CHEST

The Seminar

TRAUMA

Presenters

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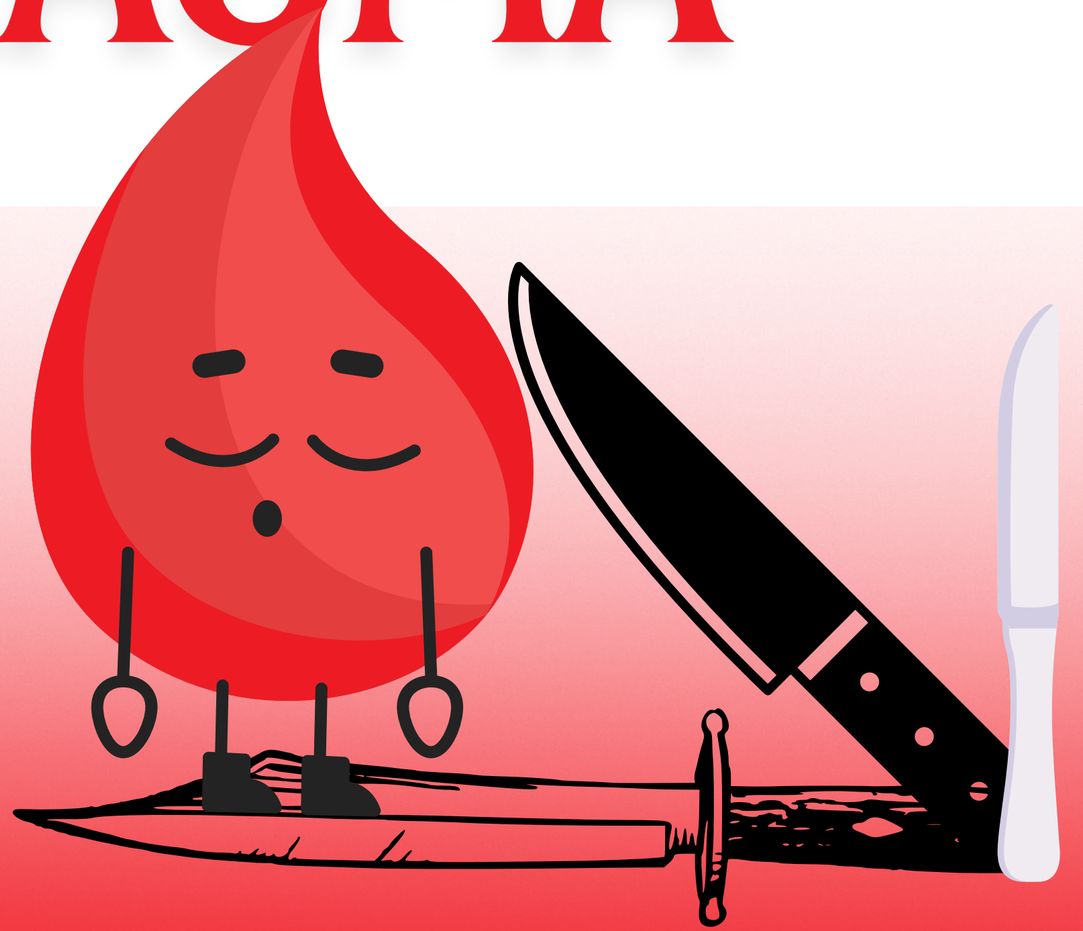
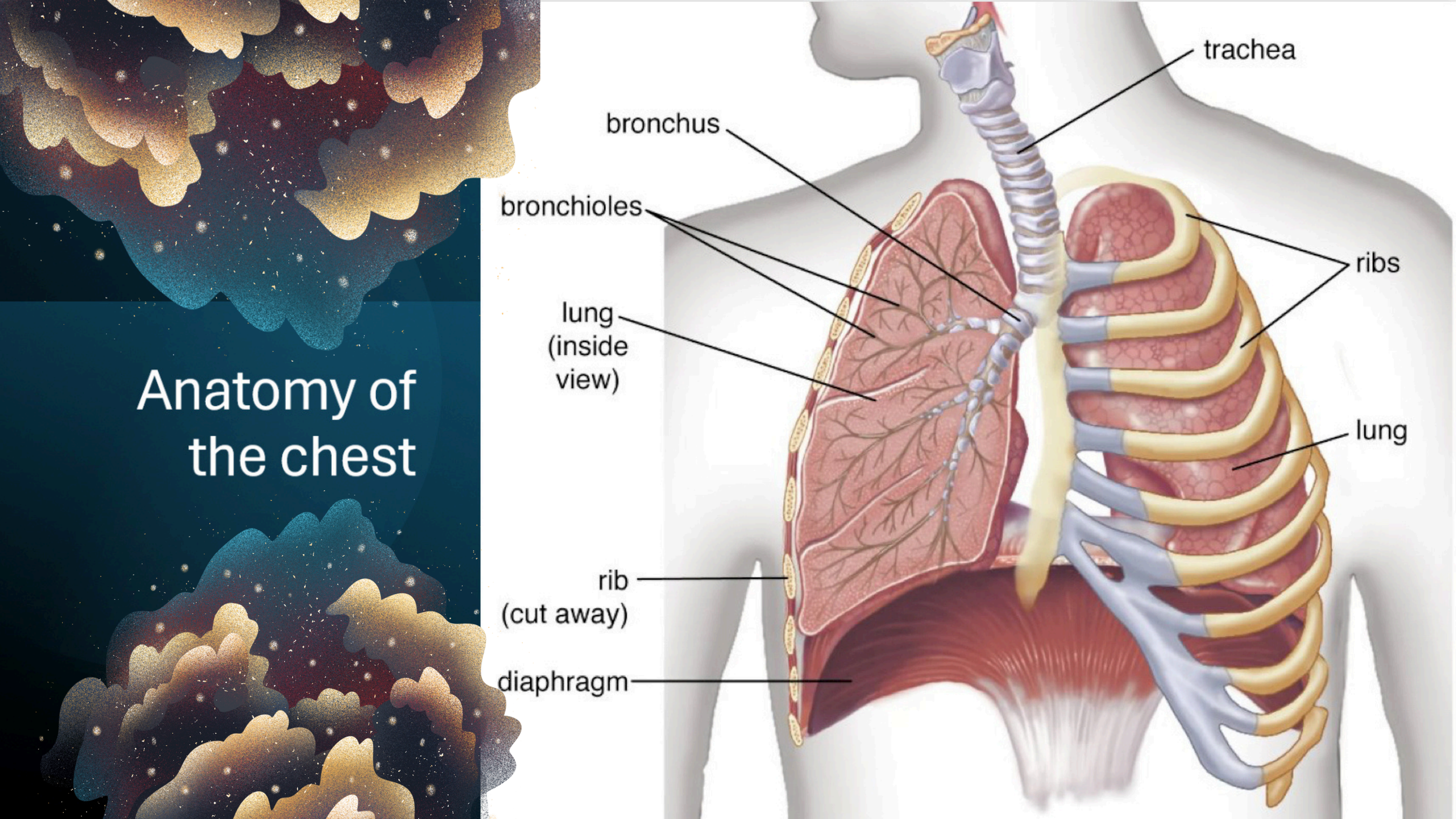
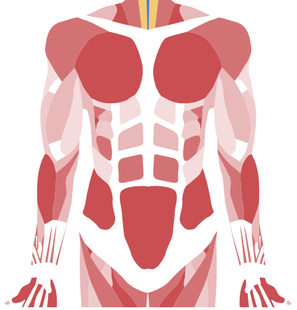


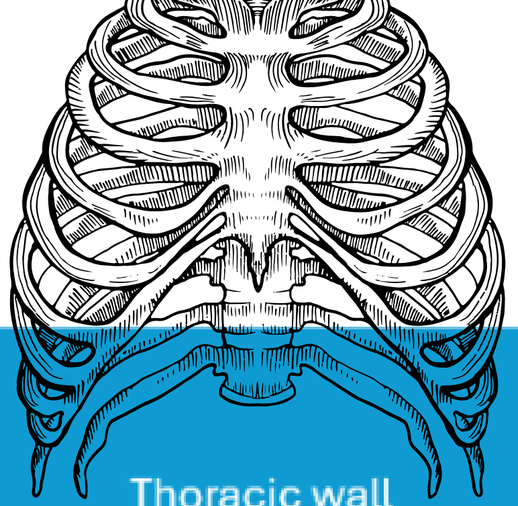
Anatomy of the chest



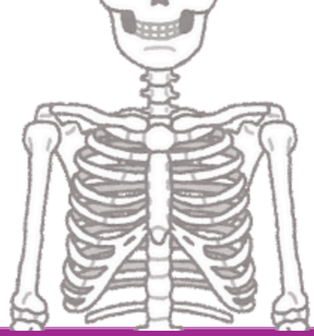
The chest, properly called the thorax, is the superior part of the trunk located between the neck and the abdomen



