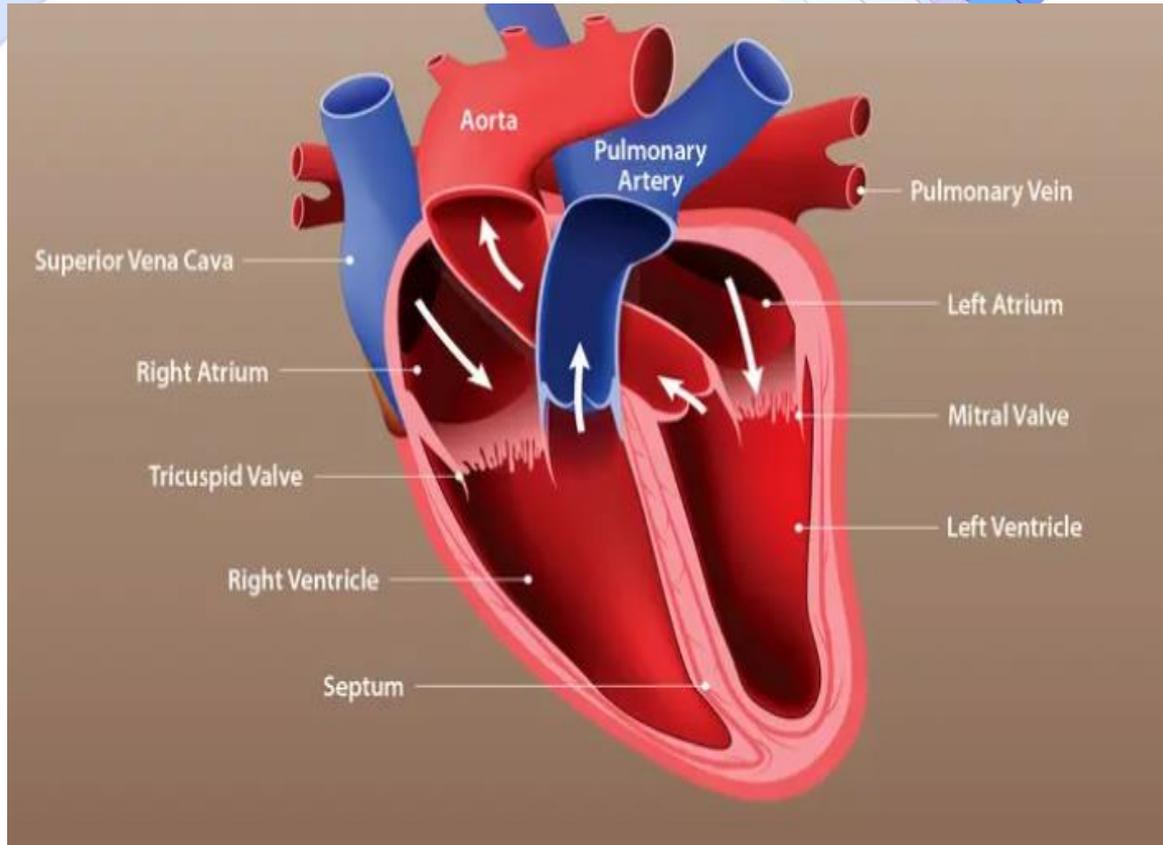


**Clinical Examination in Cardiovascular Diseases.**  
**Peripheral vascular examination.**  
**Assessment of arterial pulse and blood pressure.**

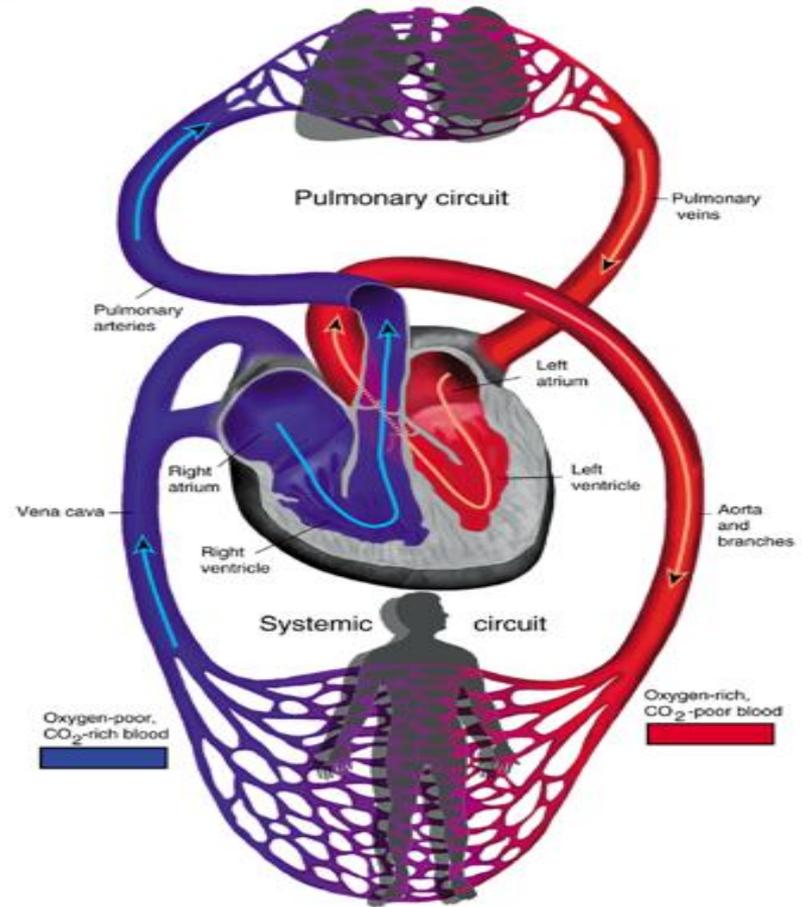
Diana Sasu  
Assistant Professor, PhD

# Anatomy of the heart



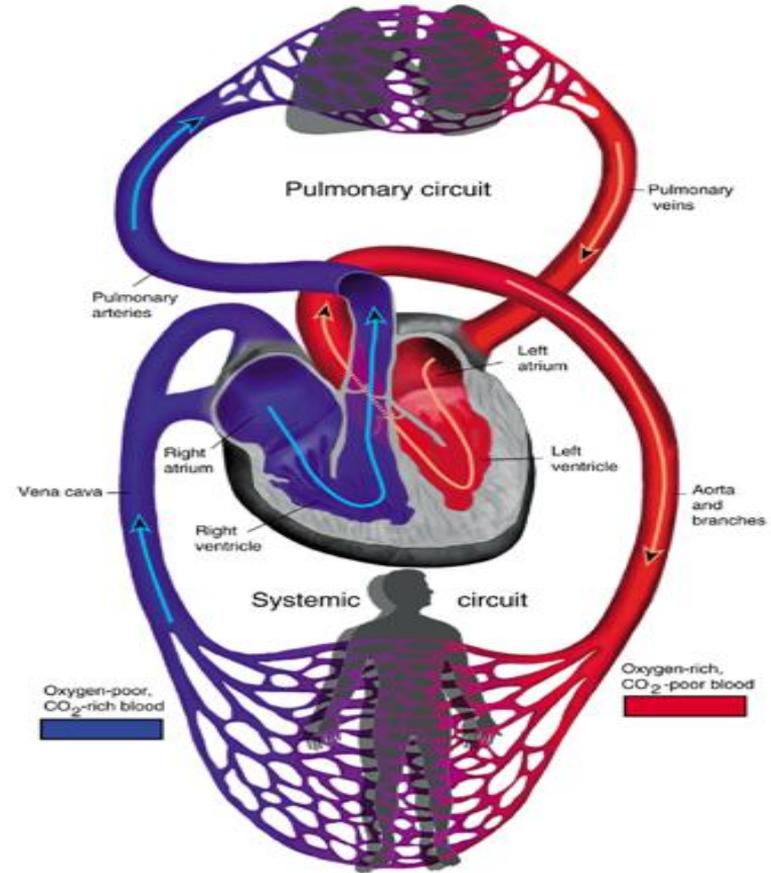
# Pulmonary circulation

- Includes arteries, veins, and expansive network of pulmonary capillaries.
- Deoxygenated blood to RA → Right AV valve → RV → pulmonary semilunar valve → pulmonary trunk → pulmonary arteries (Rig & Left) → lung capillaries (gas exchange) → oxygenated blood to pulmonary veins → LA



# Systemic circulation

- arteries, veins and capillaries (pressure 110-120/70-80 mm Hg)
- Oxygenated blood in LA → Left AV valve → LV → aortic semilunar valve → aorta → arteries of body → capillaries of body (gas exchange) → deoxygenated blood to veins of body → inferior & superior vena cava and coronary sinus (of heart) → RA



# Cardiovascular Disease Risk Factors

## 1. Non-Modifiable Risk Factors

- **Advanced age** (risk increases significantly after 45 years in men and 55 years in women)
- **Male sex** (and post-menopausal state in women)
- **Family history of premature CVD**
- **Genetic predisposition**

# Cardiovascular Disease Risk Factors

## 2. Major Modifiable Risk Factors

- These are directly involved in atherosclerotic plaque formation:
- **Arterial hypertension** – causes endothelial damage and increased vascular stress
- **Dyslipidemia** – elevated LDL-cholesterol, low HDL-cholesterol, hypertriglyceridemia
- **Diabetes mellitus** – accelerates atherosclerosis and microvascular damage
- **Smoking** – promotes vasoconstriction, thrombosis, oxidative stress
- Obesity (especially central obesity)
- Sedentary lifestyle

# Cardiovascular Disease Risk Factors

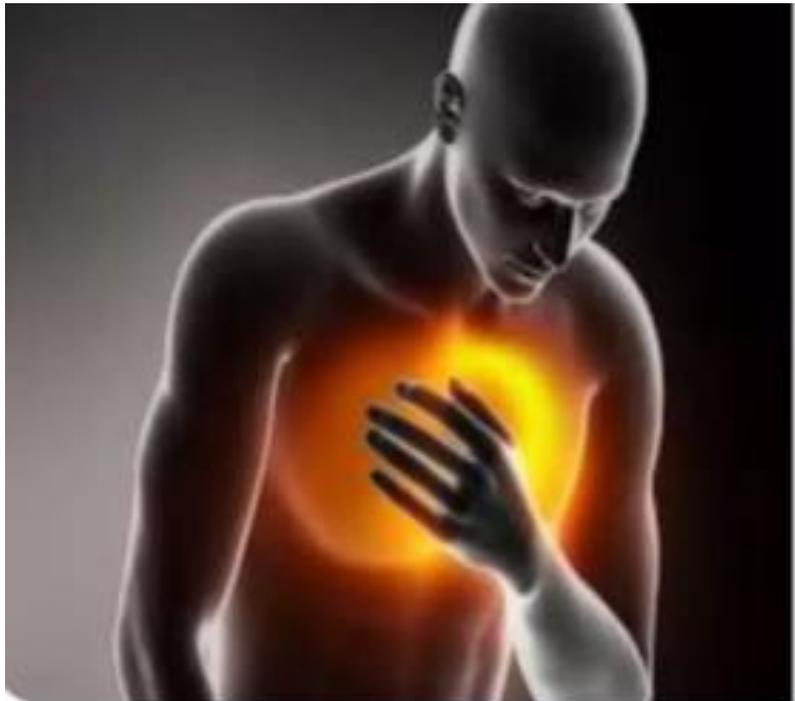
## **Additional / Contributing Factors**

- Metabolic syndrome
- Chronic kidney disease
- Chronic inflammatory disorders
- Psychosocial stress
- Unhealthy diet (high saturated fats, salt, processed foods)
- Excessive alcohol intake

# The most common complaints

- **Chest pain**
- **Shortness of breath (dyspnea)**
- **Palpitations**
- **Fatigue and reduced exercise tolerance**
- **Dizziness or syncope**
- **Peripheral edema**
- **Cough**
- **Hemoptysis**
- **Orthopnea and paroxysmal nocturnal dyspnea**
- **Cyanosis**

# Approach to chest pain



**Chest pain** is any discomfort located in the anterior thorax between the diaphragm (epigastrium) and the base of the neck (mandible).

