only captures a few seconds of heart activity.

How It Works:

1. Electrodes (sticky patches) are placed on the chest (hypoallergenic electrodes reduce skin irritation)
2. Wires connect the electrodes to a small recording device worn on a strap or clipped to a belt.
3. The patient wears the monitor for the prescribed period and keeps a diary of symptoms and activities.
4. After the monitoring period, the device is returned to the provider, and the data is analyzed.

What It Detects:

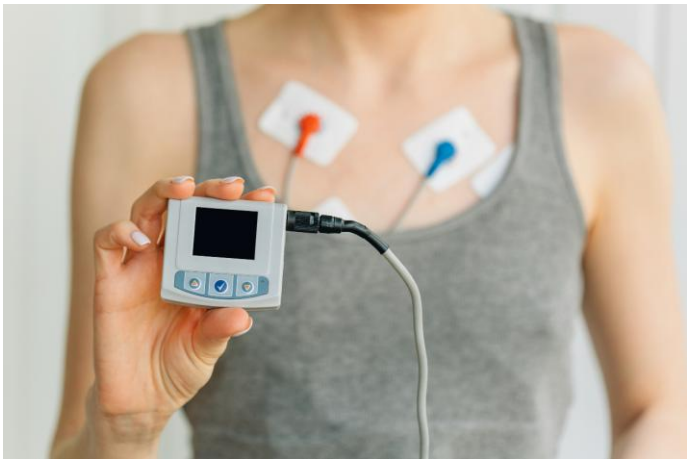
- Atrial fibrillation or flutter
- Premature beats (PACs, PVCs)
- Supraventricular tachycardia (SVT)
- Bradycardia
- Pauses or heart block
- Ischemic changes (less common)

Why It's Used

- You have symptoms like palpitations, lightheadedness, or syncope

- Your resting ECG is normal but symptoms persist
- You are starting or adjusting heart medications
- You've had a procedure like a pacemaker implant

Event Monitor - A typical Event Monitor (cardiac event recorder) that patients activate when symptoms occur.



An *event monitor* is a portable device that doctors use to record a patient's heart rhythms over an extended period—usually days to weeks—to detect intermittent arrhythmias that might not show up during a short ECG in the clinic.

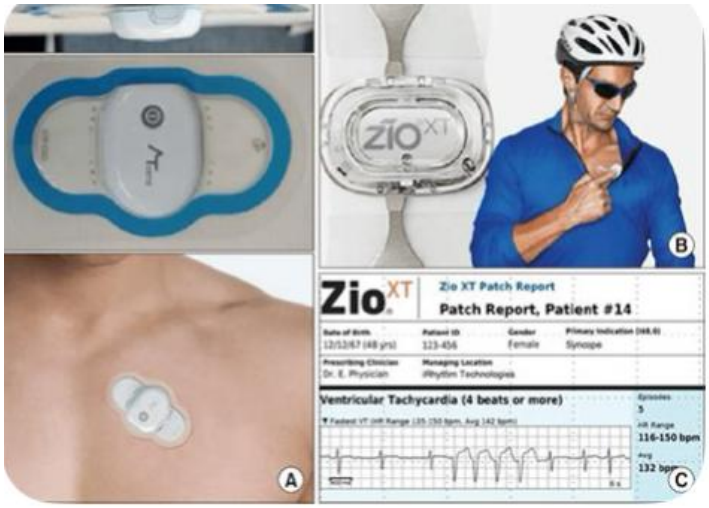
The MD orders an event monitor when symptoms like palpitations, dizziness, or fainting are suspected to be heart rhythm-related. A technician or nurse places the electrodes (similar to ECG leads) on the patient's chest, and the monitor is connected. The patient wears the monitor while going about daily activities.

Unlike a Holter monitor (continuous recording), an event monitor records only when triggered—either by the patient pressing a button when symptoms occur or automatically when an abnormal rhythm is detected.
The monitor then transmits recorded data wirelessly to a secure database or directly to the doctor's office for review.

The MD analyzes the captured heart rhythm strips to determine if arrhythmias (e.g., atrial fibrillation, PVCs, tachycardia) correlate with reported symptoms.

Findings are compared with baseline ECG studies to determine treatment, such as medications or further interventions.

Patch Monitor (e.g., Zio Patch), - a single-lead adhesive ECG that sticks to the chest for up to two weeks.



A doctor would recommend a patch monitor (e.g., Zio Patch) when they need to capture heart rhythm data over an extended period — usually 7 to 14 days — in a way that is comfortable, non-invasive, and easy for the patient to wear during everyday activities.

Situations When a Doctor Would Use a Patch Monitor:

Intermittent Palpitations or Irregular Heartbeats

> Why: Patient reports fluttering, pounding, or skipped beats that happen only a few times a week.
>
> Goal: Capture any supraventricular tachycardia (SVT), premature beats, or atrial fibrillation.
>
> Why patch is chosen: Longer wear time than Holter; better for detecting occasional events.

Suspected Paroxysmal Atrial Fibrillation (Afib)

Why: Afib that starts and stops on its own may not show up in a short Holter study.

Goal: Confirm diagnosis or assess frequency of Afib episodes.

Why patch is chosen: Discreet, continuous ECG monitoring without wires for up to 14 days.

Post-Ablation or Post-Stroke Surveillance

Why: Monitor for recurrence of Afib or other arrhythmias after procedures or events.

Goal: Catch rhythm abnormalities that could cause future stroke or symptoms.

Why the patch is chosen: Non-intrusive monitoring that fits daily routine during recovery.

(Ablation medical procedure to remove or destroy abnormal tissue in order to treat various conditions, including arrhythmias and cancer)

Patients Who Cannot Tolerate Traditional Monitors

Why: Holter and event monitors use wires and leads that may irritate skin or get in the way.

Goal: Provide comfort and compliance with longer monitoring periods.

Why patch is chosen: Stick-on design allows for normal activities and sleep.

Unclear Symptoms (e.g., Dizziness, Fatigue, Mild Chest Discomfort)

Why: Doctor suspects a rhythm issue but symptoms are vague or infrequent.

Goal: Rule in or out an electrical cause.

Why patch is chosen: Offers a longer window to capture abnormal rhythms.

How It’s Used:

- Doctor applies or prescribes the patch (usually Zio Patch or similar).
- Patient wears it continuously (including bathing and sleeping).
- After wear time ends, the patient mails it back or returns to the office.
- A detailed ECG report is generated for review.

Schematic of an Implantable Loop Recorder (ILR) placed under the skin near the heart for long-term use.

A doctor would use a schematic of an Implantable Loop Recorder (ILR) during specific situations where long-term, continuous heart rhythm monitoring is needed, particularly when episodes are rare or unpredictable and other devices (like Holter or Event Monitors) have not captured the issue.

Here are the clinical situations where an ILR is indicated

Unexplained Syncope (Fainting)

- Why: Patient has fainting spells, but ECGs, Holter, and other testing haven't identified a cause.
- Goal: Detect if the fainting is due to arrhythmias like bradycardia, asystole, or heart block.
- Schematic Use: Helps the patient and care team understand where and how the device is implanted.

Cryptogenic Stroke (Stroke of Unknown Cause)

Why: Stroke occurred, but no embolic source was found through standard tests.

Goal: Monitor for paroxysmal atrial fibrillation (Afib), which can be silent but cause clots.

Schematic Use: Assists neurologists and cardiologists in explaining the benefit of long-term monitoring for Afib.

Infrequent Palpitations or Arrhythmia Symptoms

Why: The patient reports chest fluttering or irregular beats that occur less than once a month.

Goal: Capture the rhythm during rare events that traditional monitors would miss.

Risk of Sudden Cardiac Events in High-Risk Patients

Why: Some patients have a family or personal history of life-threatening arrhythmias but no current symptoms.

Goal: Early detection of dangerous rhythms for preventive intervention.

Monitoring After Cardiac Ablation or Device Removal

Why: After a procedure (like Afib ablation), to watch for recurrence.

Goal: Ensure the treatment was effective or catch recurrence early.

Wearable Smart Devices (e.g., Apple Watch, KardiaMobile)

Use: On demand or intermittent.

How it works: Records single-lead ECGs; useful for patient-initiated symptom tracking.

Best for: Tech-savvy patients with known or suspected arrhythmias.

Intermittent Palpitations or Irregular Pulse

Why: A patient frequently notices irregular or fast heartbeats.

Use: The patient can capture a single-lead ECG on demand.

Goal: Identify patterns like Afib or PVCs between doctor visits.

Screening for Atrial Fibrillation

Why: Some smartwatches now alert users to possible Afib episodes.

Use: May help identify silent Afib in high-risk individuals (e.g., elderly or hypertensive patients).

Patient Education and Engagement

Why: Empowering patients to learn about their own heart health.

Use: Encourages tracking pulse, rhythm trends, and sharing data with healthcare providers.

Follow-up After Cardiac Procedures

Why: For low-risk monitoring between visits (e.g., after ablation or cardioversion).

Use: Allows the patient to record ECGs if symptoms reappear.

Not Ideal For:

- Continuous rhythm monitoring (use a patch or MCT instead)
- Diagnosing rare, dangerous arrhythmias
- Official documentation unless validated by a physician

ECG (electrocardiogram) - shows the electrical activity of the heart.

Settings on ECG machine

Setting	Normal / Default Value	When to Change	Why It's Changed
Paper Speed	25 mm/sec	Increase to 50 mm/sec for tachycardia; decrease to 12.5 mm/sec for very slow rhythms	Faster speed spreads out waves for easier measurement; slower speed fits long intervals on one strip
Gain (Amplitude)	10 mm/mV	Reduce to 5 mm/mV if waves are too tall; increase to 20 mm/mV if waves are too small	Keeps waveforms visible without clipping or shrinking too much
Lead Selection	Auto 12-lead	Manual mode for troubleshooting; rhythm strip for continuous monitoring	Allows focus on specific leads or continuous rhythm capture
Rhythm Strip Lead	Lead II (common)	Switch to V1 for suspected ventricular arrhythmias	Provides best visualization of P waves or ventricular activity

AC/Notch Filter	On (50 or 60 Hz based on country)	Turn off only if filtering distorts ST segment	Reduces power line interference
Low-Pass Filter	40–150 Hz	Use higher setting for pediatric patients	Removes muscle tremor noise
High-Pass Filter	0.05–0.5 Hz	Increase to remove baseline wander	Prevents slow drift in baseline from breathing or movement
Patient Data Entry	Name, ID, DOB, sex, age, height, weight	Always before recording	Ensures correct patient identification and accurate interpretation ranges
Pediatric/Adult Mode	Adult	Switch to Pediatric for patients under ~12 years	Adjusts normal ranges for age
Interpretation On/Off	On	Off if manual interpretation only	Allows or disables computer-generated preliminary report

Memory Recall	N/A	Use to review past ECGs	Compare with previous recordings
Transmission Mode	Off	On to send to EMR or remote physician	Allows telemedicine review

Chapter 16: Patient Consent

Patient Consent is the voluntary agreement of an informed individual to undergo a specific medical intervention or procedure, such as venipuncture.