It consists of several components

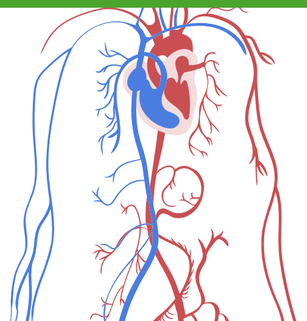


Thoracic wall

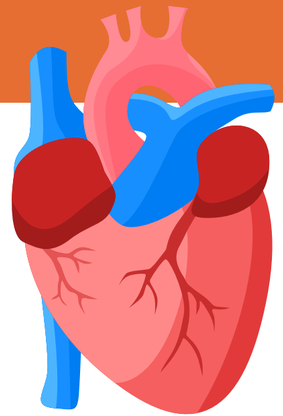


Several cavities

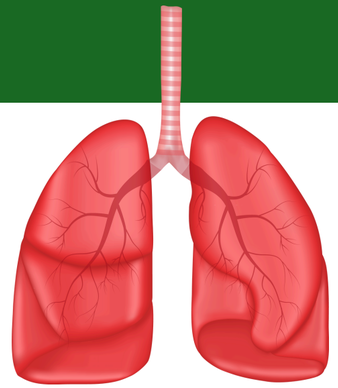
Neurovasculature and lymphatics

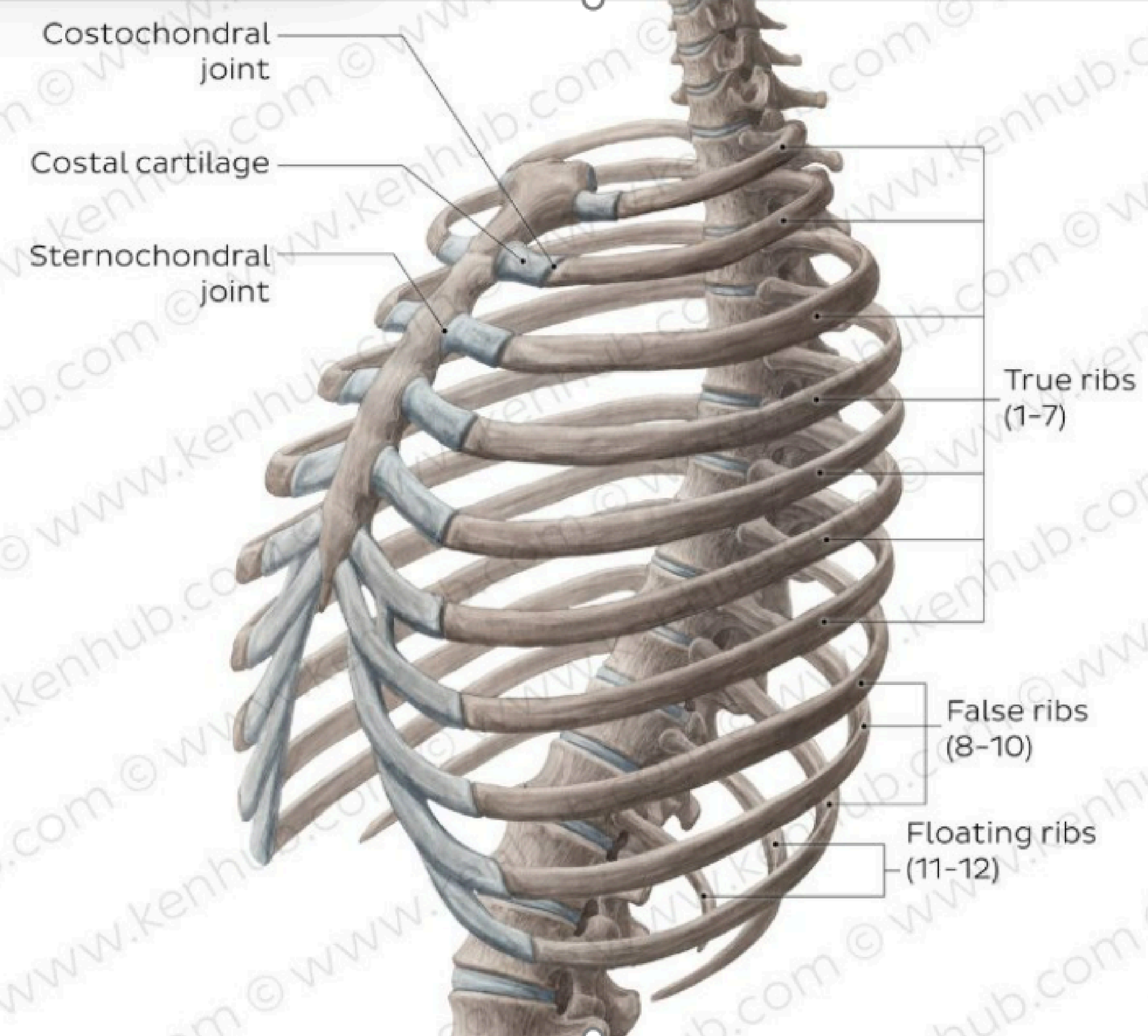


Internal organs



Breasts





The first step in understanding the thorax anatomy is finding out its boundaries

The thoracic wall
Consists of : skeletal framework, fascia , muscles and neurovasculature – all connected together to form a strong yet flexible cage

The thorax has two major openings : the superior thoracic aperture and the inferior thoracic aperture

The superior thoracic aperture is bounded by the first pair of ribs , body of t1 , manubrium sterni

The inferior thoracic aperture is almost complete covered by the diaphragm

The thoracic skeleton, is made up of the sternum , twelve pairs of ribs, twelve thoracic vertebrae and interconnecting joints

Running between every two ribs is the intercostal space, it contains the intercostal muscles (external , internal , innermost) with the neurovascular bundle (11 intercostal spaces in total)

finally the thoracic muscles responsible for breathing in addition to the diaphragm and intercostal muscles

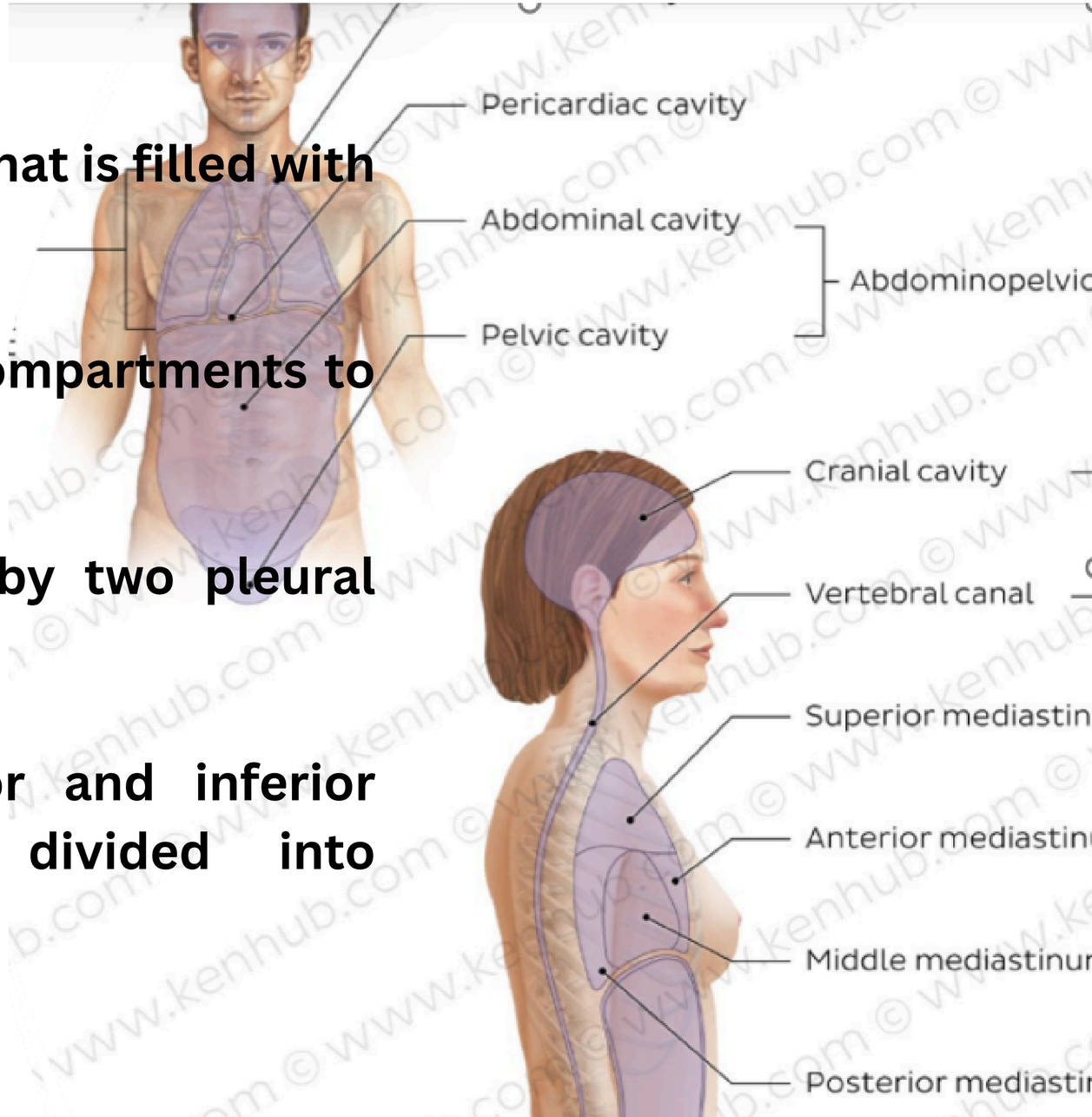
Cavities of the thorax

The thoracic wall actually encloses a cavity, that is filled with various anatomical structures.

The thoracic cavity is divided into several compartments to aid their localization

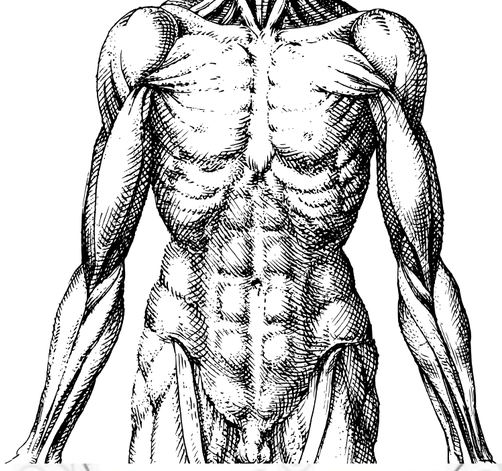
Mediastinum : located centrally bounded by two pleural cavities laterally

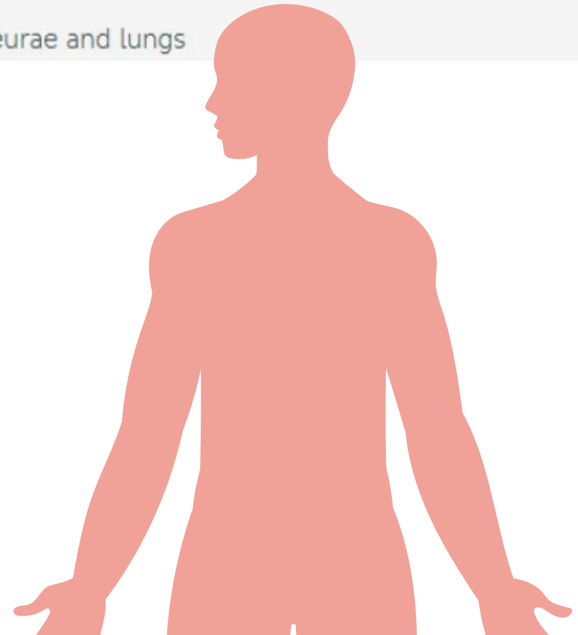
The mediastinum is divided into superior and inferior mediastinal cavities (the inferior is divided into anterior,middle and posterior compartment)