In cardiac ischemia, reduced coronary blood flow leads to myocardial hypoxia and accumulation of metabolic by-products, which activate visceral nociceptors and produce a retrosternal pressure or squeezing sensation.

# Pain Assessment Model

<b>S</b>	<b>Site</b>	Where exactly is the pain?
<b>O</b>	<b>Onset</b>	What were they doing when the pain started?
<b>C</b>	<b>Character</b>	What does the pain feel like?
<b>R</b>	<b>Radiates</b>	Does the pain go anywhere else?
<b>A</b>	<b>Associated symptoms</b>	e.g. nausea/vomiting
<b>T</b>	<b>Time/duration</b>	How long have they had the pain?
<b>E</b>	<b>Exacerbating/ relieving factors</b>	Does anything make the pain better or worse?
<b>S</b>	<b>Severity</b>	Obtain an initial pain score

# Chest pain

## Component

## Clinical details in cardiovascular pain



## Site

Usually retrosternal chest pain. The pain is typically located in the central chest behind the sternum. Patients often describe a "pressure", "tightness", or "squeezing" sensation in the chest.

## Onset

Often provoked by physical exertion, emotional stress, cold exposure, or after heavy meals. In acute coronary syndrome, onset may be sudden and at rest.

# Chest pain

## Character

Classically described as **pressure-like, constricting, heavy, squeezing, or burning** pain rather than sharp stabbing pain. Some patients report chest discomfort rather than true pain.

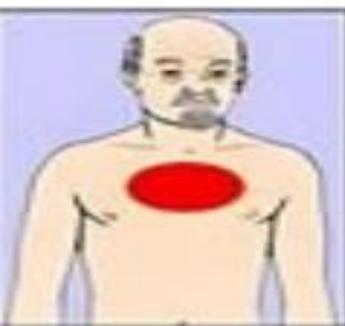
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## Radiates

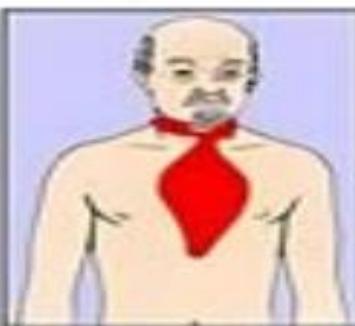
Pain may radiate to:

- Left shoulder and left arm (especially medial arm and forearm)
- Neck and jaw
- Back or interscapular region
- Epigastrium in some cases

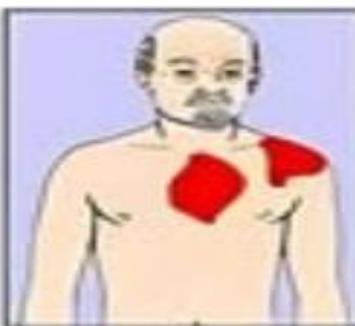
## Location of chest pain during angina or heart attack



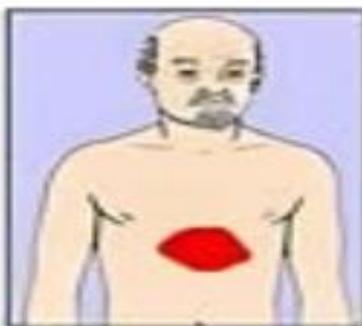
**Upper chest**



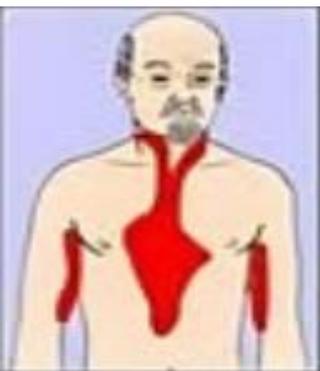
**Substernal radiating to neck and jaw**



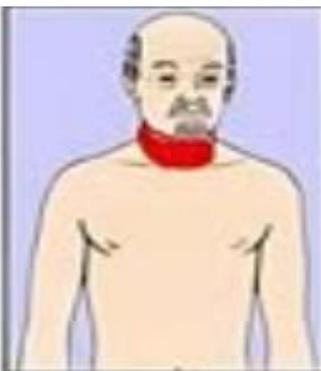
**Substernal radiating down left arm**



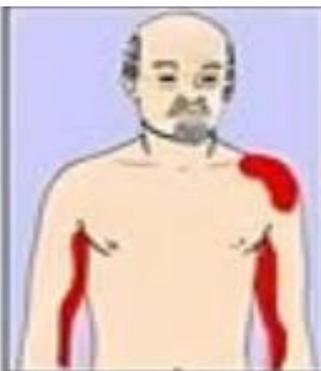
**Substernal radiating down left arm**



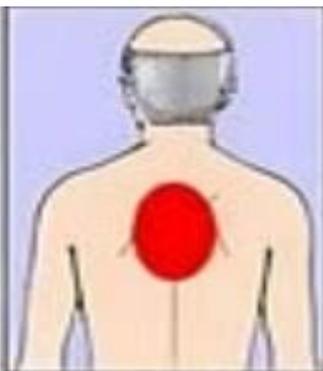
**Epigastric radiating to neck, jaw, and arms**



**Neck and Jaw**



**Left shoulder and down both arms**



**Intrascapular**

# Associated symptoms and time duration

---

## symptoms

- Dyspnea
- Nausea or vomiting
- Cold sweat (diaphoresis)
- Palpitations
- Anxiety or sense of impending death
- Dizziness or weakness

---

## Time / duration

Stable angina episodes usually last **2–10 minutes** and are relieved by rest.  
Acute ischemic episodes may last **>20 minutes** and require urgent evaluation.

---

# Chest pain

## Exacerbating / relieving factors

Worsening factors: physical activity, emotional stress, hypertension, tachycardia, cold weather.

Relieving factors: rest and administration of nitrates.

---

## Severity

Variable. Often moderate to severe. Pain severity does not always correlate with the extent of ischemia, especially in elderly or diabetic patients.

# Nitroglycerin

- It is mainly used for relief of chest pain in Angina pectoris and other ischemic
- **Sublingual nitroglycerin (most common for acute chest pain)**
- **Dose:** 0.3 – 0.6 mg tablet under the tongue
- **How to use:**
  - Put the tablet under the tongue and allow it to dissolve
  - Do not swallow immediately
- **Repeat:** every **5 minutes** if pain persists
- **Maximum:** usually **3 doses** within 15 minutes. If chest pain is not relieved after 3 doses → urgent medical evaluation is required because of possible Myocardial infarction.

# UNIVERSAL PAIN ASSESSMENT TOOL

This pain assessment tool is intended to help patient care providers assess pain according to individual patient need. Explain and use 0-10 Scale for patient self-assessment. Use the faces or behavioral observations to interpret expressed pain when patient cannot communicate his/her pain intensity.

0 1 2 3 4 5 6 7 8 9 10

Verbal Descriptor Scale	NO PAIN	MILD PAIN	MODERATE PAIN	MODERATE PAIN	SEVERE PAIN	WORST PAIN POSSIBLE
WONG-BAKER FACIAL GRIMACE SCALE						
ACTIVITY TOLERANCE	NO PAIN	CAN BE IGNORED	INTERFERES WITH TASKS/SLEEP	INTERFERES WITH CONCENTRATION	INTERFERES WITH BASIC NEEDS	BEDREST REQUIRED

# Common causes of chest pain

Organ System	Cause
Cardiac	Coronary artery disease Aortic valvular disease Pulmonary hypertension Mitral valve prolapse Pericarditis Idiopathic hypertrophic subaortic stenosis
Vascular	Dissection of the aorta
Pulmonary	Pulmonary embolism Pneumonia Pleuritis Pneumothorax

Musculoskeletal	Costochondritis* Arthritis Muscular spasm Bone tumor
Neural	Herpes zoster†
Gastrointestinal	Ulcer disease Bowel disease Hiatal hernia Pancreatitis Cholecystitis
Emotional	Anxiety Depression

# Dyspnea

- Subjective sensation of breathing discomfort.

Usually in cardiac patients is a sign of the developing heart failure, the degree of dyspnea being a measure of this insufficiency.

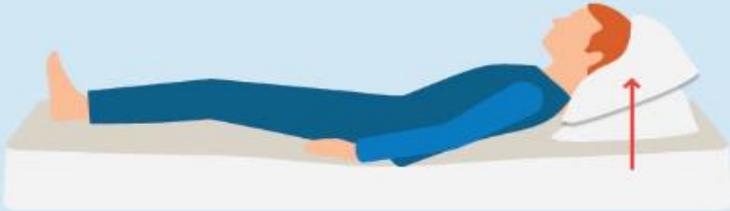
Key mechanisms include:

- Elevated left ventricular filling pressure
- **Pulmonary interstitial fluid accumulation** → reduces lung compliance and impairs gas exchange.
- **Reduced cardiac output** → leads to inadequate oxygen delivery during activity
- For example, at the initial stages of heart failure dyspnea develops only during exercise (climbing stairs, fast walk); at the advanced stages it develops during normal walk or even at rest.

# Orthopnea



**Trouble breathing while lying down.**



**Breathing is easier when propped up with pillows, sitting or standing up.**

- Shortness of breath occurring in the supine position.
- Improves when sitting or standing.
- Often associated with Heart failure

# Paroxysmal nocturnal dyspnea

- Sudden severe dyspnea that awakens the patient from sleep.
- Related to nocturnal fluid redistribution and pulmonary congestion.

Feature	Pulmonary edema	Cardiac asthma
Definition	Fluid accumulation in lung interstitium and alveoli	Nocturnal wheezing due to cardiac congestion
Main mechanism	Increased hydrostatic pressure in pulmonary circulation	Pulmonary venous congestion with bronchial wall edema
Dyspnea	Severe, persistent	Episodic, often nocturnal
Auscultation	Fine crackles	Wheezing may be present

# Cough

Causes of cough due to cardiac diseases include:

- pulmonary hypertension,
- pulmonary edema,
- pulmonary emboli leading to infarction
- aortic aneurisms compressing the tracheobronchial tree.

*Cough associated with dyspnea may be due to cardiac or pulmonary disease.*

Main mechanisms:

- ↑ Pulmonary venous pressure → interstitial edema
- Stimulation of cough receptors in bronchial walls
- Fluid accumulation in alveoli and airways
  
- A cough that produces pink, frothy sputum is suggestive for acute pulmonary edema,

# Hemoptysis

**Hemoptysis** is the expectoration of blood originating from the respiratory tract, usually due to marked congestion in the pulmonary circulation and rupture of small bronchial vessels.

It can be seen in:

- mitral stenosis,
- pulmonary emboli leading to infarction,
- pulmonary arteriovenous fistulas,
- rupture of an aortic aneurism into the tracheobronchial tree.

The cough in heart diseases is usually dry, sometimes with small amount of sputum.

# Palpitations

- Are the sensation of accelerated, intensified, or irregular heartbeats, described as an uncomfortable awareness of cardiac activity.

Palpitations are usually caused by **increased excitability of the cardiac conduction system.**

Palpitations may be a sign of heart diseases such as:

- Myocarditis
- Myocardial infarction
- Congenital heart disease
- Cardiac arrhythmia
- Heart valve disease
- Heart failure

# Syncope

- **Syncope** is a temporary loss of consciousness caused by a transient reduction of cerebral blood flow, usually associated with muscle weakness and inability to maintain upright posture.
- Cardiac causes of syncope are generally related to a **decrease in cardiac output**, leading to reduced cerebral perfusion.

# Causes of syncope

Type	Causes
Cardiac syncope	Arrhythmia, Heart failure, structural heart disease
Reflex (neurally mediated) syncope	Vasovagal syncope, emotional stress, pain
Orthostatic syncope	Sudden standing, dehydration, autonomic dysfunction
Cerebrovascular causes	Less common; transient cerebral ischemia

# Edema

- **Edema** is the visible accumulation of excess fluid in the interstitial tissues.