Important Reasons for Obtaining Patient Consent

Respect for Autonomy

- Obtaining informed consent respects the principle of autonomy, acknowledging the patient's right to make decisions about their own body and healthcare.
- This empowers patients to actively participate in the decision-making process related to their treatment.

Informed Decision-Making

- Consent ensures that patients are adequately informed about the procedure, including its purpose, potential risks, benefits, and alternatives.
- This information allows patients to make informed decisions based on a clear understanding of what to expect during and after the venipuncture.

Enhanced Trust and Communication

- Seeking patient consent fosters trust between healthcare providers and patients.
- It promotes open communication, allowing patients to express any concerns, ask questions, and actively engage in their care.
- Trust is a fundamental element in the patient-provider relationship.

Legal and Ethical Requirements

- In many healthcare jurisdictions, obtaining patient consent is a legal and ethical requirement.
- Failure to obtain proper consent can result in legal consequences and damage the patient-provider relationship.
- Adhering to these standards reinforces the principles of medical ethics.

Protection Against Coercion and Pressure

- Patient consent ensures that the decision to undergo venipuncture is voluntary and free from coercion or undue pressure.
- It safeguards against situations where patients may feel compelled to agree to the procedure without fully understanding its implications.

Communication of Privacy and Dignity

- Consent reinforces the importance of respecting the patient's privacy and dignity during the venipuncture procedure.
- Patients have the right to know who will be performing the procedure and the steps that will be taken to maintain their comfort and confidentiality.

Patient-Centered Care

- Incorporating patient consent into the venipuncture process aligns with the principles of patient-centered care.
- It recognizes that patients are individuals with unique values, preferences, and priorities, and their active involvement in decision-making is crucial to achieving positive health outcomes.

Mitigation of Anxiety and Fear

- Venipuncture can be anxiety-inducing for some patients.
- Discussing the procedure and obtaining consent allows healthcare providers to address any fears or concerns the patient may have, contributing to a more positive and cooperative experience.

Documentation of Consent

- Obtaining written or verbal consent provides documentation that the patient agreed to the venipuncture procedure.
- This documentation serves as evidence that the healthcare provider adhered to ethical and legal standards, offering protection in case of any disputes.

Educational Opportunity

- The consent process serves as an educational opportunity for patients to learn more about their health and the importance of specific tests.
- It encourages a collaborative approach where patients and healthcare providers work together for optimal health outcomes.

Obtaining patient consent during venipuncture is vital for respecting autonomy, promoting informed decision-making, building trust, meeting legal and ethical obligations, and ensuring patient-centered care. It is an integral component of ethical medical practice that contributes to positive patient experiences and outcomes.

Explaining the Procedure to the Patient

Explaining the procedure before drawing blood is crucial for several reasons, all of which contribute to ensuring patient comfort, informed consent, and overall satisfaction with the healthcare experience

Patient Understanding and Informed Consent

- Explaining the procedure provides patients with information about what to expect during the blood draw, including the steps involved, any sensations they may experience, and the purpose of the procedure.
- This empowers patients to make informed decisions and allows them to ask questions or express concerns before the procedure begins.

Reducing Anxiety and Fear

- Many patients experience anxiety or fear when undergoing medical procedures, including blood draws. Providing a clear explanation of the procedure helps alleviate anxiety by demystifying the process and reassuring patients about what will happen. This can lead to increased patient comfort and cooperation during the blood draw.

Building Trust and Rapport

- Transparent communication builds trust between healthcare providers and patients. When patients feel that their healthcare provider is open and honest about the procedure, they are more likely to trust their provider's recommendations and feel confident in the care they receive. This helps strengthen the patient-provider relationship and improves overall patient satisfaction.

Enhancing Patient Cooperation and Compliance

- Patients who understand the rationale behind a medical procedure are more likely to cooperate and comply with the instructions provided by their healthcare provider. By explaining the procedure beforehand, healthcare providers can encourage patient cooperation and ensure that the blood draw is conducted smoothly and efficiently.

Empowering Patients

- Explaining the procedure empowers patients to take an active role in their healthcare. When patients understand why a blood draw is necessary and how it fits into their overall treatment plan, they are more likely to feel engaged and invested in their health. This can lead to better adherence to treatment recommendations and improved health outcomes.

Addressing Patient Concerns

- Patients may have specific concerns or fears related to the blood draw procedure, such as pain, discomfort, or the possibility of complications.
- By explaining the procedure in advance, healthcare providers can identify and address these concerns, providing reassurance and personalized support to each patient.

Respecting Patient Dignity and Autonomy

- Providing information about the procedure respects the patient's dignity and autonomy by involving them in the decision-making process and allowing them to participate actively in their care. This promotes a patient-centered approach to healthcare that prioritizes the individual needs and preferences of each patient.

Chapter 17: Legal and Ethical Obligations of Patient Identification

Healthcare providers have legal and ethical obligations to protect patients' safety and privacy. Proper identification is a fundamental aspect of meeting these obligations and maintaining the trust of patients.

Proper Patient Identification

Proper *patient identification* before drawing blood is paramount for patient safety, accurate test results, legal and ethical compliance, and the overall efficiency of healthcare delivery. It is a fundamental practice that aligns with the principles of patient-centered care and contributes to positive health outcomes. Health systems and providers should implement robust identification protocols and continuously emphasize the importance of accurate patient identification in clinical practice.

Patient-Centered Care

- Respecting the individuality of each patient is a core principle of patient-centered care. Proper identification acknowledges and honors the patient's identity, fostering a positive and respectful healthcare experience.

Prevention of Identity Theft and Fraud

- Verifying patient identity helps safeguard against identity theft and fraud within the healthcare system. This is especially crucial in an era where personal health information is valuable and subject to misuse.

Avoidance of Medication Errors

- Accurate patient identification is vital in preventing medication errors. Administering medications based on incorrect patient information can lead to adverse drug reactions and other serious consequences.

Efficient Workflow

- Ensures the efficiency of healthcare processes by minimizing errors and avoiding the need for corrective actions. Correct patient identification streamlines workflow, allowing healthcare providers to focus on delivering timely and effective care.

Confidence in Decision-Making

- Healthcare providers rely on accurate patient information to make informed decisions about diagnosis, treatment, and care plans.
- Proper identification contributes to the confidence and reliability of these decisions.

Enhanced Communication

- Accurate patient identification supports effective communication among healthcare team members. When everyone is certain about the patient's identity, there is less risk of misunderstandings or confusion in the coordination of care.

Reduction of Healthcare Costs

- Proper patient identification helps avoid costly errors, readmissions, or legal consequences associated with misidentification. This contributes to overall cost reduction in healthcare delivery.

Quality Improvement Initiatives

- Accurate patient identification is a foundational element for quality improvement initiatives in healthcare. It supports data accuracy, allowing healthcare organizations to analyze outcomes, identify areas for improvement, and implement evidence-based practices.

Chapter 18: Infection Control

Checklist for ECG Infection Control

■ Perform hand hygiene before & after patient contact

■ Wear PPE as needed (gloves, mask, gown)

■ Use disposable electrodes OR disinfect reusable ones

■ Clean ECG cables and the machine after each use

■ Prepare patient skin properly (shaving/cleaning)

■ Dispose of razors, gloves, and single-use items correctly

■ Clean and disinfect ECG room surfaces regularly

■ Follow isolation protocols for infectious patients

■ Document cleaning & infection control measures

■ Educate staff and patients on infection control importance

Chain of Infection

The Chain of Infection is a model used to understand how an infectious disease is transmitted from one host to another. This model helps identify different ways to break the chain and stop the spread of infections.

If an individual has recovered from and developed antibodies against a certain virus, it is called "*acquired immunity*" by Johns Hopkins, this type of immunity is a possible response to infection or disease. **[1]**

Most of us are born with an *innate immune* system. It's inherited and made from skin, mucous membranes, and other tissues, all to protect us against germs, parasites, and even cells.

Our acquired immune system gets assistance from our innate system and makes antibodies that protect the body from invaders.

The chain consists of six links:

1. Infectious Agent

- Definition: The pathogen that causes the disease. This can be a virus, bacterium, fungus, or parasite.
- Control Measures: Use of proper sterilization techniques, antibiotics, antivirals, antifungals, or anti-parasitic to eliminate or reduce the infectious agent.

2. Reservoir

- Definition: The natural habitat of the infectious agent where it lives, grows, and multiplies. Reservoirs can include humans, animals, insects, soils, or organic matter.
- Control Measures: Isolation of infected individuals, vector control (e.g., controlling mosquito populations to prevent malaria), and proper sanitation and hygiene to eliminate or control reservoirs.

3. Portal of Exit

- Definition: The path by which the infectious agent leaves the reservoir. This could be through bodily fluids, secretions, excretions, or skin lesions.
- Control Measures: Use of protective barriers (e.g., masks, gloves), covering wounds, and safe handling/disposal of waste and secretions.

4. Mode of Transmission

- Definition: How the infectious agent is spread from the reservoir to a new host. Modes of transmission can be direct (e.g., touching, biting, kissing) or indirect (e.g., airborne, vehicle-borne, vector-borne).
- Control Measures: Hand hygiene, use of personal protective equipment (PPE), proper food handling, air filtration systems, and vector control.

5. Portal of Entry

- Definition: The path through which the infectious agent enters a new host. This can be like the portal of exit and includes the respiratory tract, mucous membranes, skin, and gastrointestinal tract.
- Control Measures: Protective barriers (e.g., masks, condoms), skin wound care, and safe food and water practices.

6. Susceptible Host

- Definition: An individual who is at risk of infection due to a lack of immunity or reduced resistance. Factors that can affect susceptibility include age, health status, immune status, and genetic factors.
- Control Measures: Immunization, health promotion, proper nutrition, and treatment of underlying diseases to boost immunity and reduce susceptibility.

Breaking the Chain

Interventions aimed at breaking the Chain of Infection focus on one or more of these links.

By disrupting the chain at any point, the spread of infections can be stopped or prevented. This is crucial in healthcare settings, community health, and during outbreaks of infectious diseases.

Understanding and implementing control measures at each link of the chain is fundamental in infection prevention and control strategies.

According to the CDC, hospitals (and the vast continuum of healthcare settings) follow CDC recommendations for infection control. **[2]**

According to the National Library of Medicine, "Infection control refers to the policy and procedures implemented to control and minimize the dissemination of infections in hospitals and other healthcare settings with the main purpose of reducing infection rates." **[3]**

Chapter 19: Immunization Requirements for the Health Care Worker:

Immunization is a critical aspect of infection control, especially in healthcare settings where workers are at an increased risk of exposure to infectious diseases and can also potentially transmit these diseases to vulnerable patients.

As a result, healthcare workers (HCWs) are strongly recommended, and in some cases required, to receive certain vaccinations.