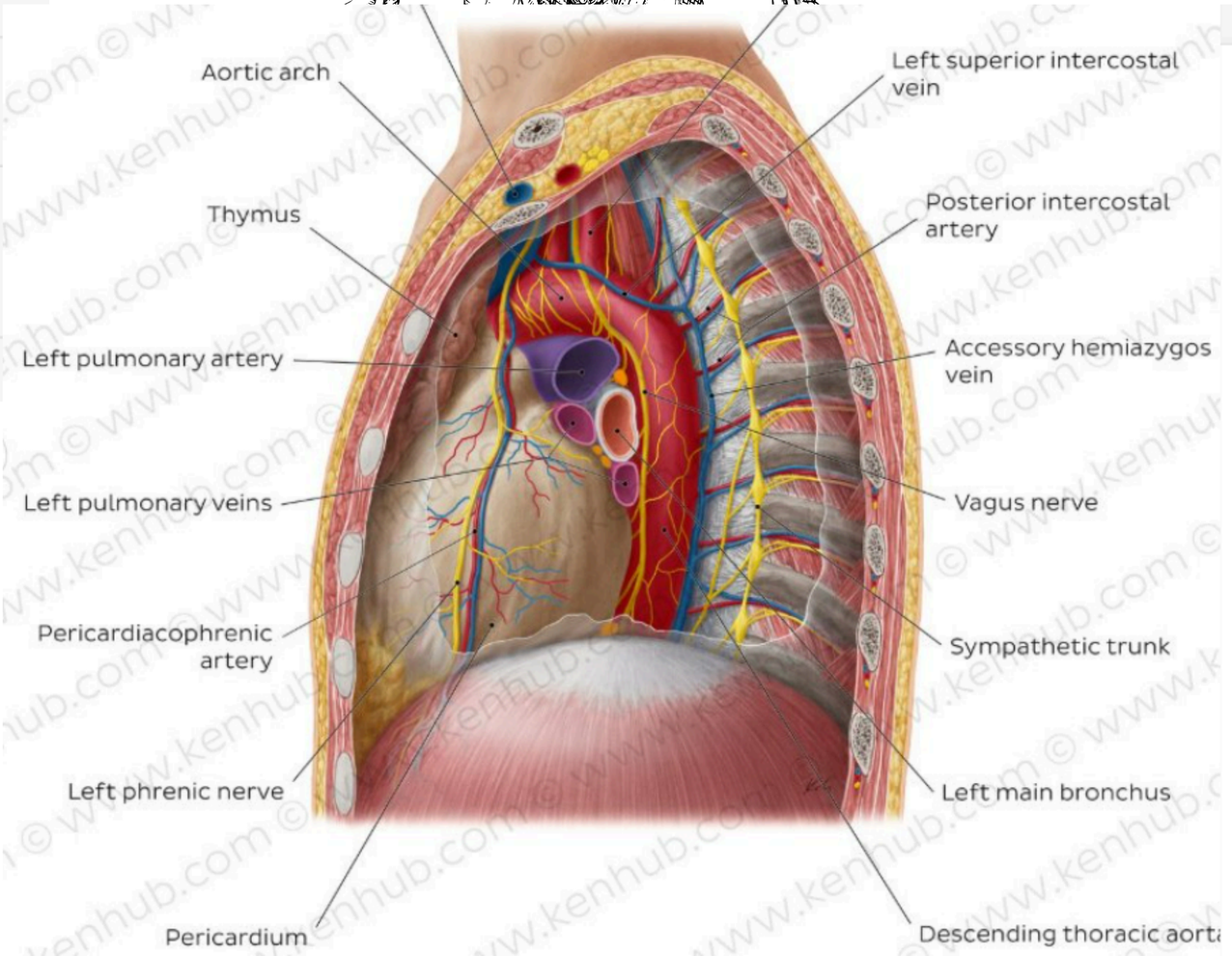


Contents of the thoracic cavity — Table quiz

Superior mediastinum	Thymus, trachea, esophagus, aortic arch, brachiocephalic trunk, left common carotid artery, left subclavian artery, internal thoracic arteries, superior vena cava, left superior intercostal vein, brachiocephalic veins, phrenic nerves, vagus nerves, left recurrent laryngeal nerve, thoracic duct, lymph nodes and vessels
Anterior mediastinum	Portion of the thymus, adipose and connective tissue, lymph nodes, branches of internal thoracic vessels, sternopericardial ligaments
Middle mediastinum	Pericardium, heart, pulmonary trunk, ascending aorta, pulmonary veins, superior vena cava, inferior vena cava, tracheal bifurcation, main bronchi
Posterior mediastinum	Esophagus, esophageal plexus, thoracic aorta and its branches, azygos and hemiazygos venous systems, thoracic duct, sympathetic trunk, thoracic splanchnic nerves
Pleural cavities	Pleurae and lungs

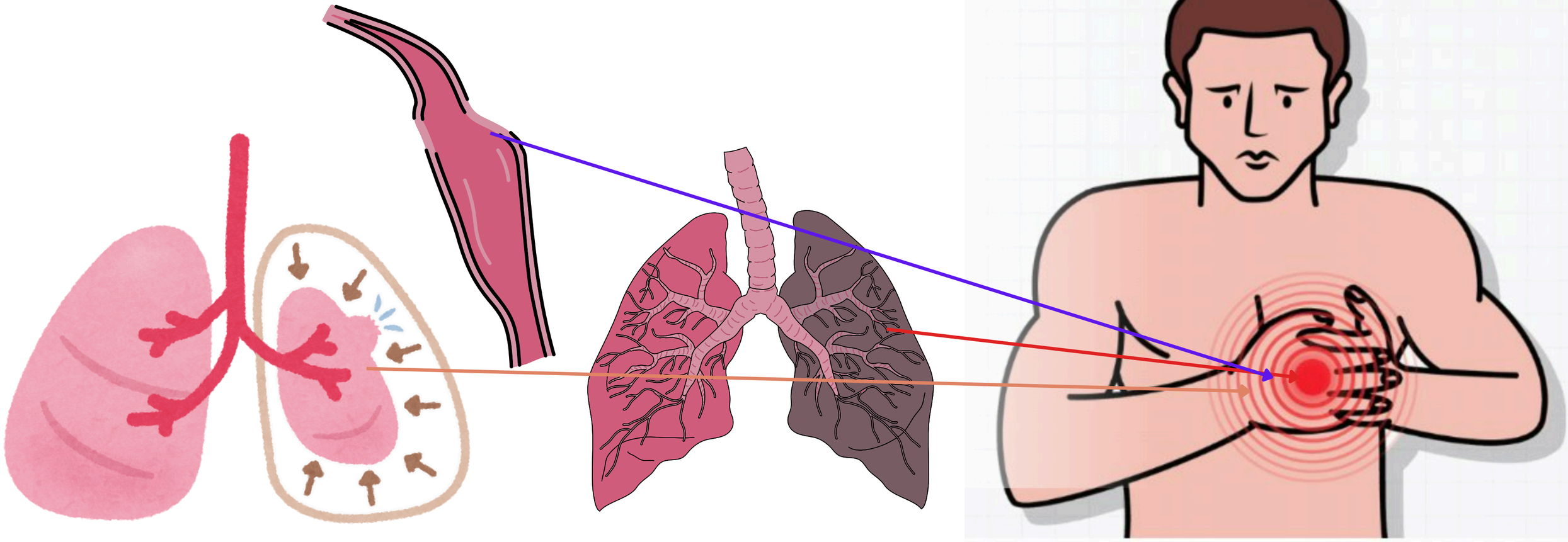






What is chest trauma?

Any trauma which leads to injury to chest is termed as chest trauma.
A chest injury is any form of physical injury to chest including the ribs , heart and the lungs .
It ranges from mild (like bruising) to life threatening conditions (like pneumothorax or cardiac tamponade.



Epidemiology

chest trauma is the second most frequently occurring unintentional traumatic injury and the thirs most common cause of death after abdominal injury and head trauma in patients with polytrauma.

Chest trauma results in high mortality reaching up to 60%,

In patients with severe trauma, 25% of deaths are due to chest trauma

Blunt trauma accounts for 80% of chest trauma

Gender : male 70-80%

Age: 15-40 years old due to high risk behaviors (driving , sports and violence)
Elderly patients are also at risk due to falls and have higher complication rates
It results in 16,000 deaths in the US per year
Chest injuries often times require icu admission, mechanical ventilation and surgical intervention leading to increased healthcare costs and longer hospital stays

Types of CHEST TRAUMA

- Blunt trauma : blunt force to the chest, distributed over large area

Examples include:

- Motor vehicle accidents
- Automobile vs pedestrian
- Falls > 3m
- Blast injury
- Penetrating trauma : projectile that enters the chest causing small or large hole, distributed over small area
- Either high velocity (gunshot , missile fragments) or low velocity (stab wound)

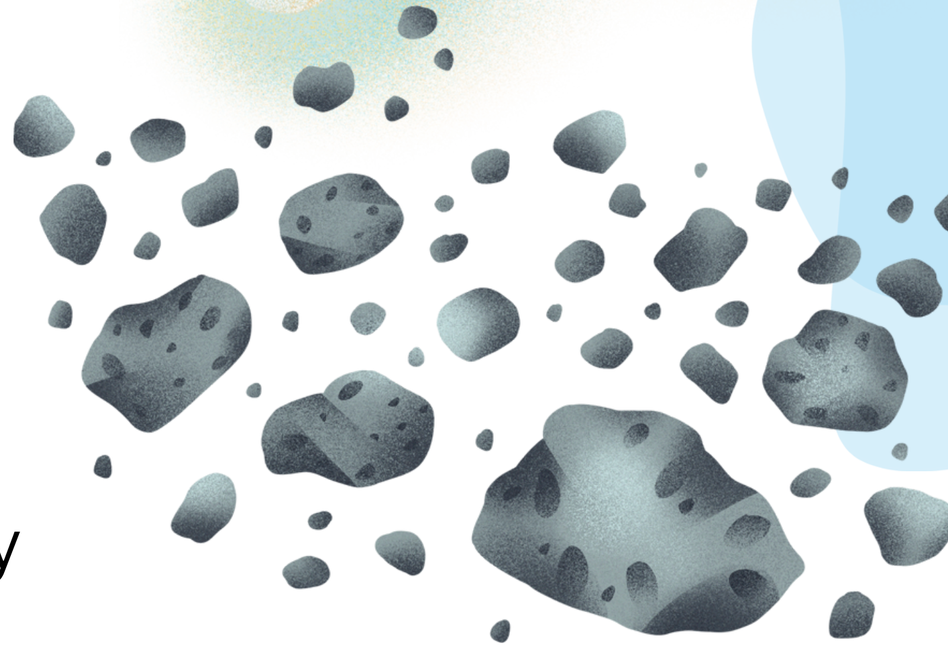
Skeletal injury :

1.Rib fracture :

A partial or complete break in a rib bone. Clinical features include pain on inspiration, respiratory distress, tachypnea, shallow breathing, crepitus, focal chest wall tenderness, and chest wall deformity.

Etiology

- Blunt thoracic trauma (e.g., RTA, fall from height)
- Nonaccidental trauma



Clinical features

- Pleuritic chest pain
- Respiratory distress (e.g., tachypnea, dyspnea)
- Chest wall tenderness, bruising, and/or deformity
- Crepitus

•Diagnosis :

•Minor trauma: CXR (AP and lateral view)

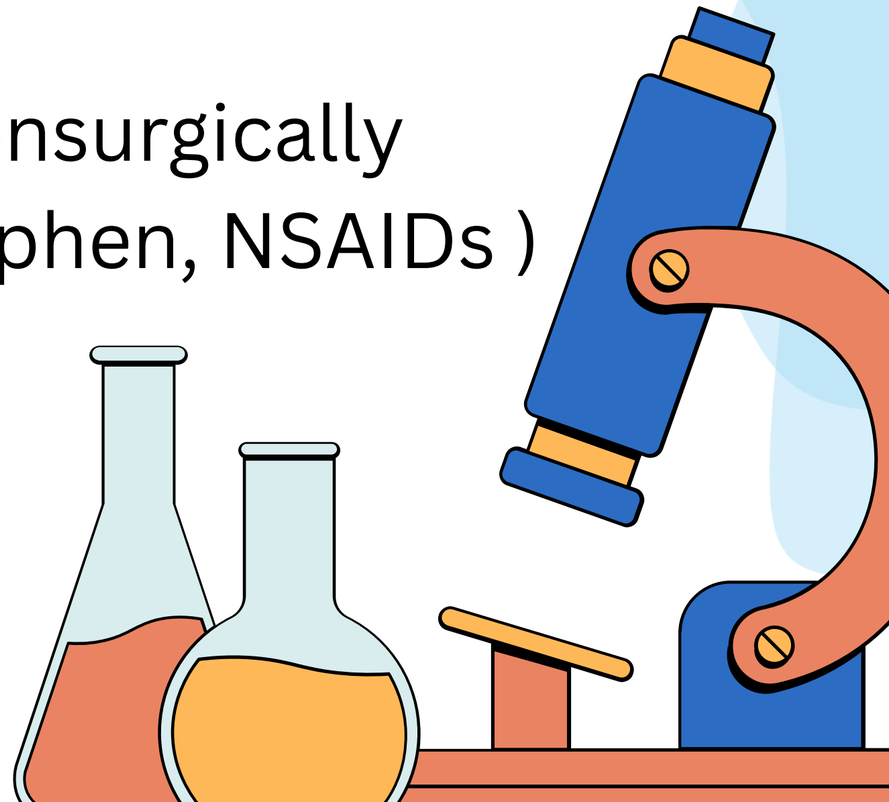
•Major trauma: chest CT.