Common cardiac causes of edema include:

- right heart failure,
- left heart failure,
- constrictive pericarditis,
- restrictive cardiomyopathy

**Peripheral cardiac edema** occurs in patients who remain in the upright position during the day. Edema typically appears in the evening and is localized to the lower extremities.

- It usually spreads from the ankles upward.
- It first develops in the **malleolar region**, dorsum of the feet, and shins.
- In early stages, edema may partially resolve after night sleep.
- The skin over edematous areas may appear **cyanotic or pale, smooth, and tense**.

- 
- **Hepatomegaly** is often one of the early signs of **right-sided Heart failure**.
  - Liver congestion and enlargement occur due to venous stasis in the systemic circulation and may present as a sensation of heaviness or discomfort in the right hypochondrium.



The edema may become generalized and extend over the entire body.

- Fluid accumulation in the abdominal cavity - **ascites.**
- Fluid accumulation in the pleural cavity - **hydrothorax.**
- Fluid accumulation in the pericardial sac - **hydropericardium.**

# Nocturia

**Nocturia** is the condition in which **urine production during the night is equal to or greater than daytime urine output**, leading to repeated nighttime urination.

- During the daytime, fluid accumulates in the tissues due to gravity.
- When lying down at night, fluid returns to the circulation (mobilization of edema fluid).
- This increases renal blood flow and urine formation.
- Nocturia is commonly seen in Heart failure.

## Other symptoms in cardiovascular diseases

- **Fever** – Rheumatic fever, acute pericarditis, and Infective endocarditis.
- **Dysphagia** – caused by esophageal compression due to left atrial enlargement or aortic aneurysm.
- **Hiccup** – may occur due to mediastinal nerve or structure compression.
- **Intermittent claudication** – pain in lower limbs during walking, caused by ischemia from Atherosclerosis, commonly affecting the femoral artery.

# Patient position or attitude

Posture/attitude	Cause
Sitting quietly	Angina pectoris
Moving restlessly	Acute myocardial infarction
Comfortable in sitting	Left ventricular failure
Bending forward	Pericarditis
Squatting	Cyanotic congenital heart disease

## Face and skin color

- It is usually more pronounced in the peripheral parts of the body such as the fingers, tip of the nose, lips, and earlobes. This is called **acrocyanosis**.
- Acrocyanosis develops due to an increased concentration of reduced (deoxygenated) hemoglobin in venous blood. It occurs because tissues extract more oxygen in conditions of slow, congestive peripheral circulation.
- This type of cyanosis is typically **peripheral**, not central.
- In heart failure, cyanosis is usually **peripheral**.

## Color of the skin may be:

- **Violet-red (malar flush)** – in mitral stenosis
- **Pale skin** – in aortic valve diseases (especially severe aortic stenosis or regurgitation)
- **Jaundice** – in advanced Heart failure due to hepatic congestion and impaired bilirubin metabolism.
- **“Coffee with milk” (pale yellow-brown skin tone)** – infective endocarditis, usually due to anemia and chronic intoxication.

# Inspection of the Neck

## Jugular venous distension (JVD)

- Visible enlargement of the jugular veins
- Indicates increased central venous pressure
- Common in heart failure, especially right-sided failure

## Carotid artery pulsations

- Visible strong pulsations may be seen in conditions such as aortic regurgitation.

## Neck swelling

- Thyroid enlargement (goiter), which may contribute to cardiovascular symptoms ( in hyperthyroidism).

# Xanthelasma

- **Xanthelasma** are soft, yellowish, lipid-filled plaques that appear around the eyelids and are often associated with Hypercholesterolemia.



**Arcus corneae (corneal arcus)** is a grayish-white lipid ring located at the periphery of the cornea, around the iris. It is caused by lipid deposition in the corneal stroma. It may be associated with Hypercholesterolemia, particularly in younger patients.



# Inspection of the nails and fingers

## Fingers clubbing

- Cardiac: infective endocarditis, cyanotic heart disease
- Respiratory: suppurative lung disease, bronchogenic carcinoma, interstitial lung disease
- Gastrointestinal : IBD, primary liver cirrhosis



# Tendon xanthoma

- A **tendon xanthoma** is a firm, painless nodular swelling located over tendons, caused by cholesterol deposition in the connective tissue.
- In severe or familial hypercholesterolemia, excess LDL cholesterol accumulates in tissues, including tendons, forming lipid-rich deposits.



# Splinter hemorrhages

- Splinter hemorrhages are small, linear, reddish-brown streaks under the nail plate caused by damage to small capillaries. They can be a sign of Infective endocarditis (especially subacute forms).



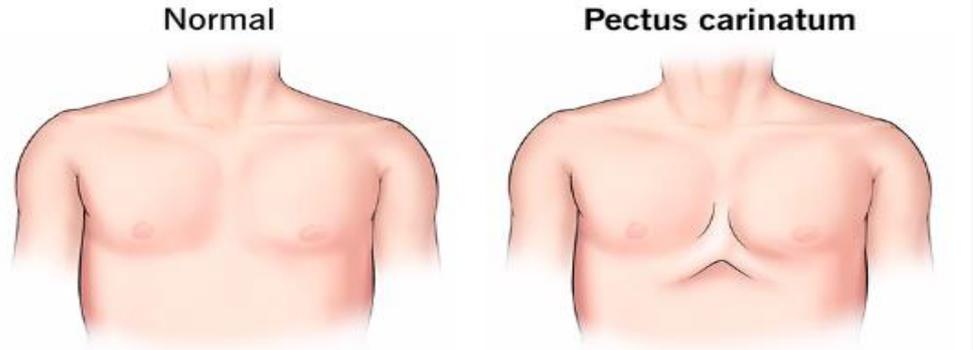
# INSPECTION OF THE CHEST

**Pectus excavatum** is a condition in which your sternum sticks out more than usual.

Pectus carinatum is a chest wall deformity in which the sternum protrudes anteriorly. It is commonly called “pigeon chest” or “keel chest”.

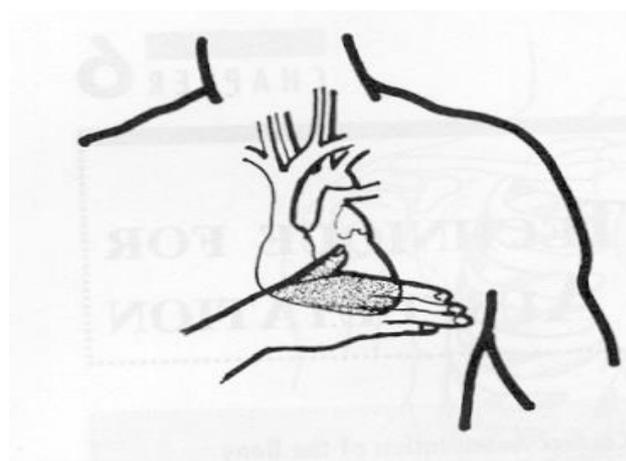
Pectus carinatum has an association with:

- Marfan syndrome, a connective tissue disorder.
- Noonan syndrome, a genetic disorder.
- Scoliosis



# Inspection of the precordial area

- The pulsation located in the fifth intercostal space, at the midclavicular line or slightly medial to it (about 1–1.5 cm to the left), is called the apex beat (apical impulse).
- It is produced by the systolic impact of the cardiac apex against the chest wall.



# Inspection of the precordial area

- **Precordial bulging** – protrusion of the chest wall over the heart region due to cardiac enlargement. It is usually observed when heart defects develop in childhood, when the thorax is still flexible.
- **Right ventricular impulse (RV impulse)** – pulsation located to the left of the sternal border over a wide area, sometimes extending toward the epigastric region. It is caused by contraction of an enlarged right ventricle and is often seen in heart failure.
- **Pulsation in the second right intercostal space** – may be associated with enlargement of the ascending aorta, such as in aortic aneurysm.

# Palpation of the precordial area

- Apex beat and its characteristics
- Right ventricular impulse (parasternal heave)
- Visible pathological pulsations
- Thrills (“cat’s purr” sign due to turbulent blood flow)

## Apex beat

- **Localization:** 5th left intercostal space, at or 1–1.5 cm medial to the **midclavicular line**
- Area (Size): Diameter **1–2 cm**
- Height - is the amplitude of vibration of the chest wall at the apex beat area:  
Normal- gentle, low-amplitude impulse.
- Power (Force / Character): force and duration (how strong and sustained it is)  
**Normal** → brief, moderate force

# Apex beat



# Right Ventricular (RV) impulse

- This is a **precordial impulse** felt on the chest wall that reflects activity of the **right ventricle** during systole.
- A **sustained outward movement of the left parasternal chest wall** with each heartbeat, best felt by placing the heel of the hand just to the **left of the sternum**.
- It occurs because the **right ventricle becomes enlarged or hypertrophied** and contracts forcefully against the chest wall.

# Right Ventricular (RV) impulse



# Visible pathological pulsations

Right sternal border, 2nd intercostal space	Usually nothing palpable	<ul style="list-style-type: none"><li>• Severe systemic hypertension</li><li>• Ascending aorta enlargement or aneurysm</li><li>• Gross enlargement of right atrium</li><li>• Severe aortic aneurysm</li></ul>
Left sternal border, 2nd intercostal space	Usually nothing palpable	<ul style="list-style-type: none"><li>- Pulmonary hypertension</li><li>- Increased pulmonary blood flow</li><li>- Right ventricular enlargement</li><li>- Enlarged left atrium</li><li>- Large posterior left ventricular aneurysm</li></ul>

# Visible pathological pulsations

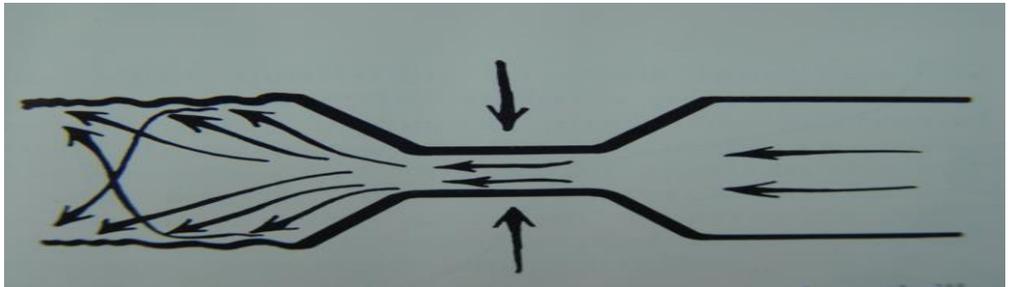


# Epigastric Pulsation

- May be due to :
  - hypertrophy and enlargement of the right ventricle;
  - pulsation of the abdominal aorta;
  - liver pulsation

# Thrills

- A **thrill** is a **palpable vibration on the chest wall** caused by **turbulent blood flow** within the heart or great vessels.
- It's often described as feeling like **“the purring of a cat”** when you place your hand lightly over the chest.
- Thrills may occur during different parts of the cardiac cycle depending on the underlying lesion: **systolic thrills** and diastolic thrills.



## Diastolic thrill

- A **diastolic thrill of mitral stenosis** is typically located at the **apex**, but it is rarely felt in practice because diastolic murmurs are usually softer and less likely to be palpable.
- Thrills and the apical impulse may be more easily detected when the patient is turned to the **left lateral position**.

# Systolic thrill

- In **aortic stenosis**, a **systolic thrill** may indeed be felt over the **aortic area** (right 2nd intercostal space at the right sternal border). This reflects **turbulent blood flow through the narrowed aortic valve**.

This thrill is usually **harsh/rough** (because the murmur of aortic stenosis is harsh) and can be quite **intense** if the murmur is loud (grade IV or higher).