While specific immunization requirements can vary by region, employer, and job role, the following are commonly recommended or required immunizations for healthcare workers: [8]

1. 1. Influenza (Flu) Vaccine
    a. *Purpose*: To reduce the risk of flu transmission in healthcare settings
    b. *Frequency*: Annually, as the flu strains covered by the vaccine may change each year.
2. 2. Hepatitis B Vaccine
    a. *Purpose:* To prevent HBV infection, which can be transmitted through exposure to blood or body fluids.
    b. *Dose Schedule*: Usually a series of three doses.
3. 3. Measles, Mumps, and Rubella (MMR) Vaccine
    a. *Purpose*: To protect against measles, mumps, and rubella, highly contagious diseases that can have serious complications.
    b. *Dose Schedule*: Usually, two doses or proof of immunity is required.
4. 4. Varicella (Chickenpox) Vaccine
    a. *Purpose*: To prevent varicella infection, as HCWs can be exposed to or transmit this highly contagious virus.
    b. *Dose Schedule*: Two doses or proof of immunity for those who have not had chickenpox or previous vaccination.
5. 5. Tetanus, Diphtheria, and Pertussis (Tdap) Vaccine

a. *Purpose*: To protect against these three diseases, with a particular emphasis on pertussis (whooping cough), which can be severe or fatal for infants.
b. *Dose Schedule*: A single dose of Tdap, followed by a Td (tetanus and diphtheria) booster every 10 years.

6. 6. Meningococcal Vaccine
    a. *Purpose*: Recommended for microbiologists or other HCWs who are routinely exposed to isolates of Neisseria meningitidis.
    b. *Dose Schedule*: Depends on the type of meningococcal vaccine used.

Additional Vaccine Considerations

Tuberculosis Screening: Regular TB testing (e.g., skin test or blood test) is recommended for HCWs.

COVID-19 Vaccine: Given the recent pandemic, COVID-19 vaccination is strongly recommended or mandated in many healthcare settings.

Regulatory and Accreditation Requirements Local, Regulations: Immunization requirements can vary by country, state, or local regulations.

Institutional Policies: Individual healthcare institutions may have their own immunization policies, which can be more stringent than national or local guidelines.

Accreditation Bodies: Accrediting organizations for healthcare institutions, such as The Joint Commission, may have standards related to staff immunization.

Communicable Diseases: Communicable diseases, also known as infectious or transmissible diseases, are illnesses caused by pathogens such as bacteria, viruses, fungi, or parasites.

These diseases can be spread, directly or indirectly, from one person to another.

Understanding communicable diseases is crucial in implementing effective control and prevention measures.

Modes of Transmission

Direct Contact: Occurs through physical contact like touching, biting, kissing, or sexual intercourse. Diseases spread this way include HIV/AIDS, herpes, and hepatitis B.

Indirect Contact: Involves contact with a contaminated surface or object (fomite), like doorknobs, utensils, or bedding. Examples include the common cold and influenza.

Droplet Transmission: This involves large droplets that are expelled by coughing, sneezing, or talking and can transmit infections over short distances. Diseases spread this way include the flu, common cold, and COVID-19.

Airborne Transmission: This occurs through smaller droplets or particles that can remain suspended in the air for long periods and can be transmitted over longer distances.

Tuberculosis, chickenpox, and measles are examples of diseases spread this way.

Vector-Borne Transmission: Occurs through vectors such as mosquitoes, ticks, and fleas. Examples include malaria (mosquito-borne), Lyme disease (tick-borne), and plague (flea-borne).

Parenteral Transmission involves direct penetration of the skin through needles, cuts, or bites-route other than through digestion

Common Vehicle Transmission: Involves contaminated substances like food, water, medications, or devices. Diseases spread this way include foodborne illnesses like salmonella and cholera.

Transmission Prevention and Control

- Vaccination: One of the most effective methods to prevent communicable diseases. Vaccines stimulate the body's immune system to protect against specific infections.
- Hygiene and Sanitation: Regular handwashing, safe food handling practices, and proper waste disposal help prevent disease transmission.

- Infection Control Measures in Healthcare Settings: Use of personal protective equipment (PPE), sterilization of instruments, and isolation of infected individuals.
- Public Health Measures: Surveillance, reporting, and tracking of communicable diseases to implement timely interventions and prevent outbreaks.
- Education and Awareness: Informing the public about the modes of transmission and preventive measures for communicable diseases.

Diagnosis and Treatment

- Diagnosis: Involves identifying the causative agent through methods like laboratory tests, imaging, and clinical assessments.
- Treatment: Depends on the type of pathogen and can include antibiotics (for bacterial infections), antivirals (for viral infections), antifungals (for fungal infections), or antiparasitic (for parasitic infections).

Supportive care and symptom management are also important.

Common Communicable Diseases

- Respiratory Infections: Such as influenza, tuberculosis, and COVID-19.
- Gastrointestinal Infections: Like norovirus, salmonella, and E. coli infections.
- Sexually Transmitted Infections (STIs): Including HIV/AIDS, syphilis, and gonorrhea.
- Vector-borne Diseases: Such as malaria, dengue fever, and Lyme disease.
- Zoonotic Diseases: Illnesses that are transmitted from animals to humans, like rabies and bird flu.

Common Pathogens Associated with Antibiotic Resistance Encountered in Health Care Facilities [6]

Antibiotic resistance is a growing global health concern, particularly in healthcare facilities where resistant bacteria can lead to severe infections and limit treatment options. **[6]**

Certain pathogens are notorious for their ability to develop and spread antibiotic resistance. **[6]**

The *Centers for Disease Control and Prevention (CDC)* and the *World Health Organization (WHO)* have classified some of these as urgent or serious threats.

Common antibiotic-resistant pathogens encountered in healthcare settings

Methicillin-Resistant Staphylococcus aureus (MRSA) Resistance

- *Characteristics*: Resistant to methicillin and other beta-lactam antibiotics.
- *Infections Caused*: Skin infections, pneumonia, bloodstream infections, and surgical site infections.
- *Control Measures*: Hand hygiene, contact precautions, screening, and decolonization strategies in certain settings.

Vancomycin-resistant Enterococcus (VRE) Resistance

- *Characteristics*: Resistant to vancomycin and often to other standard treatments.
- *Infections Caused*: Urinary tract infections, bloodstream infections, and wound infections.
- *Control Measures*: Hand hygiene, contact precautions, and prudent use of antibiotics.

Carbapenem-Resistant Enterobacteriaceae (CRE) Resistance

- *Characteristics*: Resistant to carbapenems, a class of antibiotics often considered the last line of defense against resistant bacteria.
- *Infections Caused*: Urinary tract infections, bloodstream infections, ventilator-associated pneumonia.
- *Control Measures*: Hand hygiene, contact precautions, and rapid identification and isolation of infected patients.

Multidrug-Resistant Pseudomonas aeruginosa Resistance

- *Characteristics*: Resistant to multiple classes of antibiotics.
- *Infections Caused*: Pneumonia, bloodstream infections, and infections in burn patients.
- *Control Measures*: Hand hygiene, contact precautions, and proper cleaning of equipment and environment.

Extended-Spectrum Beta-Lactamase (ESBL)-Producing Enterobacteriaceae Resistance

- *Characteristics:* Produce enzymes (ESBLs) that confer resistance to many beta-lactam antibiotics, including penicillin and cephalosporins.
- *Infections Caused*: Urinary tract infections, bloodstream infections, and abdominal infections.
- *Control Measures*: Hand hygiene, contact precautions, and prudent antibiotic use.

Chloridoids difficile (C. difficile) Resistance

- *Characteristics*: Not typically resistant to antibiotics but causes severe, hard-to-treat infections, often due to antibiotic use.
- *Infections Caused*: Diarrhea, colitis.
- *Control Measures*: Hand hygiene (with soap and water, as alcohol-based hand rubs may not be effective against spores), contact precautions, environmental cleaning, and prudent use of antibiotics.

Disease and Pathogen Prevention and Control Strategies

1. *Antimicrobial Stewardship*: Promoting the appropriate use of antibiotics to avoid unnecessary prescriptions and selecting the most appropriate antibiotic, dose, and duration.
2. *Infection Control Practices*: Rigorous hygiene practices, use of personal protective equipment, and isolation of infected patients.
3. *Surveillance and Reporting*: Monitoring and reporting antibiotic-resistant infections to identify outbreaks quickly and implement control measures.
4. *Education*: Training healthcare workers and educating patients about the importance of infection prevention and antibiotic stewardship.

Addressing antibiotic resistance requires a multifaceted approach involving prudent antibiotic use, stringent infection control measures, ongoing surveillance, and continuous education for healthcare professionals and the public. **[6]**

Transmission Precautions **[4]**

Transmission precautions are infection control measures taken in healthcare settings to prevent the spread of infectious agents. **[4]**

These precautions are additional practices that go beyond standard precautions and are used when patients are known or suspected to be infected with pathogens that can be transmitted by airborne, droplet, or contact routes, (EG: precautions or immunocompromised patients.)

The 3 key types of transmission precautions: **[4]**

Contact Precautions

- *Purpose*: To prevent the spread of infectious agents that are transmitted by direct contact with the patient or by indirect contact with surfaces or objects in the patient's environment. Requires standard precautions and PPE
- *Examples of Pathogens*: Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococcus (VRE), and certain gastrointestinal infections like Clostridioides difficile (C-Diff), also includes Respiratory syncytial virus (RSV) and Covid-19.
- *Key Measures*: Wear gloves and a gown when entering the patient's room. Limited patient movement within the facility ensures that patient-care items, bedside equipment, and frequently touched surfaces are cleaned and disinfected regularly.

Droplet Precautions

- *Purpose*: To prevent the spread of pathogens that are transmitted by large respiratory droplets that can be generated by the patient during coughing, sneezing, or talking
- *Examples of Pathogens*: Influenza, adenovirus, and Neisseria meningitidis.
- *Key Measures*: Wear a mask when working within 6 feet of the patient. Patients' placement in a private room, if available.
- If a private room isn't available, keep the patient's bed at least 3 feet from other patients. Limit the patient's movement within the facility.

Airborne Precautions

- *Purpose*: To prevent the spread of infectious agents that remain suspended in the air.
- *Examples of Pathogens*: Mycobacterium tuberculosis, varicella (chickenpox) virus, and measles virus.
- *Key Measures*: Place the patient in an airborne infection isolation room (AIIR). These rooms have negative pressure relative to the surrounding areas and use high-efficiency particulate air (HEPA) filtration to prevent the spread of pathogens.

Healthcare providers should wear a respirator (e.g., N95 respirator) when entering the room.

Limit patient movement within the facility and ensure that the patient wears a mask when being transported outside the room.

Additional Considerations

Patient Education: Inform patients and their visitors about the precautions being taken, the reasons for those precautions, and how they can help prevent the spread of infection.

Hand Hygiene: Perform hand hygiene before and after all patient contact, contact with potentially infectious material, and before putting on and after removing PPE.

Environmental Cleaning and Disinfection: Ensure that environmental cleaning and disinfection procedures are followed consistently and correctly.

Use of Personal Protective Equipment (PPE): Ensure proper use and disposal of PPE to prevent contamination and the spread of infection.

Transmission precautions are essential in preventing the spread of infectious diseases, especially in healthcare settings. **[4]**

Adhering to these precautions protects not only the patients but also healthcare workers and visitors from potential infections.