Treatment :

Isolated rib fractures: typically managed nonsurgically

•Provide pain management (e.g., acetaminophen, NSAIDs)

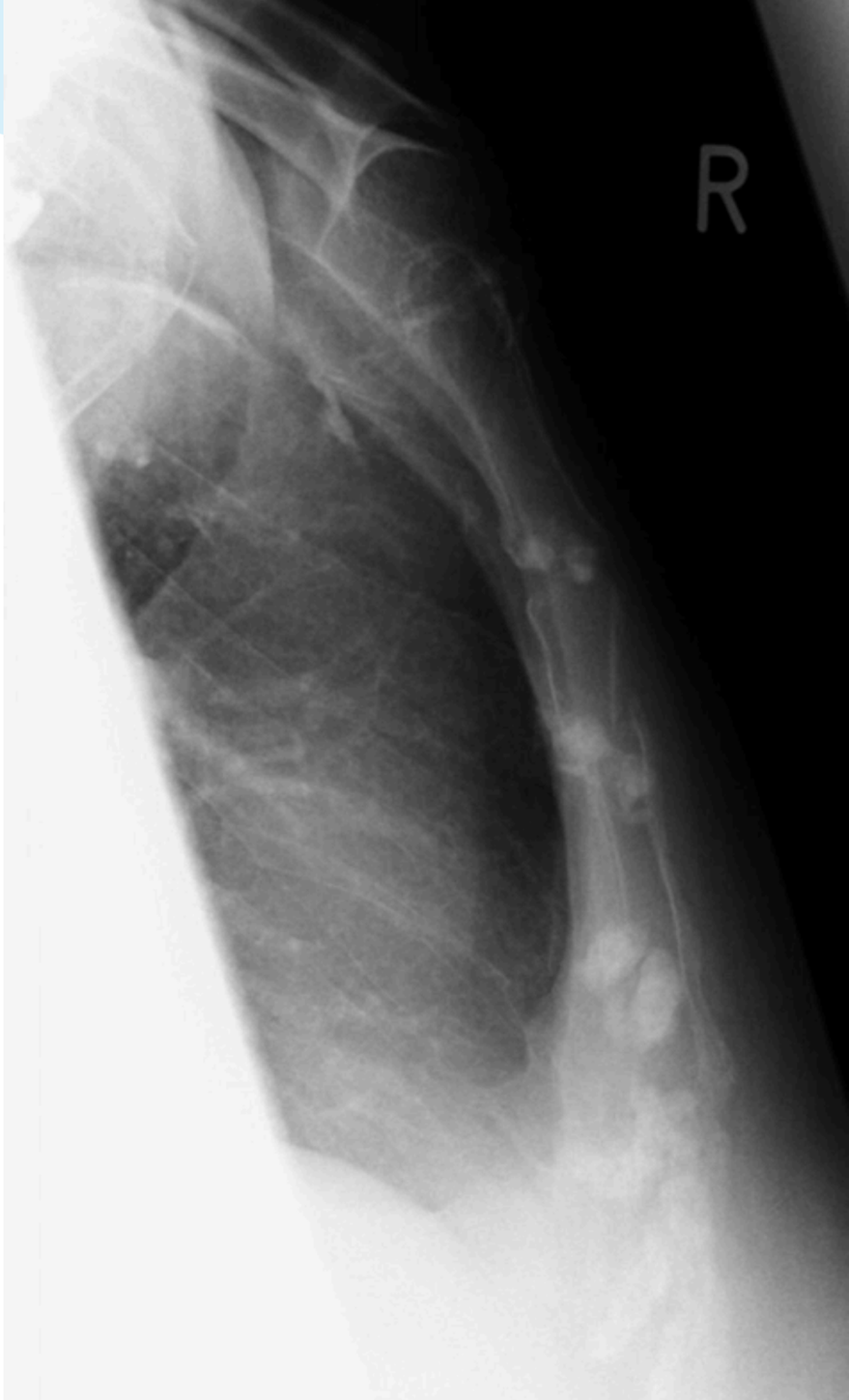
Encourage deep breathing exercises .



2.Sternal fracture:

•A fracture of the sternum that typically occurs as a result of blunt chest trauma.

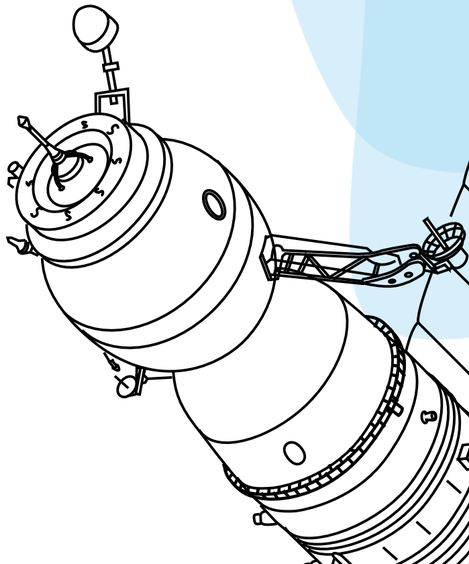
Clinical features include :
chest pain and tenderness, difficulty breathing, and bruising over the sternal area.
Treatment involves pain control and, in severe cases, surgical stabilization.



Diagnosis

A portable CXR is often the first imaging test obtained in the trauma bay and is typically unremarkable in a patient with isolated sternal fracture

CT scan remains the gold-standard for diagnosis of sternal fracture , also CT detects associated thoracic injuries in over 80% of patients.

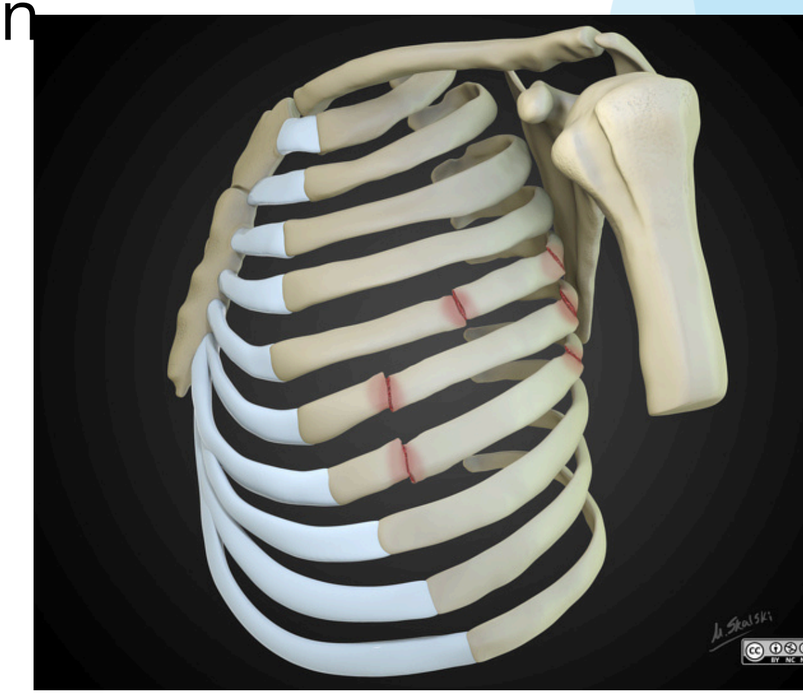


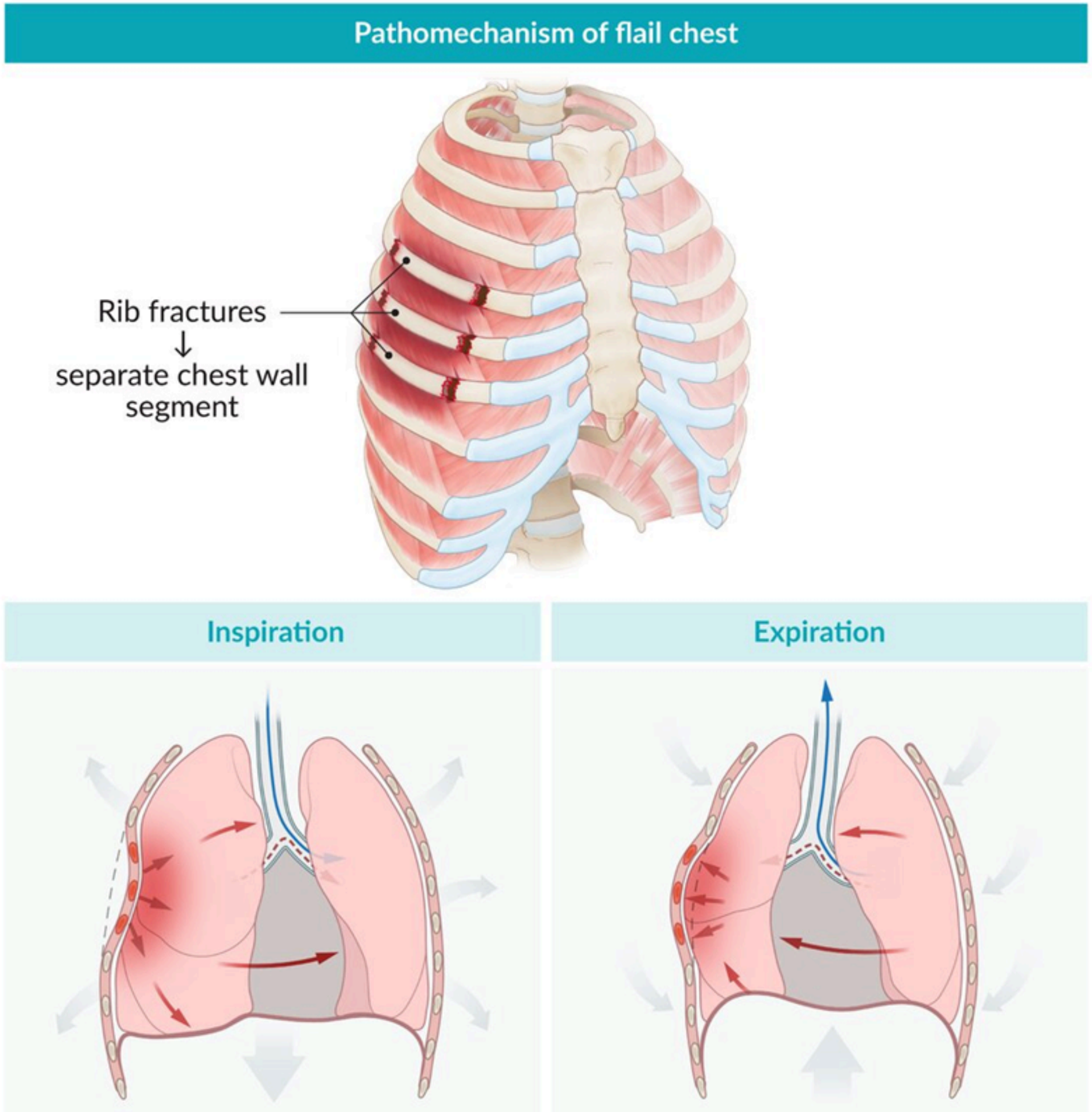
3.Flail Chest

Flail chest is a serious thoracic injury resulting from blunt trauma, characterized by the fracture of three or more adjacent ribs in at least two places. This creates a segment of the chest wall that moves independently, leading to significant respiratory complications.