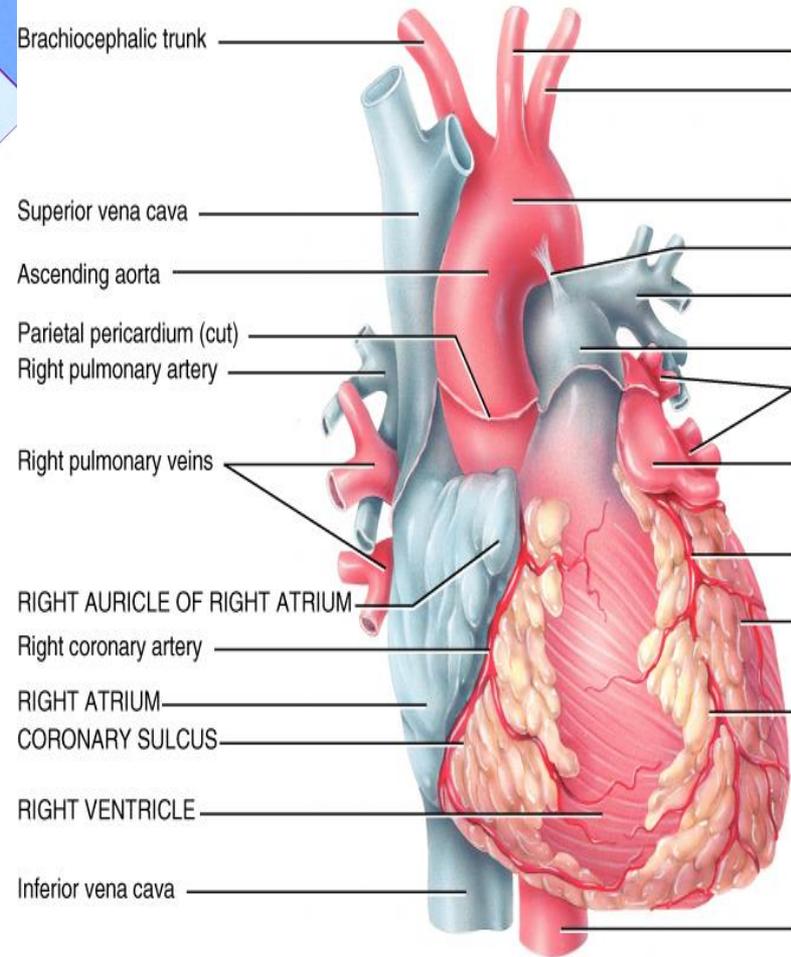
- In **pulmonary stenosis**, a **systolic thrill** is usually felt over the **pulmonary area** — the 2nd left intercostal space at the left sternal border.

# Percussion of the heart

- Size of the Heart
- Position of the Heart
- Shape (Configuration) of the Heart
- Vascular Bundle (Great Vessels)

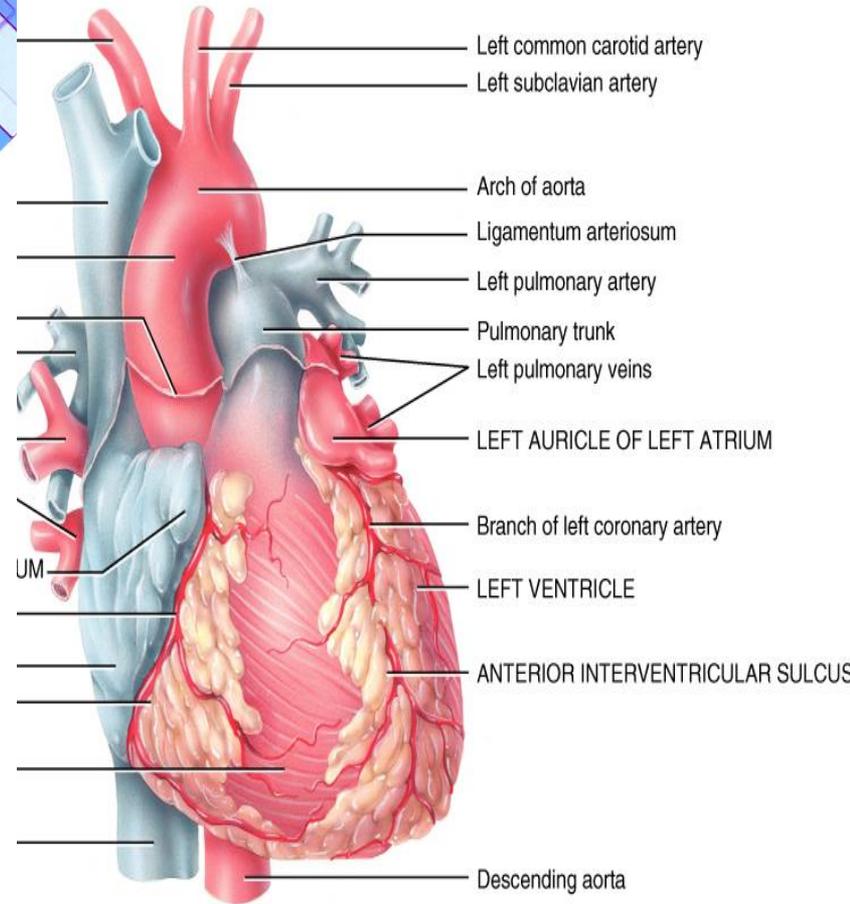
The **right configuration of the heart and great vessels** that forms the right border of *relative cardiac dullness* on percussion, the structures that contribute from *top to bottom* are:

- **Superior vena cava** — forming the upper part of the right contour
- **Ascending aorta** (aortic arch) — near the 2nd intercostal space contributes to the upper/middle part
- **Right atrium** — forming the lower part of the right contour (around the 3rd–4th intercostal spaces)



(a) Anterior external view showing surface feature

- The **left contour of relative cardiac dullness** (the left border of the heart's percussion outline) is formed from top to bottom by :
  - **Left part of the aortic arch** – around the **1st intercostal space**. Forms the upper most part of the left contour.
  - **Pulmonary trunk** – around the **2nd intercostal space**. Lies just below the aortic arch; contributes to the left superior contour.
  - **Auricle (appendage) of the left atrium** – around the **3rd intercostal space**.
  - **Narrow strip of the left ventricle** – around the **3rd, 4th, and 5th intercostal spaces**.

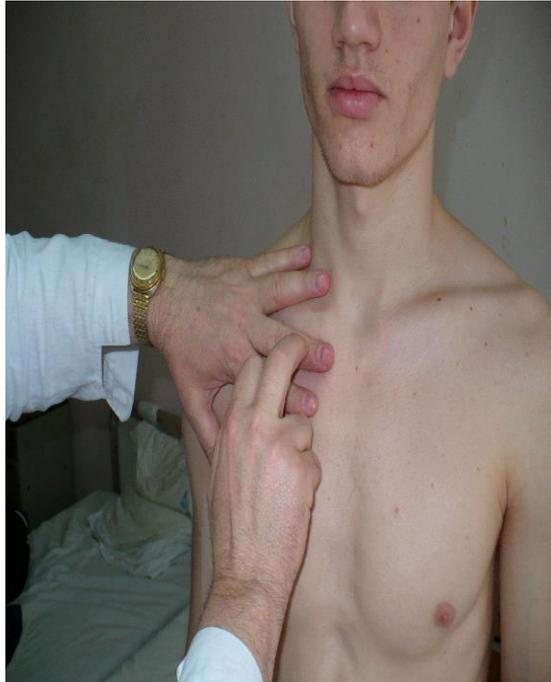


(a) Anterior external view showing surface features

## Relative Cardiac Dullness

- **Right border** – 4th right costal intercostal space, 1 cm laterally from the right edge of the sternum.
- **Left border** - 5th left intercostal space, 1-1,5 cm toward the sternum from the left midclavicular line; it coincides with the apical impulse.
- **Upper (superior) border** - 1 cm to the left of the sternal line, in the 3rd intercostal space.

# Right border of the relative heart dullness



# Left border of relative heart dullness



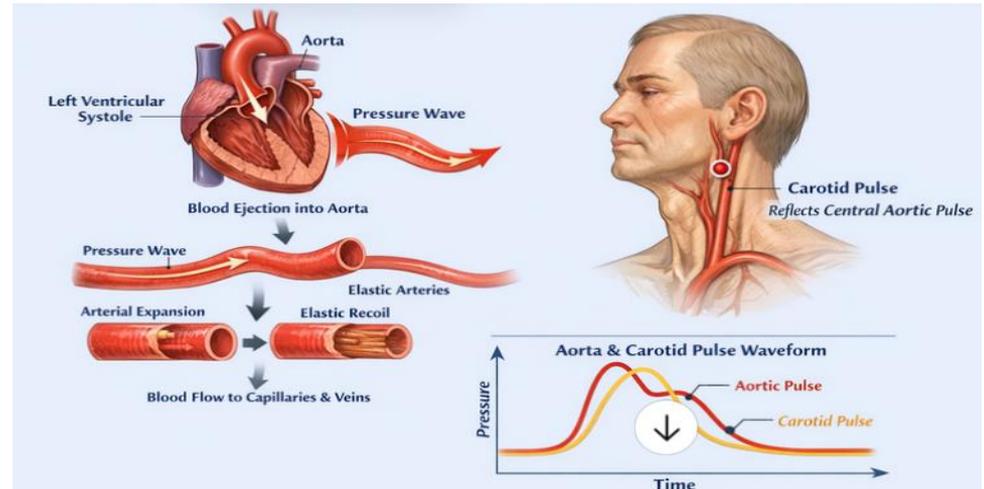
# Pathological heart configurations

1. Aortic configuration - in hypertrophy and dilation of left ventricle (aortic stenosis and regurgitation, arterial hypertension);
2. Mitral configuration - in hypertrophy and dilation of the left atrium (mitral stenosis and regurgitation)

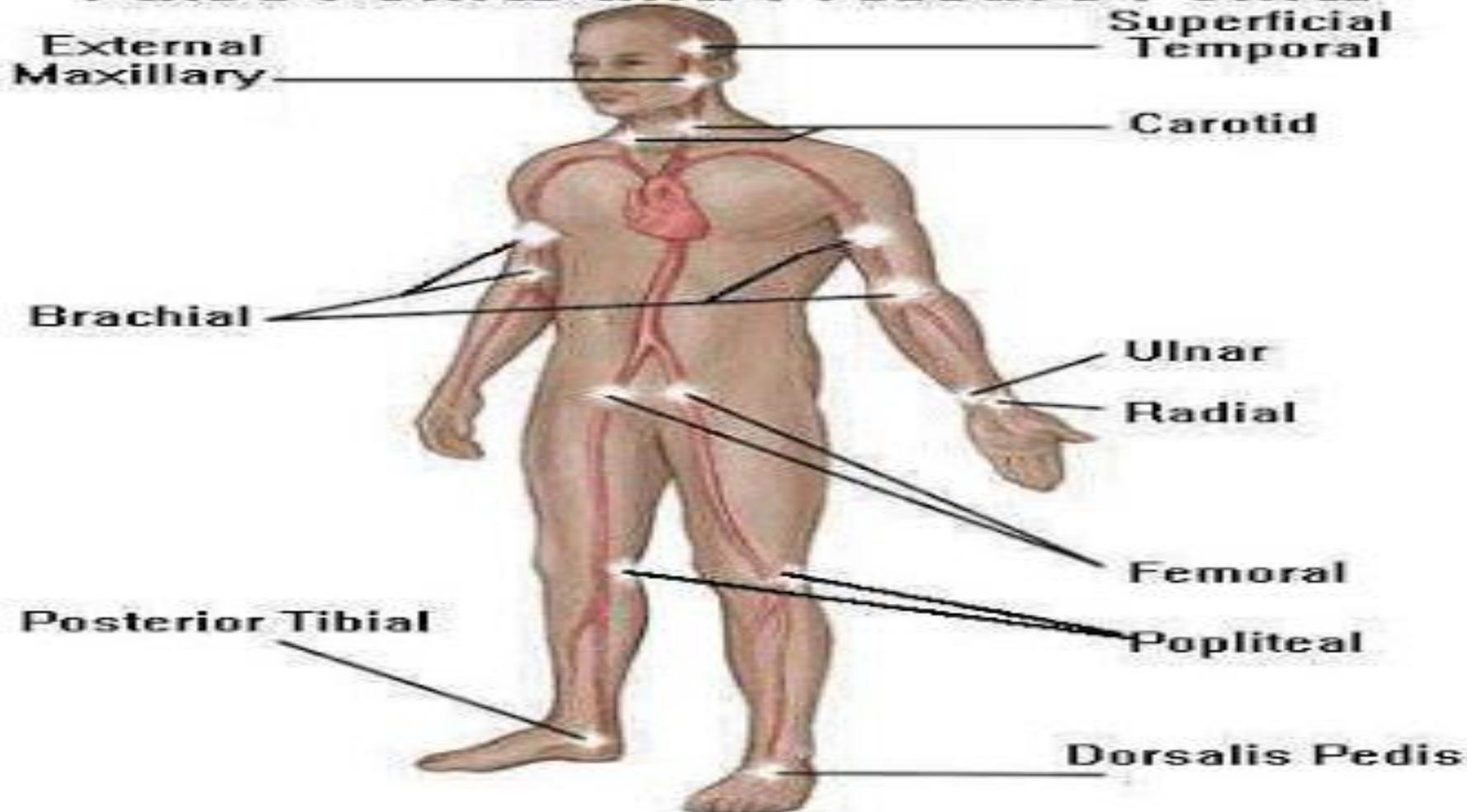
# Physiological Basis of the Arterial Pulse