Procedures in Isolation Areas

Procedures in isolation areas are designed to prevent the spread of infections when caring for patients with contagious diseases.

These areas are specially designated for healthcare facilities to isolate patients who are infected with or suspected of being infected with communicable diseases.

The procedures not only protect healthcare workers and other patients from acquiring these infections but also ensure the safe and effective management of isolated patients.

General procedures typically followed in isolation areas

Proper Identification and Signage

- *Purpose*: To identify isolation areas and communicate the necessary precautions to all who enter.
- *Procedure:* Place appropriate signage on the doors of the isolation rooms to indicate the type of precautions required (e.g., contact, droplet, airborne).

Use of Personal Protective Equipment (PPE)

- *Purpose*: To protect healthcare workers and visitors from infection.
- *Procedure*: Ensure that PPE is available and used appropriately according to the type of isolation. This may include gloves, gowns, masks, respirators, face shields, or goggles.

Hand Hygiene

- *Purpose*: To prevent the spread of pathogens via hands, which are a common vector.
- *Procedure:* Perform hand hygiene before entering and after leaving the isolation area, before and after removing PPE, and after any contact with the patient or their immediate environment.

Limiting Patient Movement and Transport

- *Purpose*: To minimize the risk of spreading the infection to other areas of the facility.
- *Procedure*: Keep the patient in the isolation area as much as possible. If transport is necessary, use appropriate barriers (e.g., masks for the patient) and inform receiving departments about the precautions needed.

Environmental Cleaning and Disinfection

- *Purpose*: To reduce the risk of environmental contamination.
- *Procedure*: Ensure regular and thorough cleaning and disinfection of the isolation area, especially frequently touched surfaces.

Follow specific protocols for the disposal of contaminated materials. Limit entry to essential personnel only.

Ensure that all who enter are aware of the necessary precautions and know how to use PPE correctly.

Proper Waste Disposal

- *Purpose*: To safely dispose of contaminated materials.
- *Procedure*: Follow protocols for the safe disposal of infectious waste, including sharps, PPE, and other materials used in patient care.

Equipment Management

- *Purpose*: To prevent equipment from becoming a source of transmission.
- *Procedure*: Dedicate medical equipment to the isolated patient, if possible.

If equipment must be shared, clean and disinfect it thoroughly before use on another patient.

Carry only necessary equipment into the isolation area for specific tests, carry extra tubes, and when you leave, dispose of everything you did not use that entered the isolation room.

Reverse Isolation

Reverse isolation, also known as protective isolation or neutropenic precautions, is a set of infection control practices used to protect patients who are highly susceptible to infections due to weakened immune systems.

Unlike *standard isolation*, where the goal is to prevent an infected patient from transmitting infections to others, reverse isolation aims to protect a vulnerable patient from external infections.

This is a common practice used in settings for patients with compromised immune systems, such as those undergoing chemotherapy, newborns, bone marrow transplants, or with certain immune deficiencies.

Reminders for the Patient:

Patients might need to wear PPE when leaving the room for tests or procedures to protect them from exposure to infectious agents.

Hand Hygiene

- Rigorous hand hygiene practices are essential. Healthcare workers, visitors, and even the patients themselves should frequently wash hands or use alcohol-based hand sanitizer.

Visitor Restrictions

- Limiting visitors to reduce the patient's exposure to potential infections. Visitors may be screened for symptoms of illness before entering the room.

Food and Item Safety:

- Dietary restrictions might be in place to avoid foods that are at a higher risk of carrying bacteria (e.g., raw fruits and vegetables, and unpasteurized products).

- Careful cleaning or avoidance of items that are difficult to clean or that commonly harbor bacteria (e.g., flowers or plants).

Staff Education and Monitoring:

- Staff should be well-trained in infection control practices specific to reverse isolation. Regular monitoring to ensure adherence to the protocols.

Chapter 20: Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) refers to protective clothing, helmets, gloves, face shields, goggles, facemasks, and/or respirators or other equipment to protect the wearer from exposure to infectious materials.

PPE acts as a barrier between infectious materials and the skin, mouth, nose, or eyes. Its use is a crucial part of infection control and safety protocols in various settings, especially healthcare.

Common types of PPE:

Gloves

- *Purpose*: To protect hands from contamination with infectious agents and chemicals.
- *Usage:* Gloves should be worn when there is potential for contact with blood, bodily fluids, mucous membranes, non-intact skin, or contaminated equipment.

Gowns or Aprons

- *Purpose*: To protect skin and clothing from contamination.
- *Usage:* Worn during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions.
- It should be the correct size, worn properly, and secured behind the neck and waist.

Masks and Respirators:

- *Purpose*: To protect the mouth and nose from splashes of blood or bodily fluids. They can also reduce the risk of spreading infections, particularly in surgical or other clinical settings or from inhalation of infectious aerosols (e viruses like tuberculosis or COVID-19)

    - Eg: 3 layers mask, Respirators (e.g., N95):
- *Usage:* Should be properly fitted and worn in situations where airborne precautions are necessary.

Goggles or Face Shields:

- *Purpose:* To protect the mucous membranes of the eyes from splashes of blood or bodily fluids.
- *Usage*: Worn during procedures and patient-care activities that are likely to generate splashes or sprays.

Head and Shoe Covers:

- *Purpose:* To protect hair and shoes from contamination, mainly used in operating rooms or in situations where a sterile environment is crucial.
- *Usage*: Worn when there is a possibility of contamination of the environment with pathogens or when entering a controlled environment.

Sequence of Donning

The Centers for Disease Control and Prevention (CDC) provide guidelines on the proper order to don PPE. [5] It's important to perform hand hygiene before putting on PPE.

Students should regularly undergo training and practice the correct way to don PPE to ensure you're protected effectively.

Remember, the correct order of donning PPE is crucial, but equally important is the sequence of doffing (removing) PPE to avoid contamination.

Proper disposal or disinfection of PPE is also essential to maintain safety standards.

Recommended Sequence of Donning:

1) *Gown:* Fully cover the torso from neck to knees, arms to end of wrists, and wrap around the back. Secure/Fasten at the neck and waist.

2) *Mask or Respirator*: Place over nose, mouth, and chin. Fit a flexible nose piece over the nose bridge. Secure on the head with ties or elastic.

Adjust to fit – for N95 respirators, perform a fit check according to the manufacturer's instructions.

- For tying the mask, *tie 1st above and behind the head and then at the neck*,
- For a mask that slips on, *fit over the nose and mouth with one hand while the other hand secures it safely over your head*

Goggles or Face Shield:

- Place over face and eyes. Adjust to fit.

3) *Gloves:* Extend to cover the wrist of the gown. Ensure there is no skin exposed between the glove and the gown.

- *No Gaps*: Ensure there are no gaps in the PPE where infectious material could enter.

Comfort and Correct Fit: Make sure the PPE is comfortable and fits correctly. Discomfort can lead to touching or adjusting the PPE, which can lead to contamination.

Sequence of Doffing (PPE Removal)

The sequence of removing (doffing) personal protective equipment (PPE) is equally as important as donning because improper technique can lead to contamination of the wearer or the environment.

The Centers for Disease Control and Prevention (CDC) provide guidelines on the proper order to remove PPE to minimize the risk of self-contamination. **[5]**

Sequence of Doffing (removal):

1)Gloves (often the most contaminated PPE)

- Grasp the outside of one glove at the wrist without touching your skin. Peel the glove away from your hand, pulling it inside out.
- Hold the glove you just removed in your gloved hand.

- Peel off the second glove by putting your fingers inside the glove at the top of your wrist and turning the second glove inside out while pulling it away from your hand, leaving the first glove inside the second.
- Dispose of the gloves safely. Do not touch your bare hands to the outside of the gloves.

2) *Goggles or Face Shield* - Handle with headband or earpieces.

- Tilt your head forward slightly, and lift the headband or earpieces up and away from your head.
- Avoid touching the front of the goggles or face shield.
- Clean and disinfect reusable eye protection according to the manufacturer's instructions before reuse.

3) *Gown*: You may need assistance from another healthcare worker to unfasten the gown ties if they are in the back.

- Peel the gown away from your neck and shoulder, turning the contaminated side inward and folding or rolling it into a bundle (only touching the inside of the gown).
- Dispose of the gown safely or place it in the designated receptacle for reprocessing if it's reusable.

4) *Mask or Respirator*: Tilt your head forward slightly.

- *For masks*: Untie or break the bottom ties, followed by the top ones, and remove by handling the ties only.
- *For respirators*: Remove the bottom strap by lifting it over your head, then remove the top strap, being careful not to touch the front of the respirator. Dispose of the mask or respirator safely.

5) *Hand Hygiene*

- *Purpose*: To ensure that any contaminants that may have been transferred to your hands are removed.
- *How to Perform*: After removing PPE, immediately wash your hands with soap and water for at least 20 seconds or use an alcohol-based hand sanitizer.
- Hand washing must be effective in preventing contamination.

- Proper procedure, according to the CDC, includes standing back from the sink, lathering 15–20 seconds, and drying hands thoroughly with a clean disposable towel.
- Once hands are thoroughly dried, use a clean, dry, disposable towel to turn the faucet off.

Important Tips Be Methodical: Remove PPE slowly and deliberately in the correct sequence to prevent self-contamination.

Dispose Properly: Dispose of or disinfect PPE appropriately after removal.

Avoid Touching Face: Throughout the process, be careful not to touch your face or adjust other PPE as this can lead to contamination.

Remember, the correct removal of PPE is a critical step in preventing the spread of contamination and ensuring the safety of healthcare workers and others in the environment.

Chapter 21: Agency Regulations

Center for Disease Control (CDC)

The CDC provides clinical and public health professionals with both technical assistance and training, helping professionals achieve the highest quality of healthcare.

The CDC, in partnership with CMS and FDA, supports, oversees, and manages the *Clinical Laboratory Improvement Advisory Committee* which assesses, diagnoses, and helps prevent disease.

The CDC and the *Hospital Infection Control Practices Advisory Committee* (HICPAC) make continued updates to the Guidelines. **[2]**

Summaries of recommendations include:

- Administrative Responsibilities
- Education & Training
- Surveillance
- Hand Hygiene
- PPE
- Respiratory Hygiene/cough etiquette
- Patient Placement
- Care of the Environment

Safety Protocols in Clinical and Laboratory Settings

Safety protocols are essential in clinical and laboratory settings to protect staff, patients, and visitors from potential hazards. These protocols encompass a broad range of practices, from handling biological specimens and hazardous chemicals to ensuring overall workplace safety.

Critical safety protocols in clinic and lab settings

Biological Safety Infection Control: Implementing standard precautions to prevent the spread of infections, including the use of personal protective equipment (PPE), hand hygiene practices, and safe injection practices.

Biosafety Levels: Adhering to the four biosafety levels (BSL-1 to BSL-4) depending on the infectious agents being handled. Each level has specific containment practices and laboratory facilities.

Specimen Handling: Ensuring proper collection, labeling, transportation, and disposal of biological specimens to minimize the risk of exposure and contamination.

Chemical Safety Chemical Hygiene Plan: Developing and implementing a plan to minimize exposure to hazardous chemicals. This includes proper labeling, storage, and handling procedures.

Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS): Providing access to MSDS/SDS for all chemicals, detailing the hazards, handling, storage, and disposal procedures.

An MSDS is not required for isopropyl alcohol.

However, all hazardous products and/or hazardous chemicals must be accompanied by an MSDS that lists chemical properties and toxicology, precautions, data, storage, and more.

Personal Protective Equipment (PPE): Ensuring the availability and proper use of PPE, such as gloves, goggles, and lab coats, when handling chemicals.

Physical Safety

Ergonomics: Designing workstations and procedures to minimize strain and prevent musculoskeletal disorders, especially for staff who work with microscopes or perform repetitive tasks.

Emergency Preparedness: Having clear procedures for dealing with emergencies, including spills, fires, and exposure incidents.

This includes proper first aid measures and readily available emergency equipment like eyewash stations and safety showers.

Equipment Maintenance: Regularly inspecting, maintaining, and calibrating laboratory equipment to ensure it is safe and functional.

Radiation Safety Controlled Areas: Designating areas for the use of radioactive materials and restricting access to authorized personnel only.

Radiation Monitoring: Monitoring levels of radiation exposure using dosimeters and ensuring they do not exceed regulatory limits.

Training and Protocols: Providing specialized training for handling radioactive materials and establishing protocols for storage, use, and disposal.

Waste Management

Segregation and Labeling: Properly segregating (e.g., biohazardous, chemical, radioactive) and labeling waste to ensure it is handled and disposed of correctly.

Disposal Procedures: Following established procedures for the safe disposal of all types of hazardous waste, including sharps, biological waste, chemical waste, and radioactive waste.

Training and Compliance Regular Training: Conduct regular safety training sessions for all staff members to ensure they are aware of potential hazards and know how to work safely.

Compliance with Regulations: Adhering to local, state, and federal regulations, as well as guidelines from bodies like OSHA, CDC, and CLIA, to ensure a safe working environment.

OSHA

The Occupational Safety and Health Administration (OSHA) is an agency of the United States Department of Labor. OSHA's mission is to ensure safe and

healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance.

Key aspects of OSHA guidelines

1. Hazard Communication
    a. *Purpose:* To ensure that the hazards of all chemicals produced or imported are classified, and that information concerning the classified hazards is transmitted to employers and employees.
    b. In healthcare, it is each individual's right to know the chemicals to which they might be exposed. OSHA regulates, promotes, and enforces the right-to-know law, and individuals can call or write to report, file a complaint, or ask questions.
    c. *Requirements*: Labeling of hazardous chemicals, provision of *Safety Data Sheets* (SDS), and proper training for workers.
2. Bloodborne Pathogens Standard
    a. *Purpose*: To protect workers from the health hazards caused by bloodborne pathogens.
    b. *Requirements:* Establishing an Exposure Control Plan, implementing the use of standard precautions, using personal protective equipment (PPE), offering Hepatitis B vaccinations, providing post-exposure evaluation and follow-up, and training employees.
3. Personal Protective Equipment (PPE)
    a. *Purpose*: To protect workers from various hazards in the workplace such as chemicals, physical, electrical, heat, and biohazards.
    b. *Requirements:* Conducting a hazard assessment, providing appropriate PPE for employees, and training employees on the use and care of PPE.
4. Respiratory Protection
    a. *Purpose:* To protect workers from insufficient oxygen environments or harmful dust, fogs, smoke, mists, gases, vapors, and sprays.
    b. *Requirements*: Providing appropriate respirators when necessary, ensuring proper fit-testing and training, and establishing a respiratory protection program.
5. Recordkeeping and Reporting

a. *Purpose:* To require employers to record and report work-related fatalities, injuries, and illnesses.
b. *Requirements*: Keeping a log of work-related injuries and illnesses (OSHA Form 300), posting an annual summary (OSHA Form 300A), and reporting any work-related fatalities, inpatient hospitalizations, amputations, or losses of an eye.

6. Exit Routes and Emergency Planning
    a. *Purpose:* To ensure that all workplaces have enough exit routes and proper emergency action plans.
    b. *Requirements*: Developing and implementing an emergency action plan, maintaining clear and unobstructed exit routes, and providing appropriate fire prevention plans.
7. Ergonomics
    a. *Purpose*: To prevent musculoskeletal disorders in workers caused by repetitive motions or overexertion.
    b. *Requirements*: Identifying risk factors, providing training, and implementing appropriate measures to reduce ergonomic hazards.
8. Lockout/Tagout Procedures
    a. *Purpose*: To ensure that machines are properly shut off and not able to be started up again before the completion of maintenance or servicing work.
    b. *Requirements*: Develop a lockout/tagout program including energy control procedures, employee training, and periodic inspections.

Compliance and Enforcement

OSHA ensures compliance primarily through workplace inspections and investigations. Compliance with OSHA standards can prevent fines and reduce workplace injuries and illnesses.

Standard Precautions

Standard Precautions are a set of infection control practices used to prevent the transmission of diseases that can be acquired by contact with blood, body fluids, non-intact skin (including rashes), and mucous membranes.

These measures are the basic level of infection control that should be used in the care of all patients all the time.

Standard Precautions are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection.

Key components of Standard Precautions:

Hand Hygiene

- *Description:* Washing hands with soap and water or using an alcohol-based hand sanitizer.
- *When to Use*: Before and after touching a patient, after contact with bodily fluids or contaminated surfaces, before performing an aseptic task, and after removing gloves.

Use of Personal Protective Equipment (PPE)

- *Description:* Wearing gloves, gowns, masks, and eye protection to protect skin and mucous membranes from exposure to pathogens.
- *When to Use*: When there's a potential for contact with blood, body fluids, secretions, excretions, non-intact skin, and mucous membranes.

Respiratory Hygiene/Cough Etiquette

- *Description*: Covering mouth and nose with a tissue when coughing or sneezing, disposing of tissues in a waste receptacle, and performing hand hygiene after contact with respiratory secretions.
- *When to Use*: For all individuals with signs of illness or those caring for them.

Safe Injection Practices

- *Description*: Using an aseptic technique for the preparation and administration of parenteral medications.
- *When to Use*: During the preparation and administration of injected medications.

Safe Handling of Potentially Contaminated Equipment or Surfaces

- *Description*: Proper cleaning and disinfection of patient care equipment and environmental surfaces.
- *When to Use*: After equipment and surfaces are visibly soiled or used in the care of a patient.

Patient Placement

- *Description:* Placing a patient in a private room if they are at risk of spreading pathogens to others or if they are at increased risk of infection.
- *When to Use*: For patients who are known or suspected to have an infection that can be transmitted in healthcare settings.

Linen Handling

- *Description*: Handling, transporting, and processing used linen in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of microorganisms to other patients and environments.
- *When to Use*: When dealing with linens contaminated with bodily fluids or when moving linens from patient rooms.

Importance of Standard Precautions:

Standard Precautions are based on the principle that all blood, body fluids, secretions, excretions (except sweat), non-intact skin, and mucous membranes may contain transmissible infectious agents.

They are applied to all patients receiving care in hospitals, regardless of their diagnosis or presumed infection status.

Adherence to Standard Precautions is crucial in preventing healthcare-associated infections (HAIs), protecting patients as well as healthcare workers from potential infections, and creating a safe healthcare environment.

The Joint Commission

The Joint Commission is a United States-based nonprofit organization that accredits and certifies more than 22,000 healthcare organizations and programs.

It is recognized nationwide as a symbol of quality that reflects an organization's commitment to meeting certain performance standards. The commission's goal is to *improve healthcare for the public*, in collaboration with other stakeholders, by *evaluating healthcare organizations* and inspiring them *to excel in providing safe and effective care* of the highest quality and value.

Key Functions of The Joint Commission

Accreditation and Certification: The Joint Commission accredits and certifies healthcare organizations and programs across a range of settings, including hospitals, doctor's offices, nursing homes, office-based surgery centers, behavioral health treatment facilities, and providers of home care services.

Accreditation and certification by The Joint Commission are recognized as symbols of quality that reflect an organization's commitment to meeting certain performance standards.

- Setting Standards: The Joint Commission develops its standards in consultation with healthcare experts, providers, measurement experts, and patients. The standards focus on improving the quality and safety of patient care.
    - They are updated regularly to reflect changes in healthcare and in response to emerging safety issues.
- On-site Surveys: The Joint Commission conducts regular on-site surveys to assess compliance with its standards. These surveys are unannounced and are conducted by a team of healthcare professionals, including doctors, nurses, hospital administrators, and others.
    - The surveyors assess the organization's performance in areas that affect patient care and safety.
- Quality Improvement: The Joint Commission provides support to healthcare organizations in their quality improvement efforts.
    - It offers educational programs and publications to help staff at all levels understand the requirements and implement changes.

    - It also shares best practices and lessons learned from other organizations, facilitating a collaborative approach to quality improvement.
- Reporting and Data Collection: The Joint Commission collects and analyzes data from accredited organizations to identify trends and areas for improvement.
    - It provides organizations with data about their performance compared to similar organizations.
- Public Information: The commission provides information to the public about how accredited organizations perform.
    - This information can help consumers make informed choices about where to receive healthcare.
    - It also uses this data to influence the standards and education it provides to healthcare organizations.

Importance of The Joint Commission

Quality Assurance: Accreditation and certification by The Joint Commission serve as an external seal of approval for quality and safety.

Risk Reduction: The standards and evaluation process help healthcare organizations identify and mitigate risks, enhancing patient safety.

Market Differentiation: Accreditation is a powerful marketing tool, demonstrating an organization's commitment to quality to patients, insurers, and the community.

Continuous Improvement: The Joint Commission's resources support continuous improvement, helping organizations to stay up to date with best practices in patient care.

The National Patient Safety Goals

The National Patient Safety Goals (NPSGs) are a critical set of guidelines developed by The Joint Commission to help accredited organizations address specific areas of concern in regards to patient safety.

The NPSGs are revised annually based on input from practitioners, literature reviews, and advisories from an advisory panel composed of nurses, physicians, pharmacologists, risk managers, and other experts who have hands-on experience in their respective fields.

Purpose of the National Patient Safety Goals

- The main aim of the NPSGs is to promote specific improvements in patient safety by highlighting problematic areas in healthcare and describing evidence-based solutions to these problems.
- These goals focus on system-wide solutions, wherever possible, for issues including the identification of patients at risk for suicide, the prevention of infection, and the improvement of staff communication.

Key Areas Addressed by the NPSG

- *Improve the accuracy of patient identification*: Use at least two patient identifiers (not including the patient's room number) to ensure that each patient gets the correct medicine and treatment.
- *Improve staff communication*: Ensuring that test results and other critical patient information are conveyed timely and clearly among healthcare providers.
- *Prevent infection*: Following guidelines for hand hygiene and other infection control practices from the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO). **[2]**
- *Prevent medication errors*: Label all medications, medication containers, and other solutions on and off the sterile field in perioperative and other procedural settings.
- *Prevent patient harm resulting from falls*: Implementing strategies to reduce the risk of falls for patients.
- *Prevent bed sores (pressure ulcers):* Assessing patients' skin condition upon their admission and periodically during their stay, and adopting preventive measures, especially for high-*risk patients.*
- *Prevent healthcare-associated infections (HAIs):* Following evidence-based practices to prevent infections that are difficult to treat, such as methicillin-resistant Staphylococcus aureus (MRSA), and central line-associated bloodstream infections.