- The flail segment moves inward during inspiration and outward during expiration, opposite to the normal chest wall movement.

This paradoxical motion impairs ventilation and can lead to hypoxia.





Paradoxical chest movement: The floating rib segment moves inward during inspiration and outward during expiration

Diagnosis

- **Clinical Evaluation:**

1. Paradoxical chest wall movement with respiration.

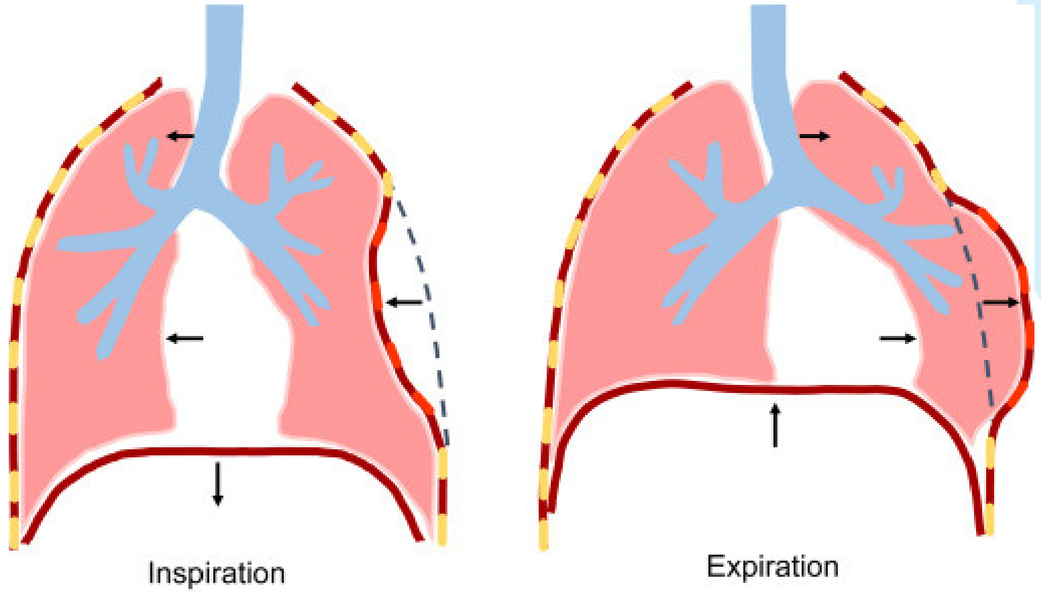
2. Impaired respiratory movement of the affected lung.

3. Pendulum breathing.

4. Mediastinal flutter.

5. Circulatory failure.

6. Lung contusion and laceration.



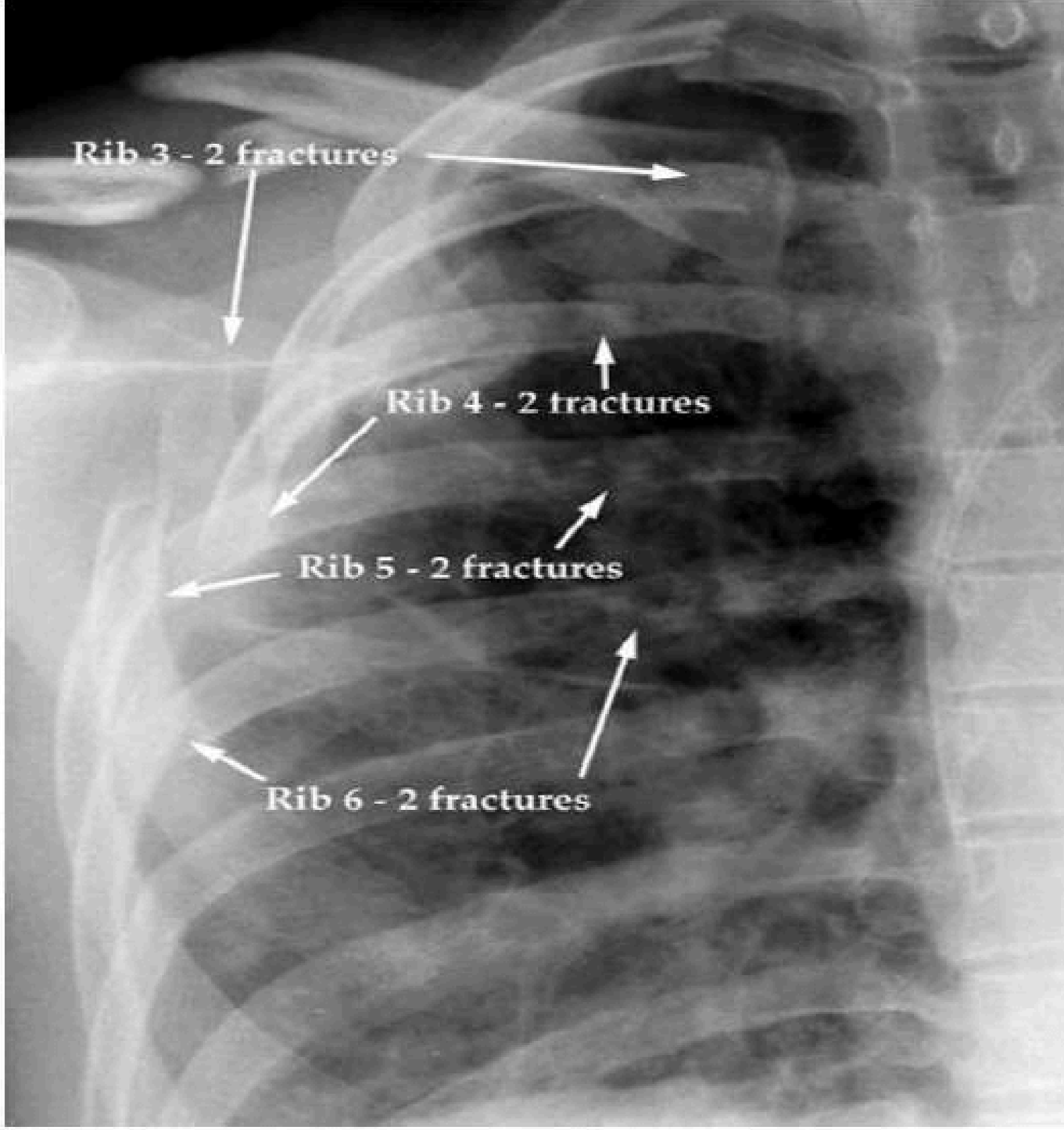
7-Palpation revealing crepitus and tenderness over the affected area.

- **Imaging**:
  - Chest X-ray:
  - CT Scan: Provides a more detailed assessment of rib fractur

Chest X-ray Findings:

Multiple adjacent rib fractures.

Possible evidence of pulmonary contusion or other thoracic injuries.

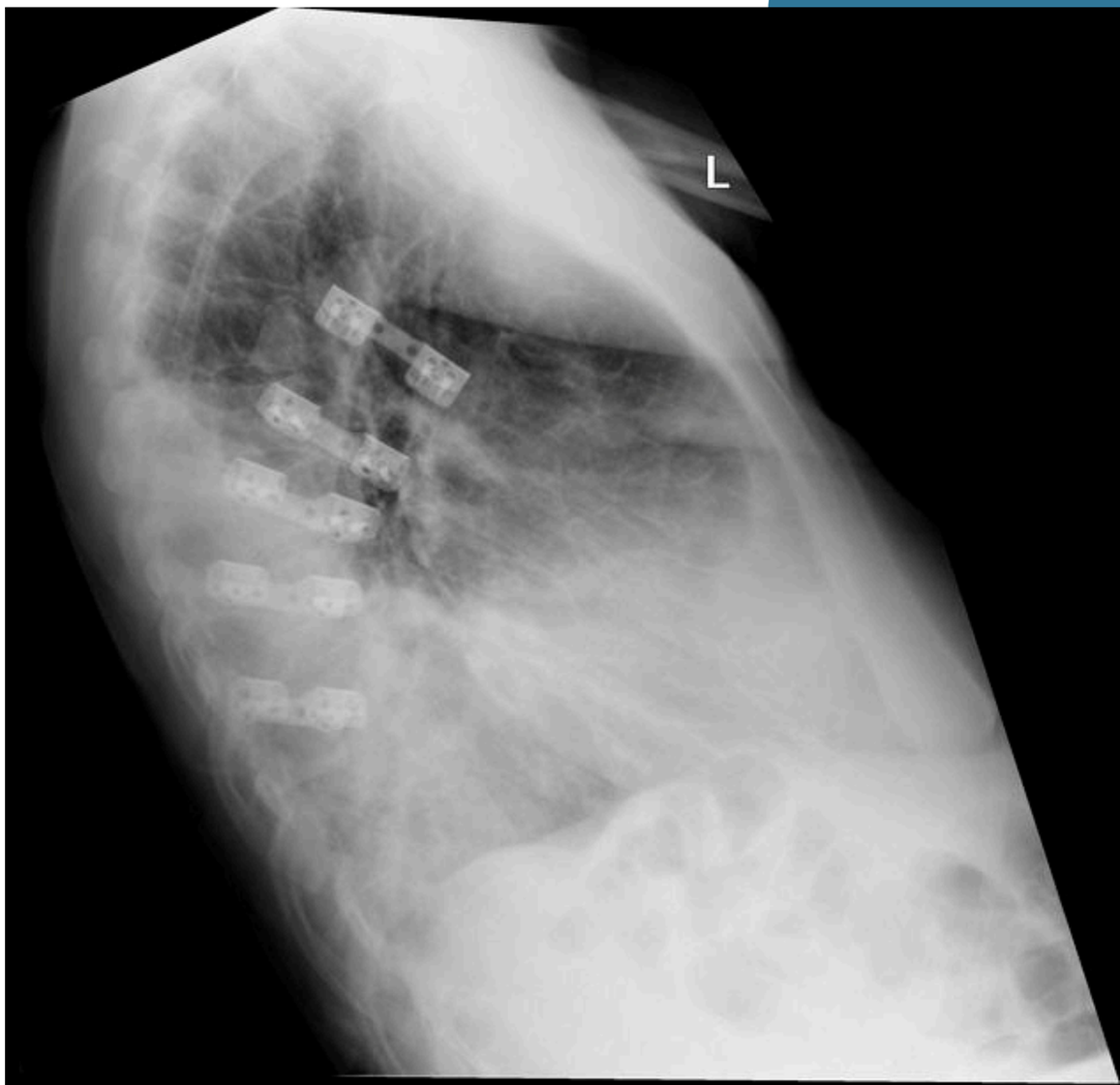


Managment:

- Pain managmant
- Respiratory Support
- In Sever cases:

-Internal fixation of the flail segment:
By endotracheal intubation with intermittent positive pressure ventilation

-Open reduction and internal fixation:
Only if thoracotomy is indicated for another cause.