The arterial pulse is the palpable pressure wave generated by left ventricular systole. When blood is ejected into the aorta, the arterial walls expand due to their elasticity. During diastole, elastic recoil maintains forward blood flow and contributes to diastolic pressure.

The carotid pulse closely reflects the central aortic pulse because of its anatomical proximity to the aorta and minimal waveform distortion.



# Pulse Points and Pressure Points



# Characteristics of the arterial pulse

The following properties of pulse are assessed:

- Equality (Symmetry)
- Rhythm
- Rate
- Volume (amplitude)
- Character (Contour/Waveform)

# Equality (Symmetry)

- **Pulse equality** - comparing the same artery on both sides of the body (usually the radial arteries) to determine whether they are feel simultaneous and equal in strength.
- Normally, pulses should be **equal in strength, volume and timing.**

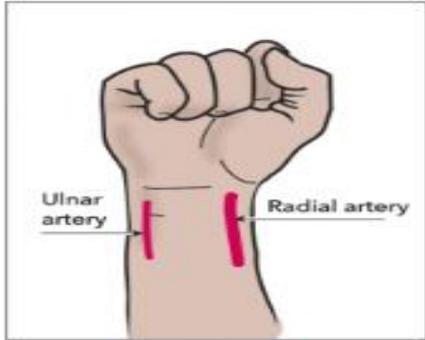


## Different pulse strength can be felt:

- Congenital deep location of the radial artery can sometimes make the pulse harder to palpate, which may give the impression of a weaker pulse;
- Arterial insufficiency due to thrombosis of the radial artery;
- Aortic dissection;
- Arterial embolism;
- Arteritis (inflammation
- Compression of the radial artery (by an enlarged lymph node or scar)

# The Allen test

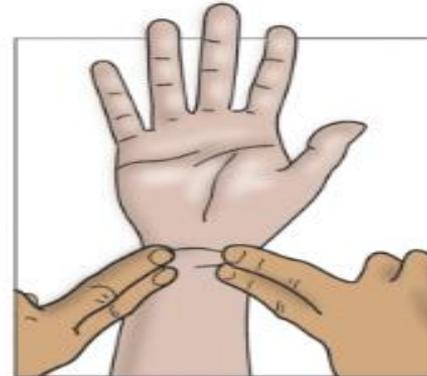
*This test is used to check the overall blood supply to the hand.*



Locate the ulnar and radial arteries. Have the patient make a tight fist for about thirty seconds.



To obstruct blood flow, press down on the ulnar artery with two fingers. At the same time, press down on the radial artery.



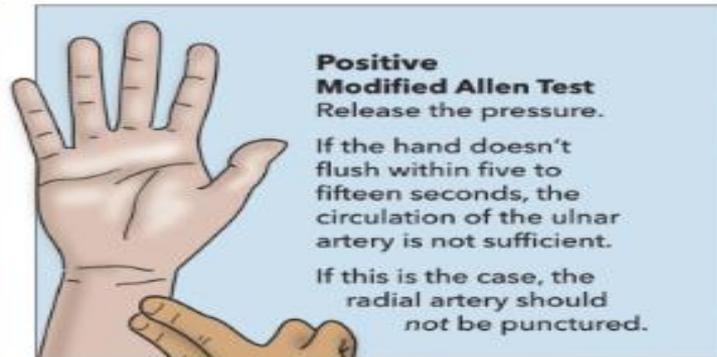
Tell the patient to unclench; their palm should blanch. If it doesn't, you are not applying enough pressure -- start again.



## **Negative Modified Allen Test**

Release the pressure on the ulnar artery.

If the hand flushes within five to fifteen seconds, this shows that the hand has good blood flow.



## **Positive Modified Allen Test**

Release the pressure.

If the hand doesn't flush within five to fifteen seconds, the circulation of the ulnar artery is not sufficient.

If this is the case, the radial artery should not be punctured.

# Types of Pulse Rhythm

- **Regular pulse**

The intervals between beats are equal.

- **Regularly irregular pulse**

The irregularity follows a repeating pattern( premature beats occurring at fixed intervals)

Can be seen in conditions such as extrasystoles.

- **Irregularly irregular pulse**

# Pulse Deficit

- Is the difference between the **apical heart rate** (heard over the heart with a stethoscope) and the **peripheral pulse rate** (usually palpated at the radial artery).

## Clinical Importance:

1. Premature ventricular contractions (PVCs)
  - Early beats with poor ventricular filling
  - Weak stroke volume → missed peripheral pulse
2. Atrial fibrillation
  - Some ventricular contractions occur too early, leading to:
    - ↓ Diastolic filling
    - ↓ End-diastolic volume
    - ↓ Stroke volume

As a result, some systoles are too weak to produce a palpable peripheral pulse, even though the apical beat is present.

**Apical heart rate > Radial pulse rate = Pulse deficit**

3. Heart failure (low stroke volume)

# Rate

Count beats for **30 seconds** and **multiply by 2** (if rhythm is regular).

- If rhythm is **irregular**, count for a full **60 seconds**.
- Normal adult pulse rate: **60–90 bpm**.
- Trained athletes: **40–60** (physiological bradycardia, normal adaptation to training)

It occurs because of increased stroke volume and enhanced vagal (parasympathetic) tone resulting from regular physical training.

# Amplitude (volum) of pulse

- **Pulse amplitude** refers to the **strength or magnitude of arterial pulsation** felt during palpation. It depends mainly on **stroke volume, arterial wall elasticity, and blood pressure**.

## Classification of pulse amplitude:

1. **Normal (full, good volume)** – strong but easily compressible pulse.
  2. **Bounding pulse** (or *pulsus altus*) is a pulse with abnormally high amplitude, meaning the arterial pulsation feels strong, forceful, and rapidly rising and falling during palpation.
- It increase stroke volume or decrease peripheral resistance, such as: fever, anemia, hyperthyroidism, aortic regurgitation

# Amplitude (volum) of pulse

**3. Pulsus parvus** is a pulse that is **weak, small, and difficult to palpate**, indicating **reduced pulse wave amplitude**.

**Causes** associated with conditions that reduce stroke volume or cardiac output:

- Aortic valve stenosis
- Heart failure
- Hypotension
- Severe blood loss or shock

# Character (waveform)

Pulse character describes the shape and contour of the pulse wave felt during arterial palpation. It reflects how quickly the artery is filled and emptied during the cardiac cycle.

## 1. Pulsus tardus

- Slow and delayed **upstroke** of pulse wave
- Gradual reaching of peak amplitude
- Often **small pulse volume** when associated with parvus (parvus–tardus)
- **Aortic valve stenosis.**



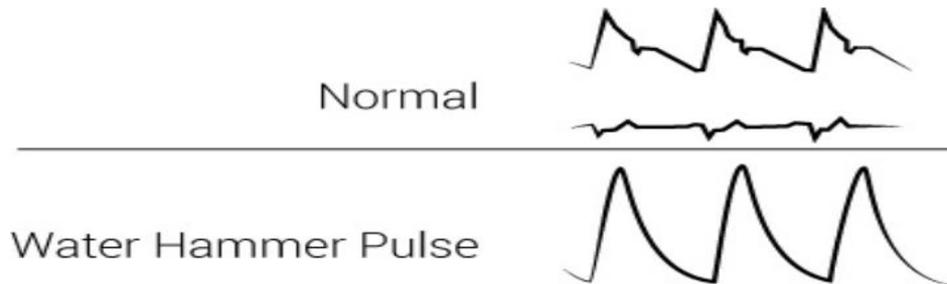
# Character (waveform)

## 2. Puls celer

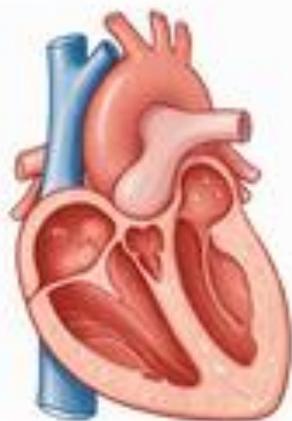
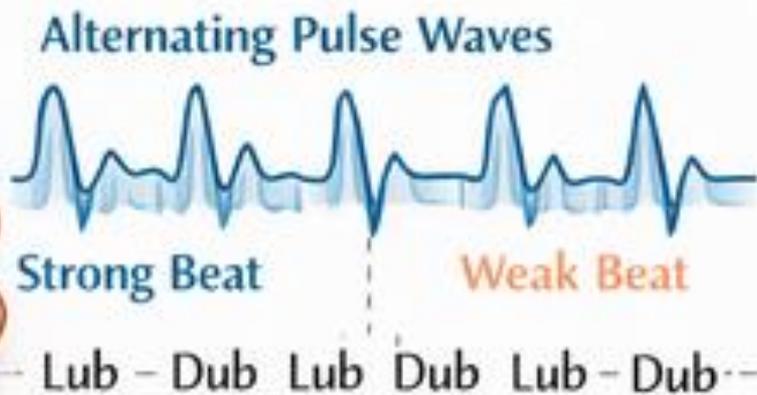
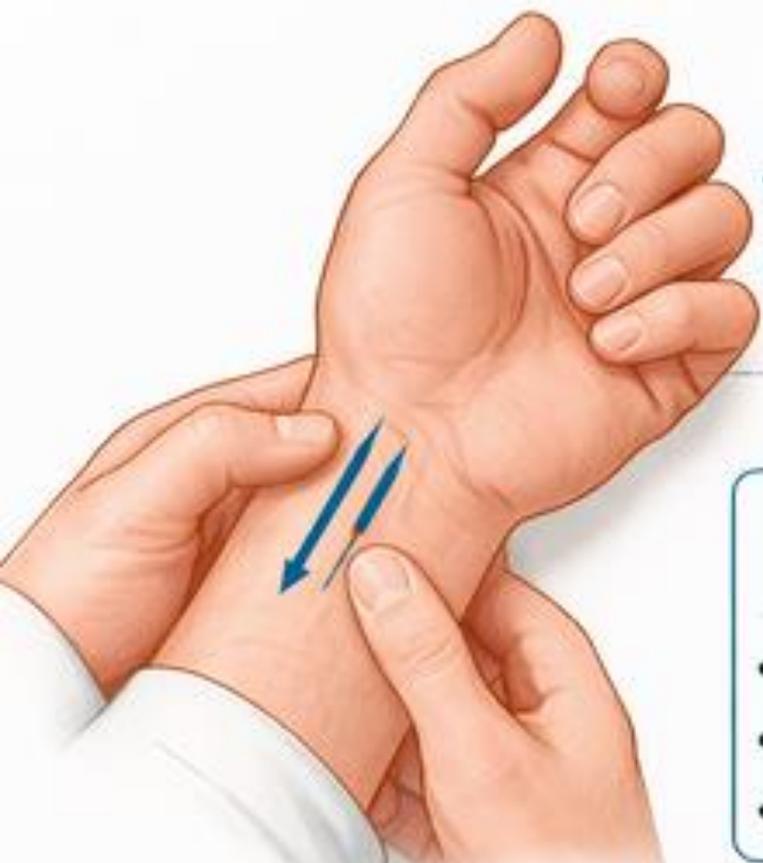
- Very **fast upstroke** (pulse reaches peak quickly)
- **High amplitude** pulse wave
- **Quick collapse** after the peak → sometimes called **water-hammer pulse**
- **Aortic valve regurgitation**

### Why it occurs

- During systole → **large stroke volume** is ejected.
- During diastole → blood quickly returns to the left ventricle, causing rapid pulse fall.