- *Prevent surgical mistakes*: Ensuring correct site, correct procedure, and correct patient surgery.

Implementation of the NPSGs

Healthcare organizations are expected to integrate these goals into their processes and ensure that their staff is educated and trained to follow them.

The Joint Commission assesses compliance with these goals during their accreditation surveys and continuous compliance monitoring.

Chapter 22: Laws and Regulations

Malpractice

Malpractice, particularly in the medical field, refers to professional negligence by a healthcare provider or practitioner. It occurs when a healthcare professional fails to provide the standard of care expected in their field, leading to patient harm, injury, or death. Understanding malpractice is crucial for both healthcare professionals and patients, as it concerns the legal and ethical dimensions of healthcare.

Types of Medical Malpractice:

Medical malpractice can take various forms, including but not limited to:

- *Misdiagnosis or Delayed Diagnosis*: Failing to diagnose a condition correctly or promptly, potentially leading to incorrect or delayed treatment.
- *Treatment Errors*: Administering the wrong treatment, medication errors, or performing a procedure incorrectly.
- *Surgical Errors*: Mistakes during surgery, such as operating on the wrong site or leaving surgical instruments inside the patient's body.
- *Birth Injuries*: Negligence during childbirth, leading to injury to the baby or mother.
- *Failure to Inform or Obtain Consent*: Not providing sufficient information about the risks and alternatives related to a treatment or failing to obtain informed consent from the patient.

Elements of a Malpractice Claim

To establish a case of medical malpractice, certain elements must be proven.

- *Duty of Care*: A professional relationship exists between the healthcare provider and the patient, establishing a duty of care.
- *Breach of Duty*: The healthcare provider failed to meet the standard of care that a reasonably competent professional would have provided under similar circumstances.
- *Causation*: There is a direct causal link between the provider's negligence and the patient's harm.

- *Damages*: The patient suffered quantifiable harm because of the breach, such as physical injury, additional medical bills, or loss of income.

Preventing Malpractice

Healthcare providers can take several steps to mitigate the risk of malpractice:

- Adhering to Standard Protocols: Following established medical protocols and guidelines diligently.
- Communication: Ensuring clear and open communication with patients about their diagnoses, treatment options, and associated risks.
- Documentation: Keeping thorough and accurate medical records for every patient.
- Continuing Education: Staying updated with the latest medical practices, technologies, and legal requirements.
- Risk Management: Implementing effective risk management strategies in healthcare settings.

Legal Aspects

Victims of medical malpractice may seek legal recourse to obtain compensation for their injuries and losses. This typically involves filing a lawsuit against the healthcare provider or institution. The legal process can be complex and may require expert testimony to establish the standard of care and how it was breached.

Risk Management

This is a systematic process of identifying, assessing, and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents, and natural disasters. A robust risk management strategy is vital for businesses, healthcare organizations, government agencies, and many other entities, as it helps them prepare for the unexpected by minimizing risks and extra costs before they occur.

Key Components of Risk Management

Risk management typically involves the following key components.

- Risk Identification: Recognizing potential risks that could negatively affect an organization's ability to conduct business. This includes risks associated with market changes, legal liabilities, management errors, financial processes, and accidents, among others.
- Risk Analysis: Understanding the nature of the risk and its potential to affect project goals and objectives. This includes aligning the type of risk with the potential impact and determining the likelihood of its occurrence.
- Risk Assessment and Evaluation: Comparing estimated risks against risk criteria that the organization has already established. Risks are prioritized in this step based on their potential impact on business objectives.
- Risk Mitigation Strategies: Developing strategies to manage and mitigate risks. This could involve.
- Risk Avoidance: Changing plans to avoid the risk.
- Risk Reduction: Taking actions to reduce the likelihood or impact of the risk.
- Risk Sharing: Sharing the risk with partners or stakeholders.
- Risk Retention: Accepting the risk and budgeting for it.

Implementation of the Risk Management Plan

Applying the risk management procedures and allocating resources and responsibilities.

- Monitoring and Review of the Plan: Continuously monitoring and reviewing the plan to ensure its effectiveness, making improvements as required.
- Communication and Consultation: Regularly communicating and consulting with stakeholders and team members about risks, their status, and the actions taken to mitigate them.
- Importance of Risk Management: Risk management is important because it.
- Protects Resources: Helps safeguard an organization's physical, human, and financial assets.
- Improves Decision Making: Provides a structured framework for identifying and understanding risks, which can lead to better decision-making regarding all areas of the business.
- Compliance: Ensures the organization complies with legal requirements and industry regulations.

- Stakeholder Confidence: Increases stakeholders' confidence in the organization's ability to manage risks.
- Business Continuity: Ensures the continuity of operations and reduces the likelihood and impact of negative events on business operations.

Challenges in Risk Management

Despite its importance, risk management faces several challenges, such as:

- Complexity of Risks: The modern business environment is dynamic and complex, making risk identification and assessment increasingly challenging.
- Resource Allocation: Determining the right number of resources to allocate can be difficult, especially for less quantifiable risks.
- Changing Nature of Risk: As the business environment evolves, new types of risks emerge, requiring continuous monitoring and adaptation of risk management strategies.
- Integration into Organizational Culture: Embedding risk management into the daily activities of an organization can be challenging, but it is essential for its effectiveness.

Health Insurance Portability and Accountability Act (HIPAA)

The Health Insurance Portability and Accountability Act (HIPAA) is a significant regulatory standard in the United States that was enacted in 1996. It sets the standard for the protection of sensitive patient data.

Organizations that deal with protected health information (PHI) must ensure that all the required physical, network, and process security measures are in place and followed.

HIPAA is composed of several key components and rules that outline the requirements for the protection and confidential handling of medical information.

Key Components of HIPAA

- Title I: Insurance Reform: Protects health insurance coverage for workers and their families when they change or lose their jobs. Prohibits group health

plans from denying coverage to individuals with specific diseases and pre-existing conditions, and from setting lifetime coverage limits.

- Title II: Administrative Simplification: Requires the establishment of national standards for electronic healthcare transactions. Mandates the implementation of national identifiers for providers, health insurance plans, and employers. Significantly, it also addresses the security and privacy of health data through the following rules.
- Privacy Rule: Establishes national standards for the protection of individually identifiable health information. It requires appropriate safeguards to protect the privacy of personal health information and sets limits and conditions on the uses and disclosures that may be made of such information without patient authorization.
- Security Rule: Specifies a series of administrative, physical, and technical safeguards for covered entities to use to assure the confidentiality, integrity, and availability of electronic protected health information (e-PHI).
- Breach Notification Rule: Requires covered entities to notify affected individuals, the U.S. Department of Health & Human Services (HHS), and in some cases, the media of a breach of unsecured PHI.
- Enforcement Rule: Contains provisions relating to compliance and investigations, the imposition of civil money penalties for violations of the HIPAA Administrative Simplification Rules, and procedures for hearings.

Importance of HIPAA

Protects Patient Privacy: Ensures that individuals' health information is properly protected while allowing the flow of health information needed to provide high-quality health care.

Security of Health Information: Sets standards for the security of electronic protected health information.

Improves Efficiency in Healthcare: Encourages the use of electronic data interchange in the U.S. healthcare system.

Trust: Builds patient trust by holding the healthcare providers accountable for the confidentiality and security of health information.

Compliance and Penalties Compliance: Covered entities, which include health plans, health care clearinghouses, and health care providers, must comply with the requirements to protect the privacy and security of health information.

Penalties Of Violating HIPAA

Entities that do not comply with HIPAA can face substantial fines. The penalty structure is tiered, based on the nature of the violation and the harm caused, and can extend up to substantial amounts per violation.

HIPAA compliance is a crucial aspect of the healthcare industry, ensuring the confidentiality, integrity, and availability of patient health information.

Regular training and updates on HIPAA regulations are essential for healthcare providers and their business associates to remain compliant and avoid penalties.

Organizations that deal with protected health information (PHI) must ensure that all the required physical, network, and process security measures are in place and followed.

Chapter 23: Blood-Borne Pathogens (BBP)

Blood-borne pathogens (BBPs) - microorganisms such as viruses or bacteria that are carried in the blood and can cause disease in people.

These pathogens can be transmitted through contact with infected blood and other potentially infectious materials, such as certain body fluids.

The most common and dangerous examples of BBP include *the Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV).*

Understanding BBPs and how they are transmitted is crucial for implementing effective preventive and control measures, especially in healthcare settings.

Modes of Transmission for BBPs

- *Percutaneous Exposure*: Through a needlestick or cut from a sharp object contaminated with infected blood.
- *Mucocutaneous Exposure*: Through contact with mucous membranes (such as the eyes, nose, or mouth) or non-intact skin (such as chapped, abraded, or afflicted with dermatitis) with infected blood.
- *Sexual Contact*: Through sexual practices that involve exposure to blood or other potentially infectious body fluids.
- *Mother-to-Child Transmission*: A pregnant woman can transmit the virus to her baby during childbirth.

Needlestick Safety and Prevention Act

OSHA requires employers to *maintain a sharps injury log to record injuries* from contaminated sharps.

The log must maintain the confidentiality of the injured employee and include details about the incident.

Employers must also provide:

- *Needle safety devices*
- *Sharps disposal systems*
- *Properly label waste containers*
- *Mandatory standard practice precautions*
- *Do not allow food, drinks, or smoking at workstations*
- *Do not allow the application of makeup at workstations*
- *Provide fitting PPE for all employees*
- *Laundry facilities*
- *Free Hep b vaccines*
- *Medical attention for BBP exposure*
- *And documentation of any incidents regarding finger sticks*

Things to remember

1) Report all needle sticks
    - Within 24 hours, antibody titers are measured and PEP (postexposure prophylaxis) should be given and to prevent infection
2) Chemical Hazards
    - Always observe labels and follow instructions when using chemicals in the lab
    - Should you be exposed to needle stick or chemicals, keep exposed area under running water for at least 15-20 mins, and seek medical attention.
3) Biological Waste
    - Bins with biological hazard signs, should always to available for items contaminated with bodily or blood fluids. These are usually color-coded yellow or red.
    - This includes items such as bandages, used gauze, alcohol pads, and PPE. Urine can be disposed of in the sink at the lab.
    - Blood spills must be cleaned with an absorbent material, then disinfected with sodium hypochlorite (1 part with 10 parts water).