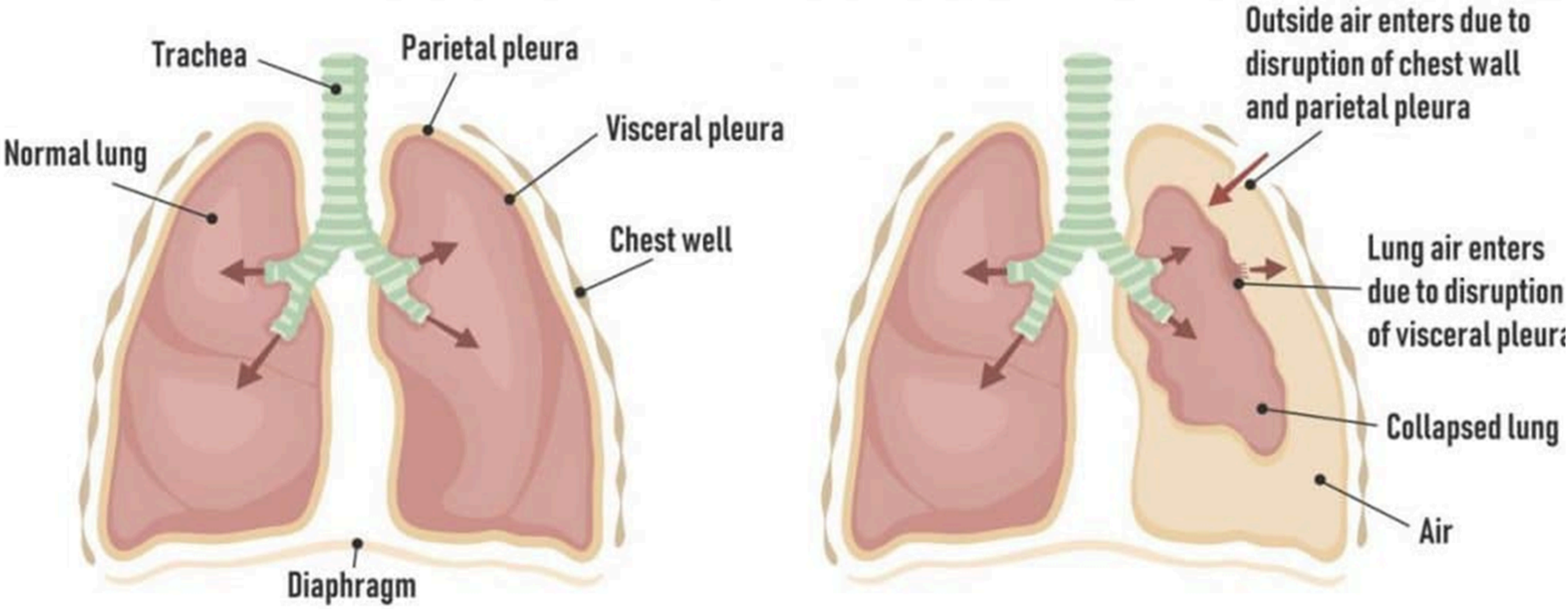
Pulmonary injury :

- **Pneumothorax:** a collection of air within the pleural space between the visceral pleura and the parietal pleura.

- Air within the pleural cavity causes the physiological pleural seal to be lost, meaning the normal negative pressure in this space, that aids the lung expanding with chest wall movement, is lost. This impedes lung expansion and lead to partial or total lung collapse.

- Pathophysiology :

Increased intrapleural pressure → alveolar collapse → decreased V/Q ratio and increased right-to-left shunting.


Trachea
Parietal pleura
Visceral pleura
Normal lung
Chest well
Diaphragm
Outside air enters due to disruption of chest wall and parietal pleura
Lung air enters due to disruption of visceral pleura
Collapsed lung
Air

Open pneumothorax

•An open pneumothorax, also known as a sucking chest wound, occurs when there is a breach in the chest wall, allowing air to enter and exit the pleural space freely, leading to the collapse of the lung on the affected side. This condition is often caused by traumatic injury, such as a gunshot or stabbing wound (penetrating), and presents as a medical emergency.

• If untreated, can lead to tension pneumothorax .

•The diagnosis of pneumothorax is usually confirmed by chest x-ray.

•Pneumothorax is very difficult to identify on supine CXR; consider ultrasound or CT chest in patients unable to sit upright.

•All patients with suspected pneumothorax should be approached in an ABCDE approach.

Clinical Features of Open Pneumothorax:

1. Visible Chest Wound:

such as a gunshot, stabbing, or blunt trauma that disrupts the chest cavity.

2. Breathing Difficulties:

shortness of breath is common due to the collapse of the lung.

3. Chest Pain:

Sharp, stabbing pain at the site of injury is typical due to the injury to the chest wall and pleura.

4. Signs of Hypoxia:

•Cyanosis and altered mental status may be present if oxygenation is significantly impaired.

5. Hemodynamic Instability:

In severe cases, there may be shock, which presents with hypotension, tachycardia , and pale or cool skin.

6. Audible or Visible Air Movement:

Air may be heard or felt moving through the wound with each breath, which is the characteristic "sucking" sound of air

•Subcutaneous emphysema (air under the skin) may be present around the wound or neck as air escapes into the soft tissues.

7. Decreased Breath Sounds:

On auscultation on the affected side

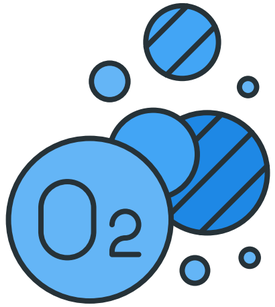
•Management:

•Open pneumothorax requires urgent treatment to prevent further lung collapse and respiratory failure.
•The immediate management includes:

•**1. Sealing the Wound**: A sterile dressing which prevents air from entering the pleural space. This is usually done with the dressing taped down on three sides to allow air to escape but not re-enter. Follow dressing with tube thoracostomy

•2. Oxygen Therapy:

•High-flow oxygen should be administered to support oxygenation and prevent hypoxia.



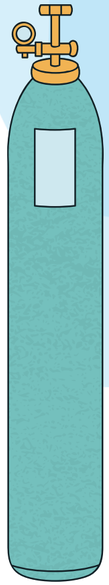
•3. Chest Tube Insertion:

•A chest tube is inserted to drain air and fluid from the pleural cavity and to re-expand the lung.

•4. Surgical Repair:

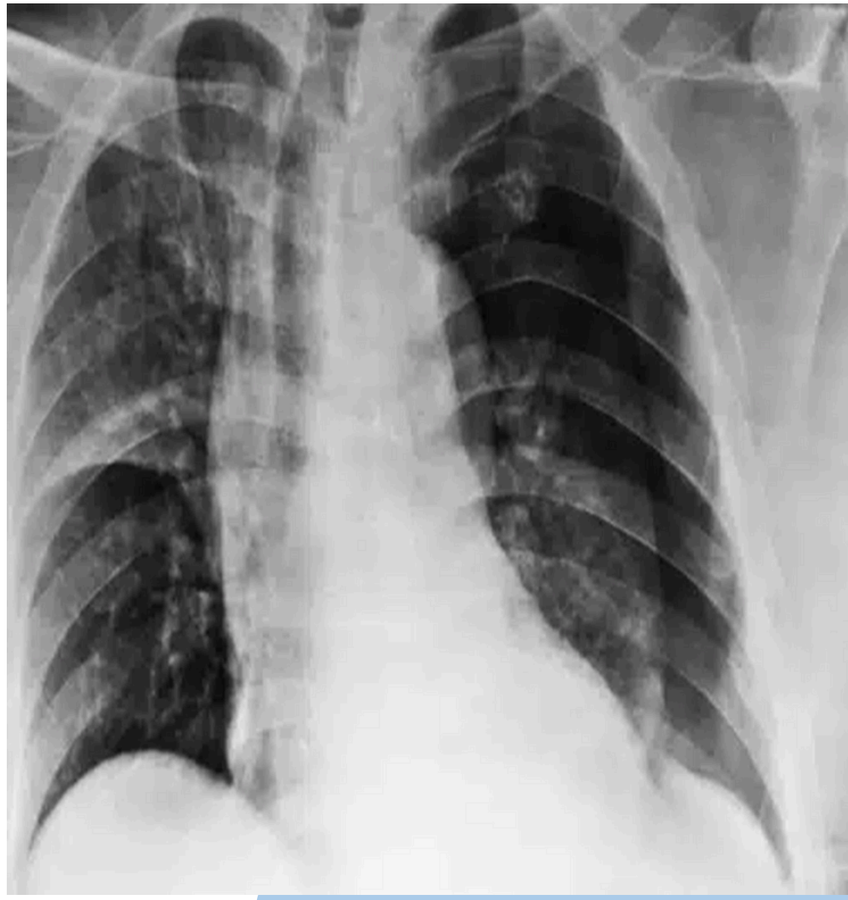
•Surgical intervention may be needed to repair the chest wall defect and any underlying injuries to the lung or other organs.

•Observe for development of tension pneumothorax



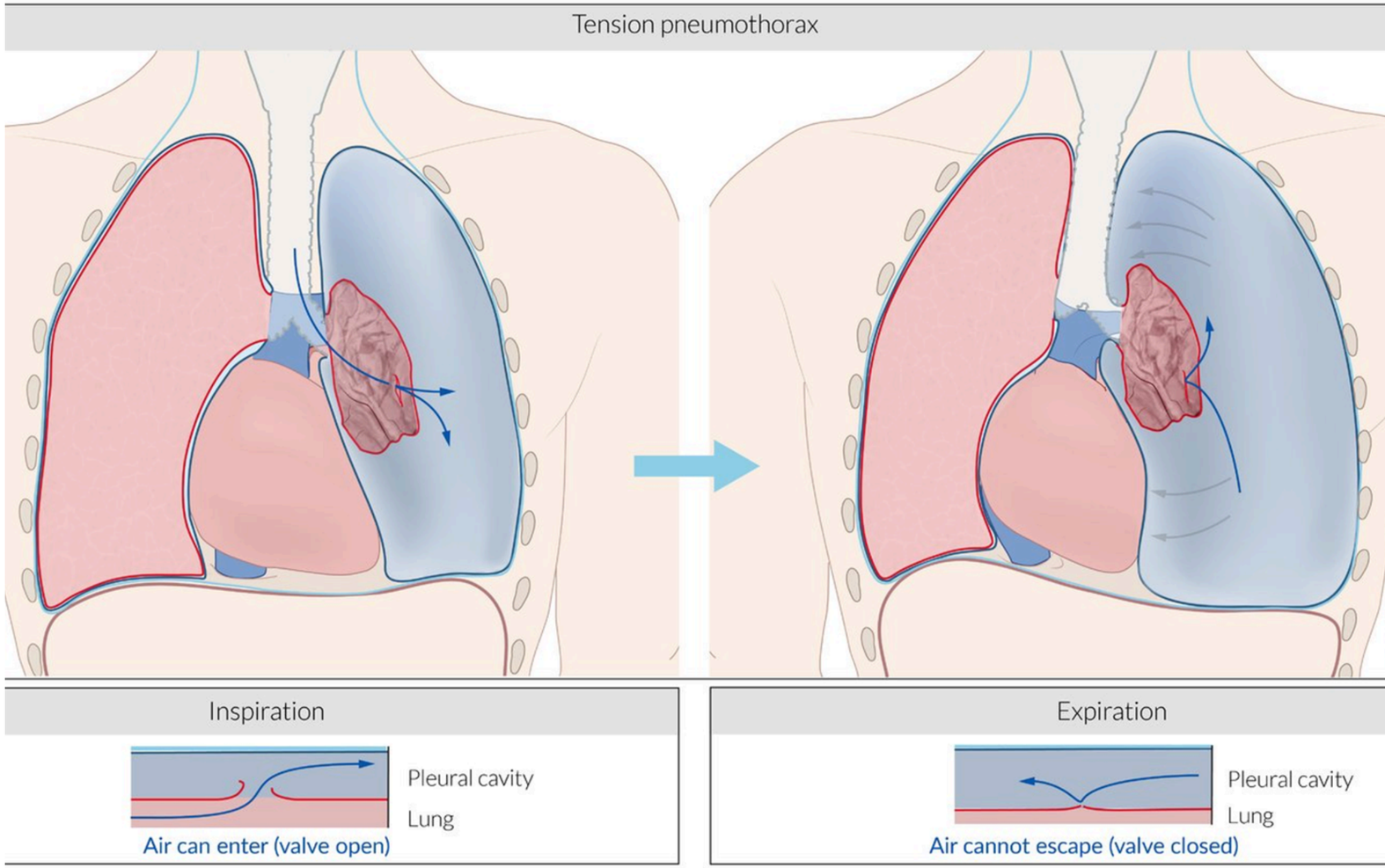
• **Tension pneumothorax** :

life-threatening condition that developed secondary to one-way valve mechanism, which is caused by an injury to the lung parenchyma or chest wall and allows air to enter the pleural space during inspiration (valve open) but not escape during expiration (valve closed).