# Pulsus Alternans

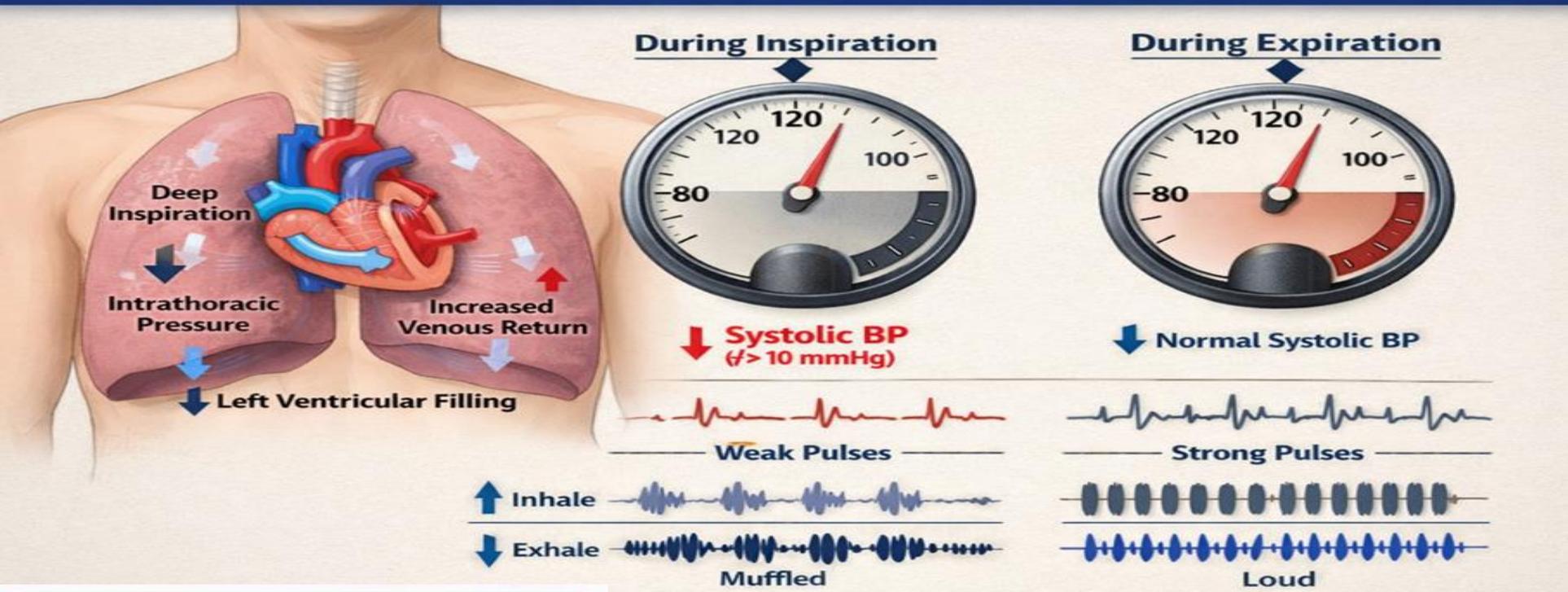


**Caused by Severe Left Ventricular Dysfunction**

- Advanced Heart Failure
- Severe Cardiomyopathy
- Advanced Valvular Heart Disease

**! Sign of Serious Cardiac Dysfunction**

# Pulsus Paradoxus



**! Dangerous Sign:  
Hemodynamic Compromise**

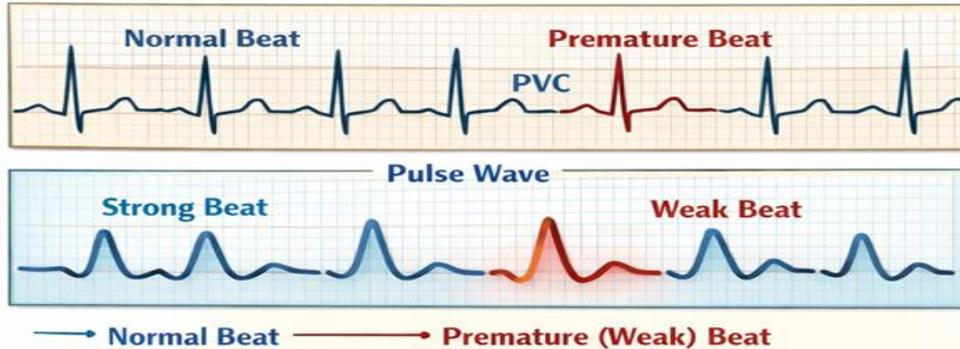
- Cardiac Tamponade
- Severe Asthma
- Constrictive Pericarditis

# Bigeminal pulse

- Is a pulse pattern in which **one normal strong pulse beat is followed by a weaker premature pulse**, repeating in pairs.



**Bigeminal Pulse:**  
“One normal beat;  
followed by a premature beat”



## Pattern

- Normal Beat + Premature Beat
- Paired Rhythm



## Causes

- Ventricular Bigeminy
- Premature Ventricular Contractions (PVCs)
- Electrolyte Imbalance

### Normal



The pulse pressure is approximately 30–40 mm Hg. The pulse contour is smooth and rounded. (The notch on the descending slope of the pulse wave is not palpable.)

### Small, Weak Pulses



The pulse pressure is diminished, and the pulse feels weak and small. The upstroke may feel slowed, the peak prolonged. Causes include (1) decreased stroke volume, as in heart failure, hypovolemia, and severe aortic stenosis; and (2) increased peripheral resistance, as in exposure to cold and severe heart failure.

### Large, Bounding Pulses



The pulse pressure is increased, and the pulse feels strong and bounding. The rise and fall may feel rapid, the peak brief. Causes include (1) increased stroke volume, decreased peripheral resistance, or both, as in fever, anemia, hyperthyroidism, aortic regurgitation, arteriovenous fistulas, and patent ductus arteriosus; (2) increased stroke volume because of slow heart rates, as in bradycardia and complete heart block; and (3) decreased compliance (increased stiffness) of the aortic walls, as in aging or atherosclerosis.

### Bisferiens Pulse



A bisferiens pulse is an increased arterial pulse with a double systolic peak. Causes include pure aortic regurgitation, combined aortic stenosis and regurgitation, and, though less commonly palpable, hypertrophic cardiomyopathy.

### Pulsus Alternans



The pulse alternates in amplitude from beat to beat even though the rhythm is basically regular (and must be for you to make this judgment). When the difference between stronger and weaker beats is slight, it can be detected only by sphygmomanometry. Pulsus alternans indicates left ventricular failure and is usually accompanied by a left-sided  $S_3$ .

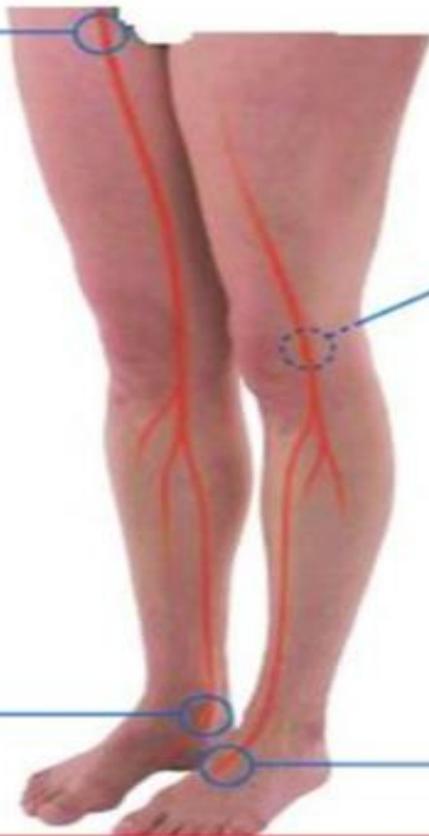
### Bigeminal Pulse



Premature contractions

This disorder of rhythm may mimic pulsus alternans. A bigeminal pulse is caused by a normal beat alternating with a premature contraction. The stroke volume of the premature beat is diminished in relation to that of the normal beats, and the pulse varies in amplitude accordingly.

# Pulse Points in Lower Limb



# Significance of peripheral leg artery palpation

## 1. Femoral artery

Abnormal findings may indicate proximal arterial disease.

## 2. Popliteal artery

Popliteal pulse is often difficult to palpate normally.

Abnormalities may suggest:

- Popliteal artery stenosis
- Thromboembolic obstruction

# Significance of peripheral leg artery palpation

## 3. Posterior tibial artery

Loss of pulse may indicate distal arterial insufficiency.

Abnormalities may suggest :

- Advanced diabetic foot
- Severe peripheral ischemia
- Small vessel disease

## 4. Dorsalis pedis artery

This pulse is important for foot perfusion assessment.

Abnormal findings occur in:

- Early peripheral arterial disease
- Embolic occlusion
- Advanced atherosclerotic disease

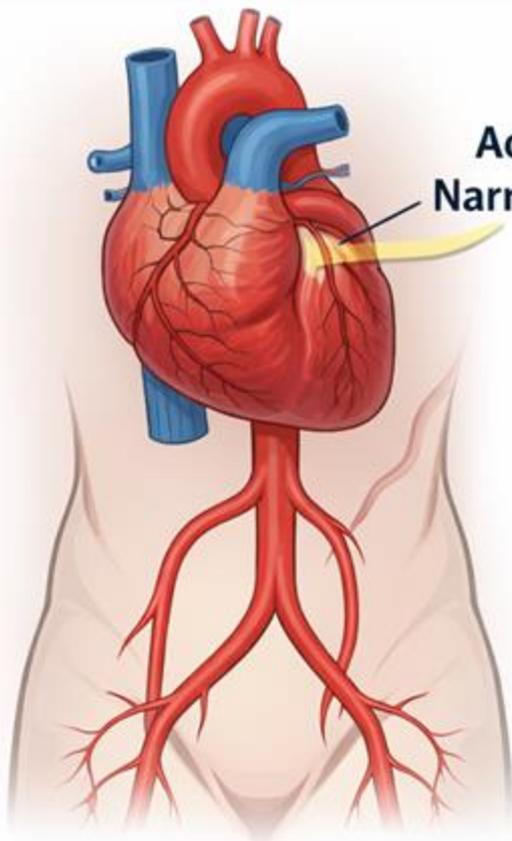
# Radio-femoral delay

- Normally, femoral pulse should be felt slightly before or at the same time as radial pulse because the femoral artery is closer to the heart.
- Radio-femoral delay means the radial pulse (wrist) is felt before the femoral pulse (groin).

When the left ventricle ejects blood into the aorta, it creates a pressure wave that travels along the arterial walls.

The femoral artery is anatomically closer to the aorta.