Other types of biological waste

- *Sharps* – needles, blades, and broken glass

- *Pathological or Anatomical* items from the human body
- *Infectious items* such as bandages, dressings, and used PPE
- *Recyclable items* – items autoclaved (cleaned with steam under pressure to kill germs), including bottles, catheters, and syringes w/o needles
- *Chemical* – Formaldehyde, or infected secretions
- *Pharmaceutical* – expired or discarded medications

Appendix

Common ECG Terms

Waveform & Interval Terms

- P Wave - Atrial depolarization
- PR Interval – Time from atrial depolarization to ventricular depolarization
- QRS Complex - Ventricular depolarization
- ST Segment - Plateau phase; ischemia/infarction marker
- T Wave - Ventricular repolarization
- U Wave - Often due to hypokalemia
- QT Interval - Ventricular depolarization + repolarization
- J Point - Junction between QRS and ST
- Delta Wave - Seen in WPW syndrome
- Artifact - Distortions in ECG recording

Leads & Anatomy Terms

- 12-Lead ECG - Standard recording
- Einthoven's Triangle - Formed by limb leads I, II, III
- Augmented Leads - aVR, aVL, aVF
- Precordial Leads - V1-V6 chest leads
- SA Node - Natural pacemaker
- AV Node - Conduction delay between atria & ventricles
- Bundle of His - Conducts impulses from AV node

- Purkinje Fibers - Rapid ventricular conduction
- Electrical Axis - Direction of depolarization
- Axis Deviation - Abnormal conduction direction

Arrhythmia Terms

- Sinus Rhythm - Normal rhythm
- Arrhythmia - Abnormal heart rhythm
- Bradycardia - HR < 60 bpm
- Tachycardia - HR > 100 bpm
- Atrial Fibrillation - Irregular atrial activity
- Ventricular Fibrillation - Chaotic ventricular rhythm
- Premature Atrial Contraction (PAC) - Early atrial beat
- Premature Ventricular Contraction (PVC) - Early ventricular beat
- Bigeminy - PVC after every beat
- Trigeminy - PVC after two normal beats

Blocks & Syndromes

- First-Degree AV Block - Prolonged PR interval
- Mobitz I (Wenckebach) - Progressive PR lengthening, dropped QRS
- Mobitz II - Sudden dropped QRS
- Complete Heart Block - No conduction between atria & ventricles
- Bundle Branch Block - Wide QRS, delayed conduction
- Wolff-Parkinson-White (WPW) Syndrome - Pre-excitation, delta wave
- Idioventricular Rhythm - Ventricular escape rhythm

- Accelerated Idioventricular Rhythm (AIVR) - Faster idioventricular rhythm
- Ventricular Tachycardia - Rapid wide QRS rhythm
- Torsades de Pointes - Polymorphic VT with prolonged QT

Electrolyte & Clinical Conditions

- Hyperkalemia - Tall T waves, wide QRS
- Hypokalemia - Flattened T, U waves
- Hypercalcemia - Short QT interval
- Hypocalcemia - Prolonged QT interval
- Ischemia - Reduced blood flow
- STEMI - ST elevation MI
- NSTEMI - Non-ST elevation MI
- Prinzmetal's Angina - Coronary spasm, transient ST elevation
- Pericarditis - Diffuse ST elevation, PR depression
- Hypertrophy - Enlarged chambers seen on ECG

Technical & Management Terms

- Holter Monitor - 24-48 hr ECG monitoring
- Telemetry - Continuous hospital monitoring
- Electrode Misplacement - Incorrect positioning, false changes
- Low Voltage QRS - Small amplitude, obesity or effusion
- Cardioversion - Synchronized shock to restore rhythm
- Defibrillation - Emergency unsynchronized shock

- Automaticity - Ability to generate impulses
- Excitability - Ability to respond to stimulus
- Conductivity - Ability to transmit impulses
- Refractory Period - Time cells cannot depolarize again

Nuclear Stress Test (Myocardial Perfusion Imaging)

A Nuclear stress test is performed and interpreted by a: Cardiologist**,** Nurse Practitioner, or Physician Assistant.

It measures blood flow to the heart muscle and how well the heart pumps, using imaging technology.

A Nuclear Medicine Technologist or Radiology Tech administers a radioactive tracer (like Technetium-99m or Thallium) into the bloodstream. A gamma camera takes images of blood flow in the heart at rest and during stress (exercise or medication). Electrodes are also placed for ECG monitoring during the stress phase.

The nuclear test also shows areas of the heart muscle that may not be receiving enough blood (blockages in coronary arteries or heart muscle damage from a previous heart attack.

A stress test is contraindicated when the patient has uncontrolled hypertension (systolic greater than 220 or diastolic greater than 110) due to risk of stroke and other cardiac complications.

Dobutamine stress test

A dobutamine stress test is a cardiac stress test used for patients who cannot exercise on a treadmill or stationary bike due to physical limitations (e.g., arthritis, disability, or severe illness).

Dobutamine is a medication that mimics the effects of exercise by making the heart beat faster and harder, similar to what happens during physical activity.

The test It's often combined with echocardiography (ultrasound of the heart), known as a dobutamine stress echo, to evaluate the heart's structure and blood flow under stress.

It diagnoses Coronary artery disease (blockages in heart arteries).
The heart's pumping function (ejection fraction).
Whether the heart muscle is getting enough oxygen under stress.

- No exercise required.
- Uses a drug (dobutamine) instead of treadmill/bike exercise.
- Usually paired with echocardiogram instead of nuclear imaging (though some centers do a dobutamine nuclear stress test).

Possible side effects include dizziness, headache and tachycardia.

A Holter monitor is a portable ECG (electrocardiogram) device that continuously records a patient's heart activity, usually for 24 to 48 hours (sometimes longer), while they go about their normal daily activities.

Low filter stress test

A *low-pass filter* in an ECG machine is a signal processing setting that removes high-frequency noise from the ECG tracing while allowing the lower-frequency cardiac signals (like P, QRS, and T waves) to pass thru

- ECG signals are typically low frequency (most important signals are < 150 Hz).
- High-frequency noise (e.g., from muscle tremors, electrical interference, or movement) can distort the tracing.

- A low-pass filter “smooths” the signal by cutting out unwanted high-frequency components, producing a cleaner ECG.
- The filter sets a cutoff frequency (often between 40–150 Hz depending on settings).
- Frequencies above the cutoff are removed or attenuated.
  For example:
- A 40 Hz low-pass filter would block signals > 40 Hz, useful for routine ECGs.
- A 150 Hz low-pass filter might be used for pediatric or stress test ECGs where higher frequency content of the QRS needs to be preserved.
- Turn ON/Lower cutoff: If the ECG shows muscle tremor artifact (somatic tremor).
- Turn OFF/Raise cutoff: If you need diagnostic precision, e.g., measuring QRS width or ST segments (as filtering can slightly distort the waveform if set too low).

Over-filtering (too low a cutoff) can distort ECG waveforms—flattening sharp QRS complexes or altering ST segments, which can lead to misinterpretation.

60-cycle interference

60-cycle interference in an ECG (also called AC interference) is a type of artifact or noise on the electrocardiogram caused by electrical power sources. In the United States, electrical power runs at 60 cycles per second (60 Hz), which can “leak” into the ECG tracing if proper precautions aren’t taken.

It appears as a continuous, regular, thick, or fuzzy baseline on the ECG.
It can obscure the P waves, QRS complexes, and T waves, making interpretation difficult.

It is caused by:

Causes of 60-Cycle Interference

- Improper grounding of the ECG machine.

- Loose or dried electrodes that don't have good skin contact.
- Electrical devices nearby, such as infusion pumps, monitors, or power cords.
- Patient touching metal surfaces or wires during the test.
- Damaged or broken lead wires.

Prevention

- Ensure electrode pads are fresh and properly placed on clean, dry skin.
- Move the patient away from electrical equipment or unplug nearby devices.
- Check that the ECG machine is properly grounded.
- Avoid placing lead wires near power cords or outlets.
- Reposition leads if necessary to reduce interference.

Vasovagal Response

A vasovagal response on an ECG refers to the changes in heart rhythm and rate seen when a person experiences a vasovagal reaction (fainting or near-fainting episode). This response occurs when the vagus nerve is overstimulated, leading to sudden slowing of the heart rate (bradycardia) and drop in blood pressure, which can cause fainting.

Typical ECG Findings During a Vasovagal Response:

Sinus Bradycardia – The heart rate drops significantly.
Prolonged PR interval – Due to increased vagal tone, slowing AV conduction.
Possible pauses or sinus arrest – If the vagal stimulation is severe.

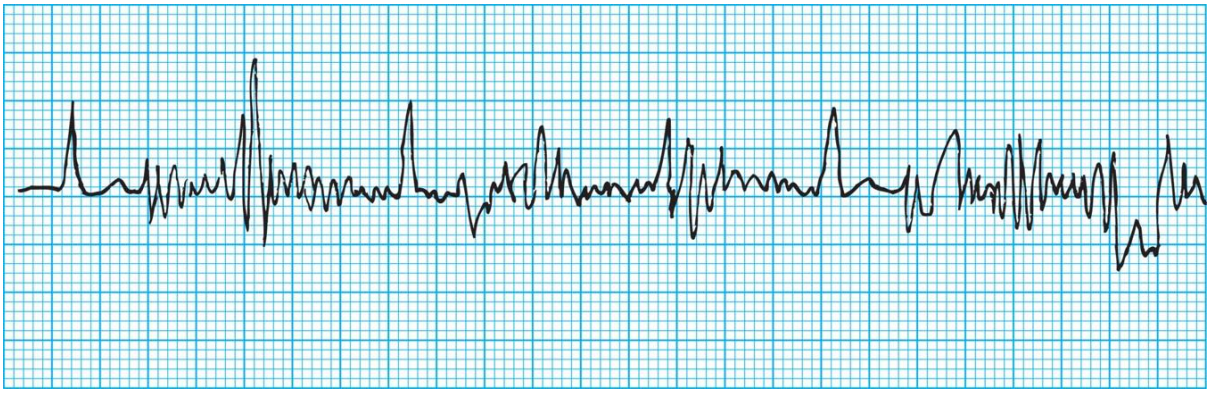
Flattened or smaller P waves – Because of the slowed conduction.
Hypotension-related changes – If prolonged, it may cause temporary ST-T wave changes from reduced blood flow.

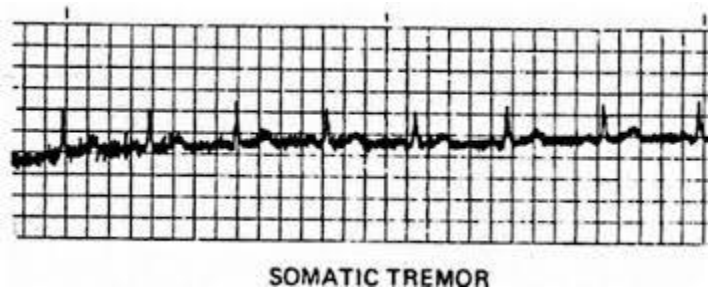
Often occurs with triggers like emotional stress, pain, standing too long, or medical procedures (e.g., blood draws, IV starts).

- It's a reflex reaction: The vagus nerve slows the heart, and blood vessels dilate, causing blood pressure to drop.

Not a true arrhythmia but rather a reflex slowing of the heart.
The ECG usually returns to normal once the patient recovers.
Can be mistaken for heart block if the bradycardia is significant.