•Progressive accumulation of air within the pleural space causes an ipsilateral increase in intrapleural pressure, leading to ipsilateral lung collapse and mediastinal shift to the contralateral side.The mediastinal shift compresses the vena cavae, trachea, and the contralateral lung, leading to hemodynamic instability and hypoxia.

•If left untreated, this positive pressure causes mediastinal shift , pressure on venous return to the heart, and can result in eventual cardiac arrest. Patients with a tension pneumothorax will often present in extremis and require urgent decompression.

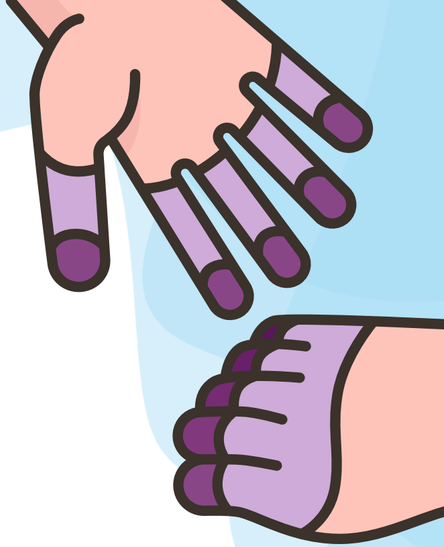


Diagnosis :

•tension pneumothorax is primarily a clinical diagnosis and prolonged diagnostic studies should be avoided in favor of initiating immediate treatment.

•Do not delay treatment of clinically diagnosed tension pneumothorax to obtain radiologic confirmation.

•All patients with pneumothorax requiring mechanical ventilation should have a chest tube inserted to prevent the development of a tension pneumothorax.



•Key Features of Tension Pneumothorax Presentation:

•1. Severe Respiratory Distress:

Severe dyspnea (difficulty breathing) and tachypnea.

•2. Hypoxia and Cyanosis

3. Tracheal Deviation:

• This occurs as the pressure within the pleural space pushes the mediastinal structures, including the trachea, away from the affected side.

4. Jugular Venous Distension (JVD):

•The increasing pressure in the chest compresses the superior vena cava, resulting in jugular venous distension. The veins in the neck appear engorged,
often visible even at rest.

•5. Hypotension and Shock:

•As the pressure inside the chest increases, it compresses the heart and great vessels, reducing venous return and cardiac output.
This leads to hypotension , tachycardia and signs of shock, including cool, clammy skin and a weak pulse.

6. Decreased or Absent Breath Sounds

7. Hyper-resonance on Percussion

8. Chest Pain:

•The patient may experience sharp, stabbing chest pain associated with the lung collapse and pressure on the pleura and surrounding structures.

•Management:

•1. Needle Decompression:

• A large-bore needle or catheter is inserted into the second intercostal space in the midclavicular line or 5th intercostal space mid-axillary line to release the trapped air and relieve pressure.

•Following chest drain insertion, a CXR must be performed

•2. Chest Tube Insertion:

• chest tube (thoracostomy tube) should be inserted to allow for continuous evacuation of air from the pleural space and to re-expand the lung.

3. Oxygen Therapy:

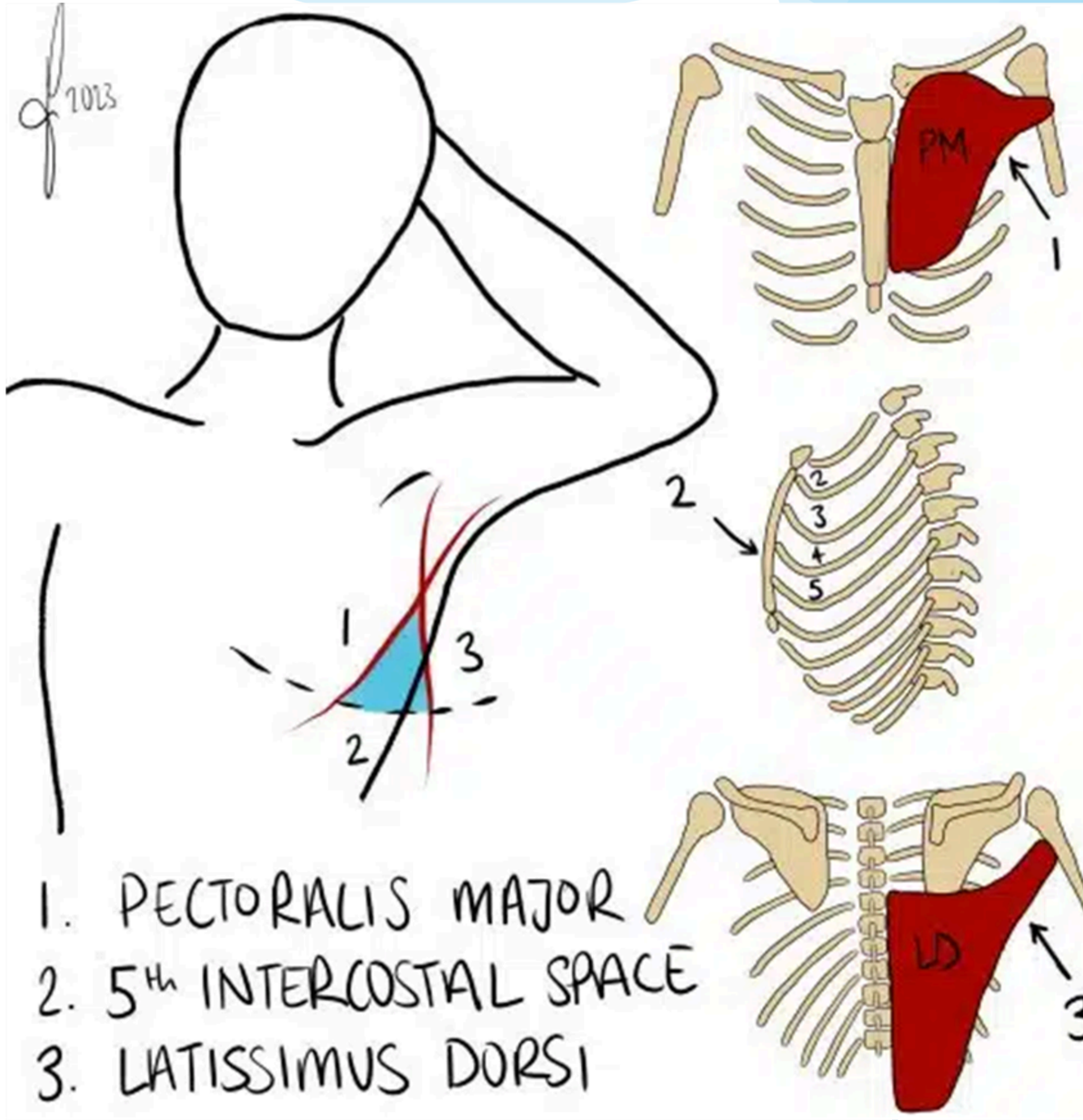
• high-flow oxygen to correct hypoxia and support the patient's breathing.

•4. Surgical Intervention:

•If the tension pneumothorax is caused by trauma, further surgical intervention may be required to repair any damage to the chest wall or lung.

Traumatic pneumothoraces will normally require a surgical chest drain insertion placed in the Triangle of Safety or otherwise admitting for observation if small and asymptomatic; importantly, there is no role in needle decompression in traumatic non-tensioning pneumothoraces*.

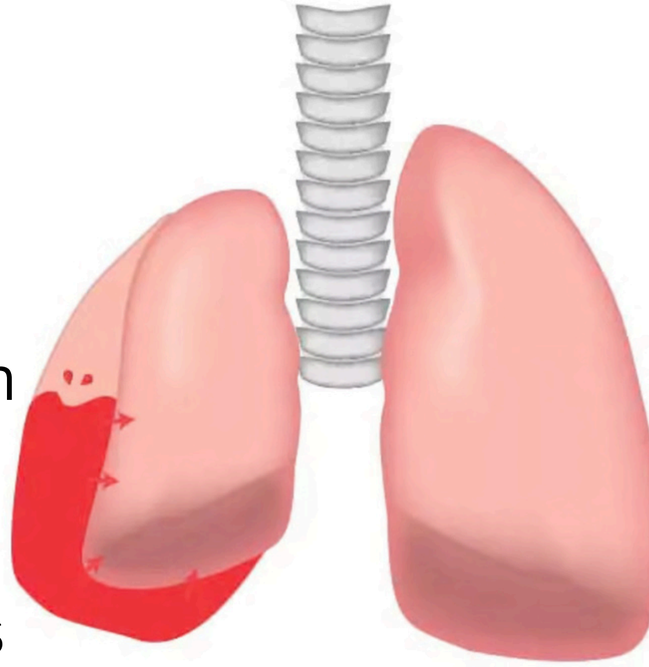
•*For traumatic tension pneumothoraces, either needle decompression (in 5th intercoastal space mix-axillary line) or finger thoracostomy is required, prior to chest drain insertion



Hemothorax

Hemothorax is the presence of blood in the pleural cavity the area between the lungs and chest wall. It typically results from trauma that disrupts blood vessels in the chest wall, lungs, or mediastinum.