# Radial Femoral Delay



Aortic  
Narrowing



## Radial Pulse



✓ Radial Pulse First

## Femoral Pulse



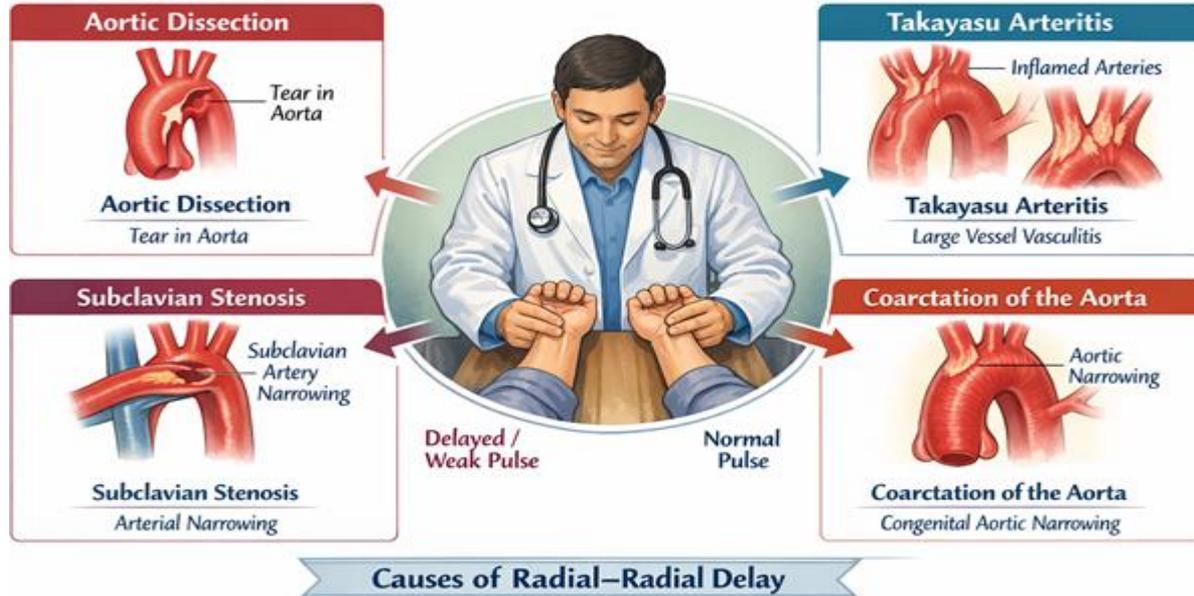
⊘ Delayed Femoral Pulse

Radial Pulse Felt BEFORE Femoral Pulse



# Radial-radial delay

- A difference in timing or strength between the right and left radial pulses (palpated at both wrists).
- It happens when there is obstruction or narrowing in one of the major arteries.



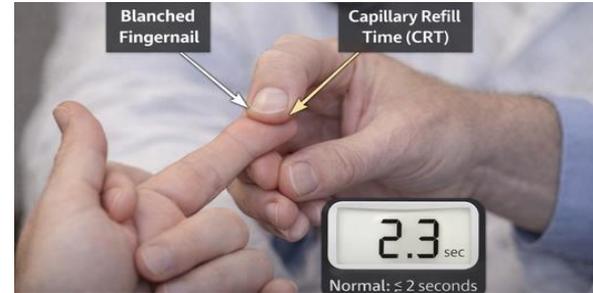
# Capillary refill time

- **Capillary refill time (CRT)** is checked by pressing on the skin (usually a nail bed or fingertip) and measuring how long it takes for color to return after releasing pressure.

The most reliable and applicable site for CRT testing is the finger pulp (not at the fingernail), and the cut-off value for the normal CRT should be 3 seconds.

## Prolonged CRT may indicate:

- Hypovolemia
- Cardiogenic shock
- Peripheral vascular disease



# Auscultation of the Carotid Artery

## Normal finding

- Usually **no sound**

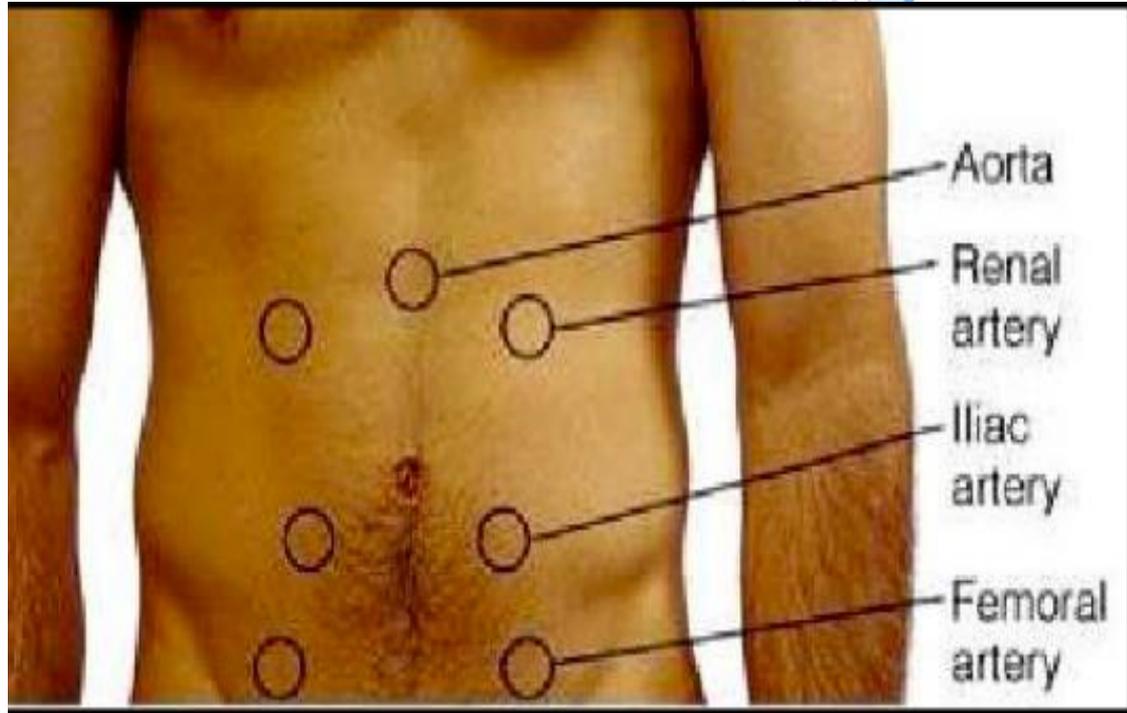
## Pathological finding – Carotid bruit

Most commonly associated with:

- Atherosclerosis → most frequent cause
- Carotid artery stenosis
- High cardiac output states (anemia, hyperthyroidism)



# Auscultation of Arteries



# Auscultation of the Renal Artery

- is performed to detect renal artery bruits, which are signs of turbulent blood flow usually caused by renal artery narrowing.

A **renal bruit** is a blowing or whooshing sound caused by turbulent flow.

## **Most commonly associated with:**

- Renal artery stenosis
- Atherosclerosis
- Fibromuscular dysplasia

# Auscultation of the Aorta

- Listen in the epigastric region, along the course of the abdominal aorta
- The abdominal aorta is usually located slightly above the umbilicus, in the midline.

## Common causes:

- Abdominal aortic aneurysm
- Atherosclerosis
- Aortic stenosis with transmitted vascular turbulence

# Auscultation of the Femoral Artery

- The femoral artery is auscultated in the **inguinal region**, just below the inguinal ligament.
- Bruits (suggesting stenosis)
- Abnormal vascular sounds

**Traube's sign**- a loud, booming "pistol-shot" sound over the femoral arteries, occurring in both systole and diastole.

## **Seen in:**

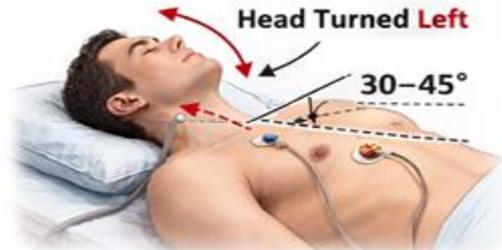
- Severe aortic regurgitation

**Duroziez's sign**- a clinical finding of double murmur heard over a partially compressed femoral artery, indicative of significant aortic regurgitation.

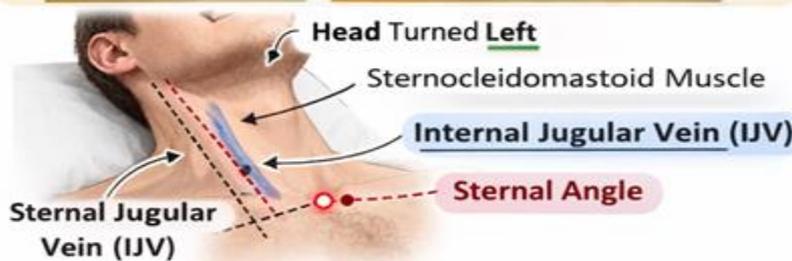
It features a systolic bruit and a diastolic murmur, resulting from rapid, reversed arterial flow.

# Assessment of Jugular Pulsation (JVP)

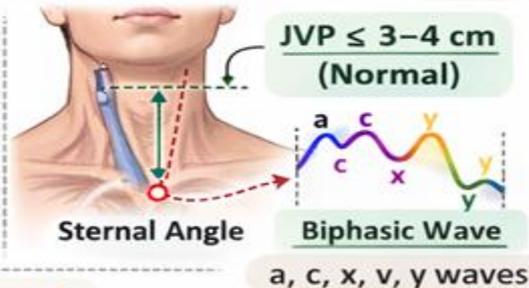
## 1. Patient Position (30–45°)



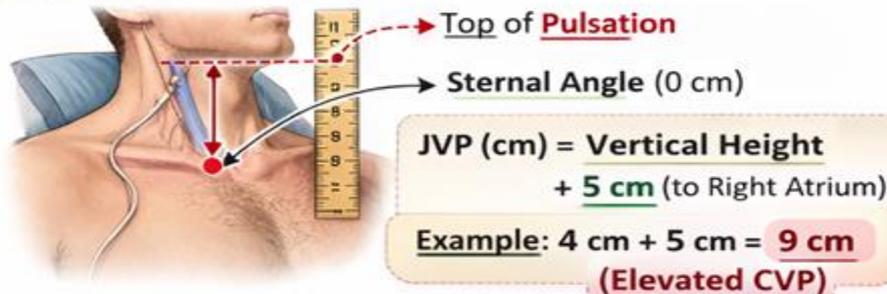
## 2. Site of Inspection – Right Internal Jugular Vein (IJV)



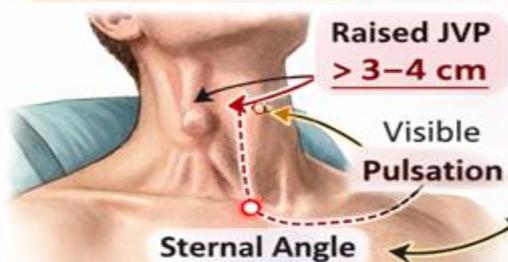
## 3. Normal Jugular Pulsation (Wave)



## 4. How to Measure JVP?



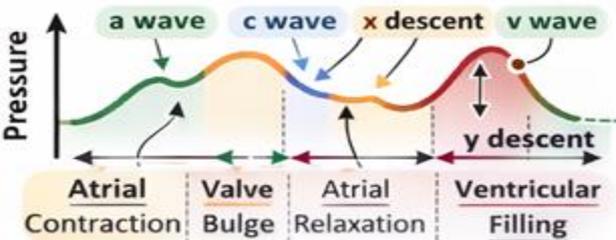
## 5. Abnormal JVP (Elevated)