Somatic tremor artifact





Somatic tremor artifact in an ECG refers to unwanted interference caused by involuntary or voluntary muscle activity in the patient during recording. These artifacts can make the ECG tracing difficult to interpret because they mimic or obscure the heart's electrical activity.

It looks like jagged, irregular, erratic spikes throughout the tracing.

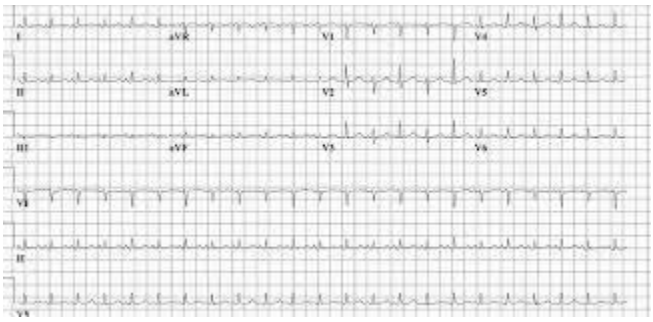
Unlike the smooth and regular waveforms of an ECG, somatic tremor appears as irregular “shaky” or “fuzzy” lines. It may be continuous or intermittent, depending on the muscle activity. It’s caused by patient movement (shivering, talking, coughing, or shifting position).

- Muscle tension or tremors (e.g., Parkinson’s disease or anxiety).
- Cold environment causing shivering.
- Electrodes not securely attached (which can exaggerate movement artifacts).

You can reduce Somatic Tremor Artifact by making sure the patient is relaxed and comfortable.

- Ask the patient to remain still and quiet during the recording.
- Warm the patient if they are shivering.
- Ensure electrodes are placed firmly on clean, dry skin.
- Use pillows or arm supports to help minimize muscle tension.

Electrical alternans



Electrical alternans on an ECG is a pattern where the amplitude or axis of the QRS complexes changes from beat to beat in a regular, alternating fashion.

It's most classically seen in large pericardial effusion (fluid around the heart), but it can also appear in other situations.

In massive pericardial effusion, the heart swings back and forth within the fluid-filled pericardial sac.

As the heart's position changes slightly with each beat, the direction and size of the electrical signal reaching the ECG electrodes changes — producing alternating tall and short QRS complexes (and sometimes P and T waves too).

Beat-to-beat alternation in QRS amplitude (tall–short–tall–short).

Sometimes also in QRS axis and even in P and T wave size.

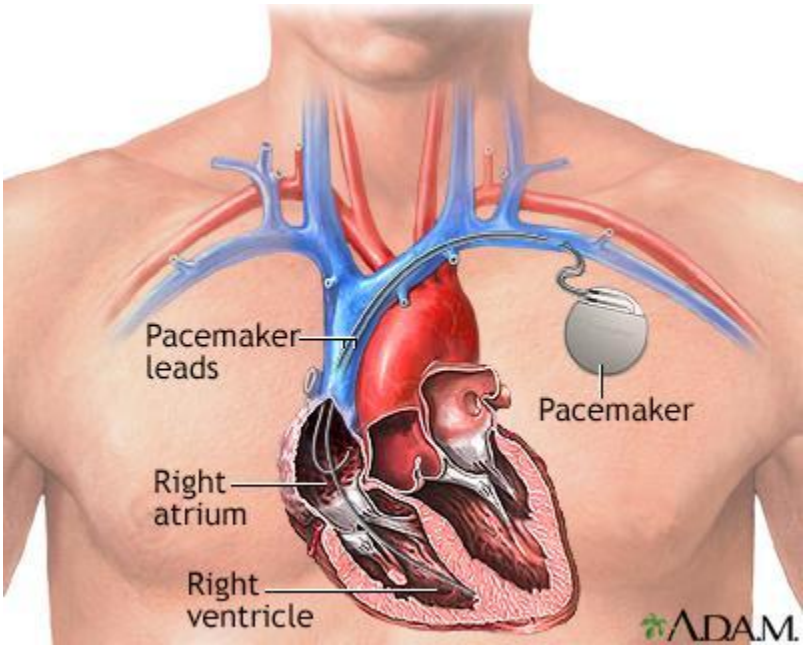
Usually regular — occurs with every other beat.

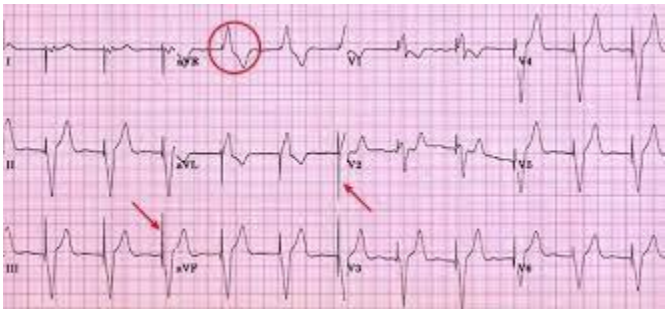
Strongly associated with cardiac tamponade when seen alongside sinus tachycardia and low-voltage QRS.

In that emergency setting, it's a red flag for urgent pericardiocentesis.

Rarely, electrical alternans can also occur in supraventricular tachycardia or very fast heart rates without pericardial effusion.

Pacemaker


Pacemaker leads
Pacemaker
Right atrium
Right ventricle
A.D.A.M.



A *pacemaker* is a small medical device that helps regulate the heart's rhythm when the heart's natural electrical system isn't working properly. It sends electrical impulses to the heart to maintain a normal heart rate and rhythm, especially in cases of bradycardia (heart beating too slowly), certain types of heart block, or irregular rhythms.

The pacemaker is usually implanted under the skin near the collarbone.

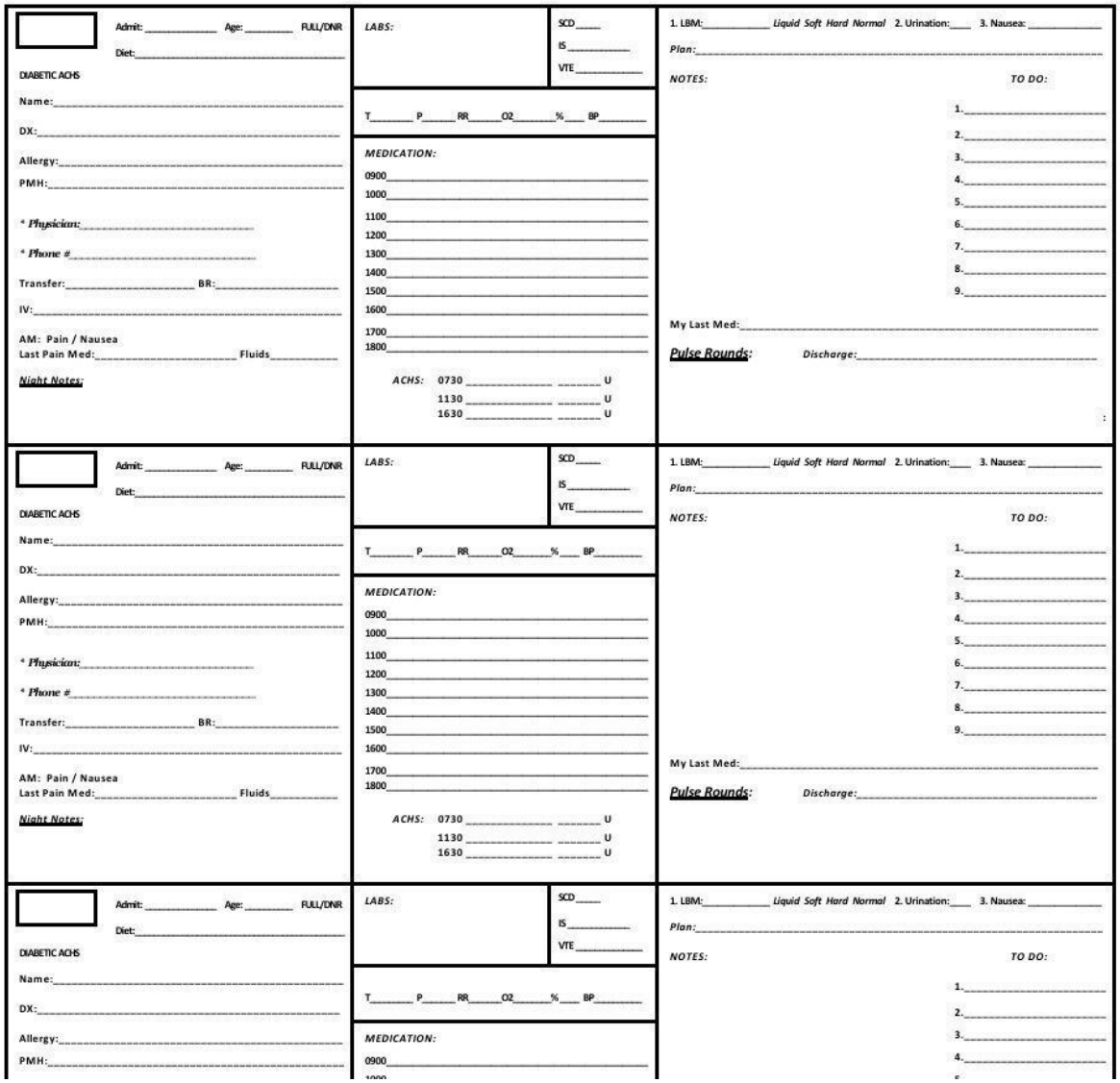
- One or more leads (wires) are threaded through the veins into the heart chambers.
- The device monitors the heart's electrical activity and sends signals when the heart rate is too slow or irregular.

An ECG records the heart's electrical activity using electrodes placed on the skin.

- In patients with a pacemaker, the ECG will show pacemaker spikes — small, sharp vertical lines — right before the P wave (atrial pacing) or QRS complex (ventricular pacing).
- These spikes represent the moment the pacemaker sends an electrical impulse to stimulate the heart.

ECGs are used to:

- Confirm that the pacemaker is firing appropriately.
- Check that the heart is responding to the pacemaker signal.
- Diagnose pacing problems or malfunctions.



Admit: _____ Age: _____ FULL/DNR

Diet: _____

DIABETIC ACHS

Name: _____

DX: _____

Allergy: _____

PMH: _____

* *Physician:* _____

* *Phone #* _____

Transfer: _____ BR: _____

IV: _____

AM: Pain / Nausea

Last Pain Med: _____ Fluids _____

Night Notes:

LABS:

SCD _____

IS _____

VTE _____

T_____ P_____ RR_____ O2_____% ___ BP_____

MEDICATION:

0900 _____

1000 _____

1100 _____

1200 _____

1300 _____

1400 _____

1500 _____

1600 _____

1700 _____

1800 _____

ACHS: 0730 _____ _____ U

1130 _____ _____ U

1630 _____ _____ U

1. LBM: _____ *Liquid Soft Hard Normal* 2. Urination: ____ 3. Nausea: _____

Plan: _____

NOTES:

TO DO:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

My Last Med: _____

Pulse Rounds: *Discharge:* _____

Admit: _____ Age: _____ FULL/DNR

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Plan: _____

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TO DO:

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4. _____