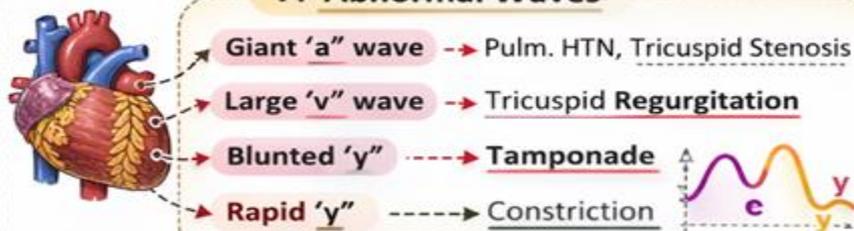
## Causes of Raised JVP



## 6. Wave Components (Normal)



## 7. Abnormal Waves



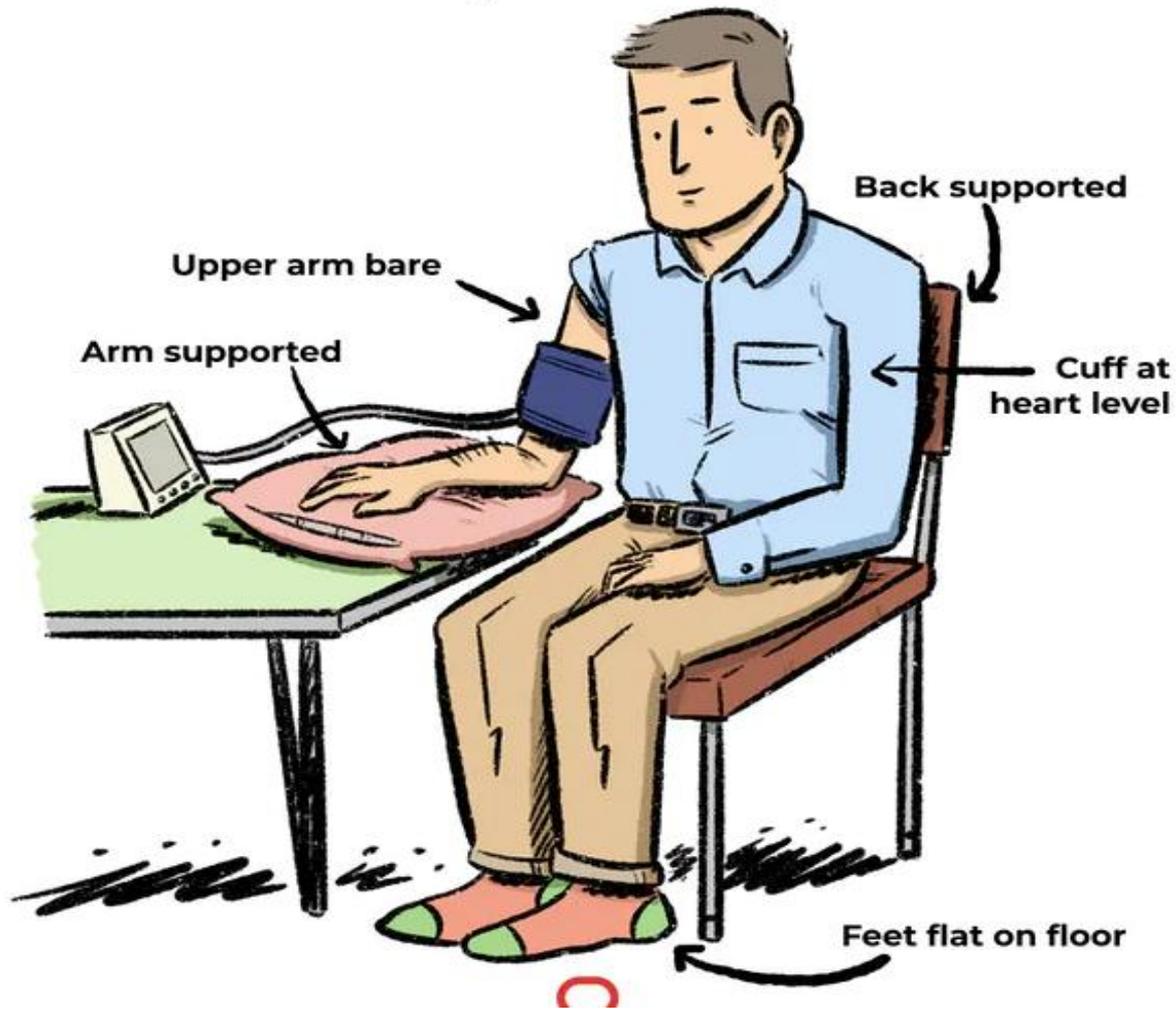
## Summary

- ✓ Patient **30–45°**
- ✓ Head **Left**
- ✓ Inspect **Right IJV**
- ✓ JVP  $\leq$  3–4 cm = Normal  
 $>$  3–4 cm = **Elevated**

# Blood Pressure Classification

Category	Systolic (mmHg)	Diastolic (mmHg)	Risk Level
● Non-Elevated BP	< 120	< 70	Low cardiovascular risk
● Elevated BP	120 – 139	70 – 89	Increased cardiovascular risk
● Hypertension	≥ 140	≥ 90	High cardiovascular risk

# How to sit to have your blood pressure taken



# Pulse Pressure

- The difference between **systolic** and **diastolic** blood pressure.

**Pulse pressure = Systolic BP – Diastolic BP**

Normal pulse pressure  $\approx$  **30–50 mmHg**

Pulse pressure reflects:

- The stroke volume (amount of blood ejected by the left ventricle)
- The elasticity (compliance) of the arteries
- The condition of large arteries (especially the aorta)

# Pulse Pressure

- **PP > 50–60 mmHg**

## **Example:**

- 160/60 → PP = 100 mmHg (very wide)

## **Causes:**

- Aortic regurgitation
- Arteriosclerosis (elderly patients)
- Hyperthyroidism
- Anemia

## **Why?**

- Increased stroke volume
- Decreased arterial elasticity (stiff arteries)

# Pulse Pressure

- **PP < 30 mmHg**

## **Example:**

- 90/80 → PP = 10 mmHg (very narrow)

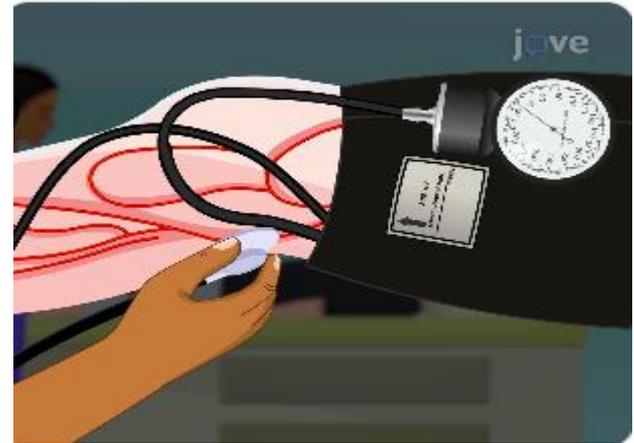
## **Causes:**

- Cardiogenic shock
- Cardiac tamponade
- Severe heart failure
- Massive hemorrhage
- Severe aortic stenosis

## **Why?**

- Low stroke volume
- Reduced cardiac output

- **Thigh systolic BP** is normally **10–20 mmHg higher than arm systolic BP**.
- If thigh systolic is **lower than arm systolic**, suspect **coarctation of the aorta** or significant peripheral arterial disease.



# Ankle-Brachial Index (ABI)

A simple, non-invasive test that compares ankle systolic BP to brachial (arm) systolic BP to detect peripheral arterial disease.

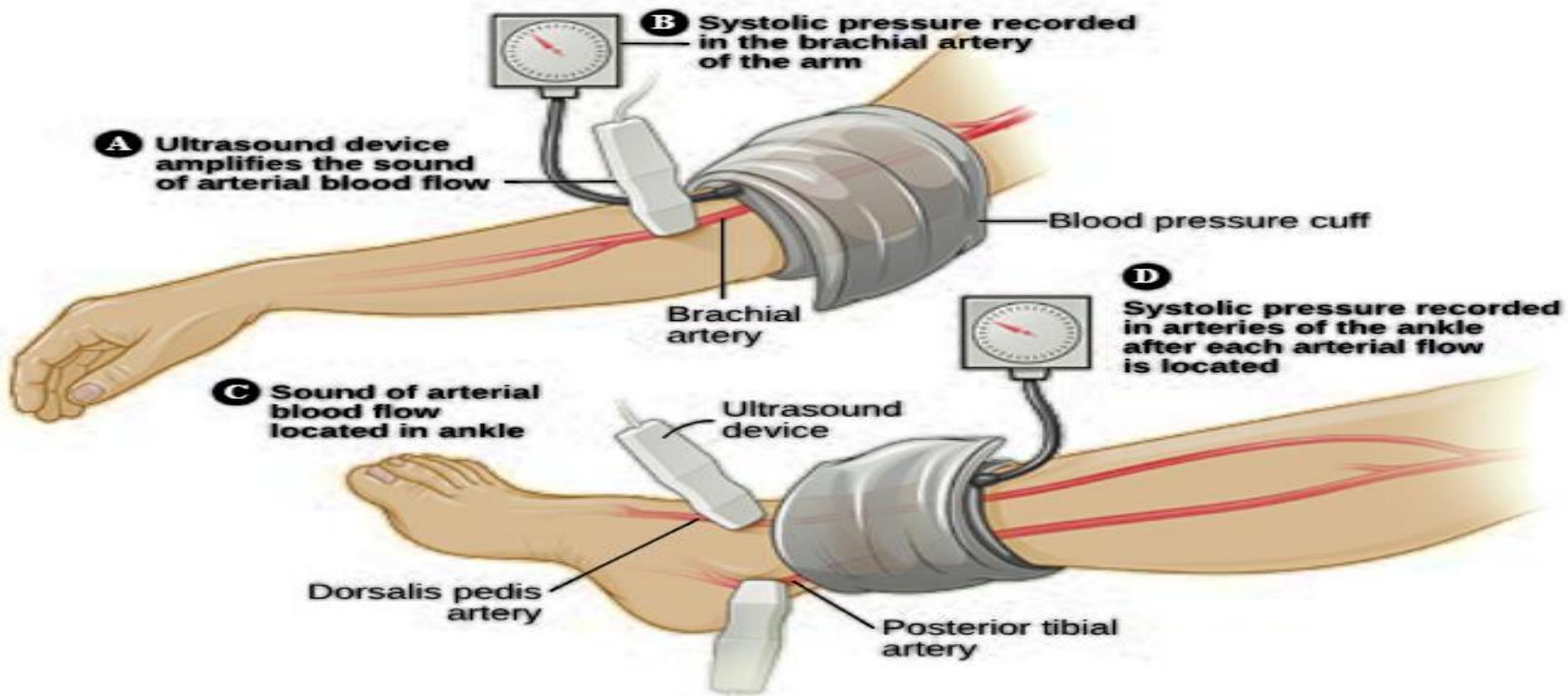
## 1. Measure systolic BP in **both arms**

- Use Doppler if available

## 2. Measure Ankle Systolic Pressure (Both Legs)

- Measure systolic pressure using Doppler at dorsalis pedis artery and posterior tibial artery;
- For each leg, record the higher of the two ankle pressures.

$$\text{ABI} = \frac{\text{Higher ankle systolic pressure (per leg)}}{\text{Higher brachial systolic pressure}}$$



# Ankle-Brachial Index Interpretation Values

ABI Value	Interpretation	Clinical Meaning
1.00 – 1.40	✔ Normal	No significant PAD
0.91 – 0.99	Borderline	Possible early disease
0.70 – 0.90	Mild PAD	Claudication likely
0.40 – 0.69	Moderate PAD	Significant obstruction
< 0.40	Severe PAD	Critical limb ischemia

## Important Clinical Notes

ABI  $\leq$  0.90 = **diagnostic for PAD**

ABI > 1.40 → suspect arterial stiffness → consider **Toe-Brachial Index**

Perform after exercise if resting ABI is normal but symptoms suggest claudication

*“The heart is the core  
of our being;  
understanding and  
caring for it is at  
the very heart  
of medicine.”*

*— Unknown*





*Thank  
you*