Blood collects in the pleural space → compresses lung → impairs ventilation and oxygenation lead to Large-volume loss can cause hypovolemic s blood may organize → fibrothorax, infection (empyema)



There are two types of hemothorax:

- Traumatic Hemothorax: Traumatic hemothorax occurs when there is an injury to the chest and/or ribs resulting in a tear in one of the blood vessels within the pleural space, allowing blood to accumulate between the layers of tissue.
- Spontaneous Hemothorax: Spontaneous hemothorax occurs when there is no external cause and is usually related to an underlying medical condition

Clinical Features:

- Symptoms:
  - Chest pain
  - Dyspnea
  - Cough up blood
  - Signs of hypovolemia: dizziness, tachycardia, hypotension

- Signs:
  - Decreased/absent breath sounds on affected side
  - tenderness to palpation of the chest wall
  - Dullness to percussion
  - Reduced chest expansion
  - Tracheal deviation (in massive hemothorax)

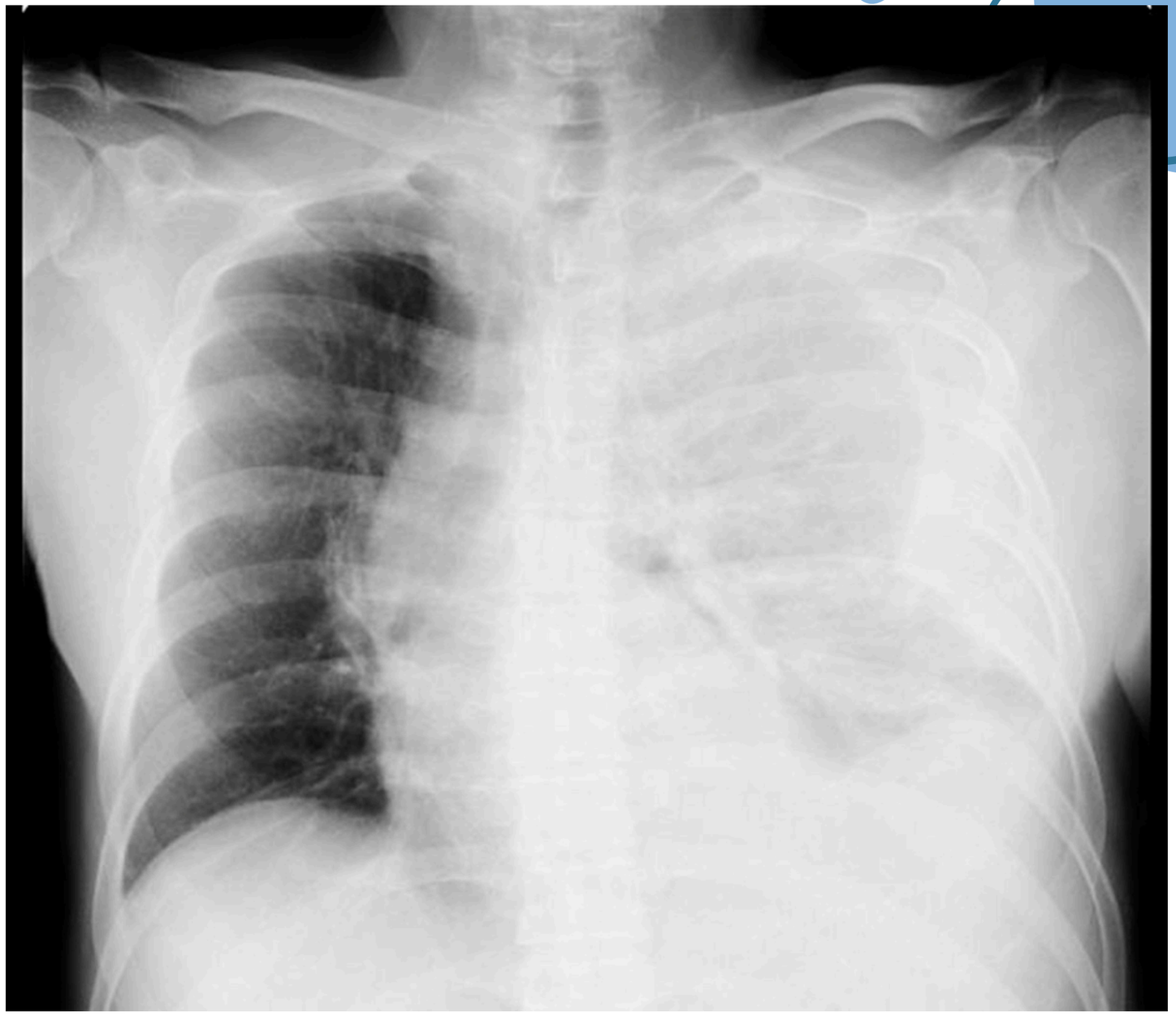
Diagnosis

Chest X-ray
Blunting of costophrenic angle, fluid level (>200 mL)

Ultrasound (eFAST)
Quick bedside tool; detects fluid >100mL

CT Chest
Gold standard for small bleeds and source identification

Thoracentesis
Diagnostic tap (rarely needed in trauma setting)



Management

1. Initial Stabilization
2. Chest Tube Placement (Tube Thoracostomy)
   - First-line intervention ,28–36 Fr tube inserted into 5th intercostal space, mid-axillary line

3-Supportive Care

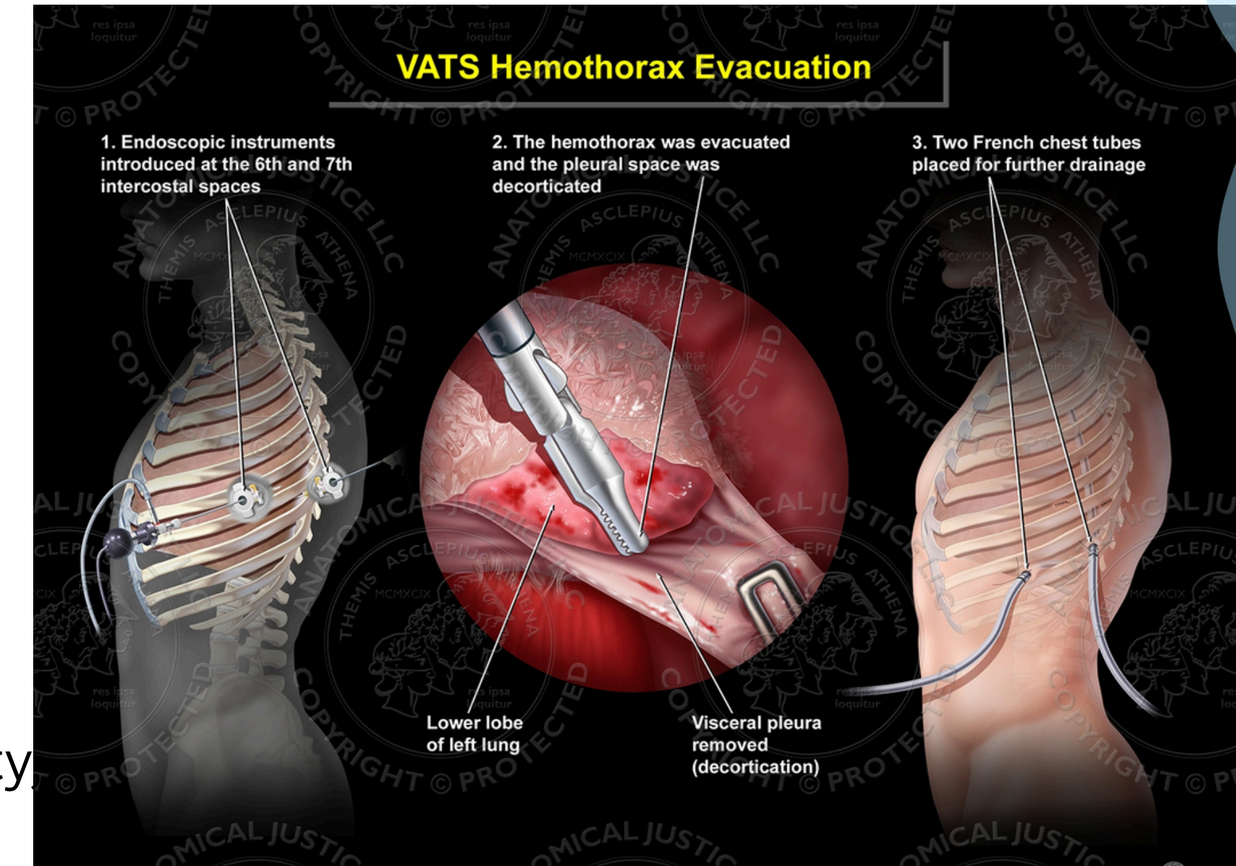
- Blood transfusion, correction of coagulopathy ,Antibiotics (especially if chest tube is in place for >48 hours),Analgesia for pain control and respiratory efforrt

4-Indications for Surgical Intervention

- Immediate drainage >1500 mL
- Persistent bleeding >200 mL/hr for >2–4 hrs
- Retained hemothorax
- Suspected great vessel or cardiac injury

5-Surgical Options

- Video-assisted thoracoscopic surgery (VATS):
  - For retained/clotted hemothorax, within 3–7 days
- Thoracotomy:
  - For massive bleeding, hemodynamic instability, or major vessel injury



Pulmonary contusion

commonly referred to as a bruised lung, is a frequent injury resulting from blunt chest trauma. It involves damage to the lung tissue, leading to hemorrhage and swelling without any laceration.

Blunt force compresses the chest wall, causing rapid pressure changes, alveolar walls rupture, leading to blood and fluid accumulation in alveoli this impairs gas exchange, increases shunt, and reduces lung compliance

Clinical features

- Symptoms often delayed 6–24 hours post-injury
- Dyspnea, hypoxia, tachypnea
- Cough, hemoptysis
- Decreased breath sounds or crackles on auscultation

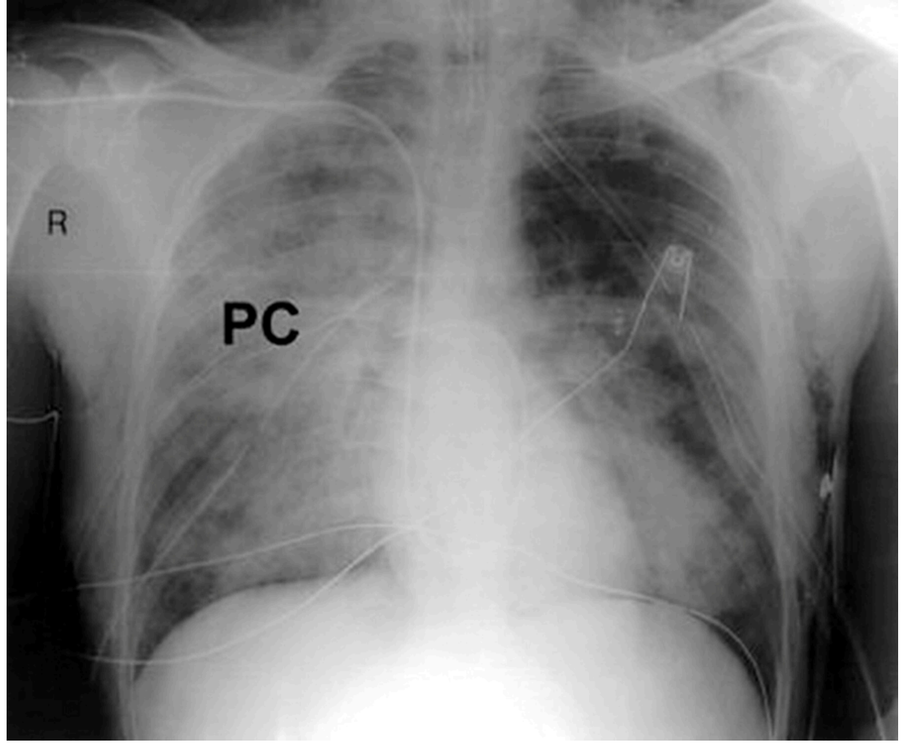
Diagnosis

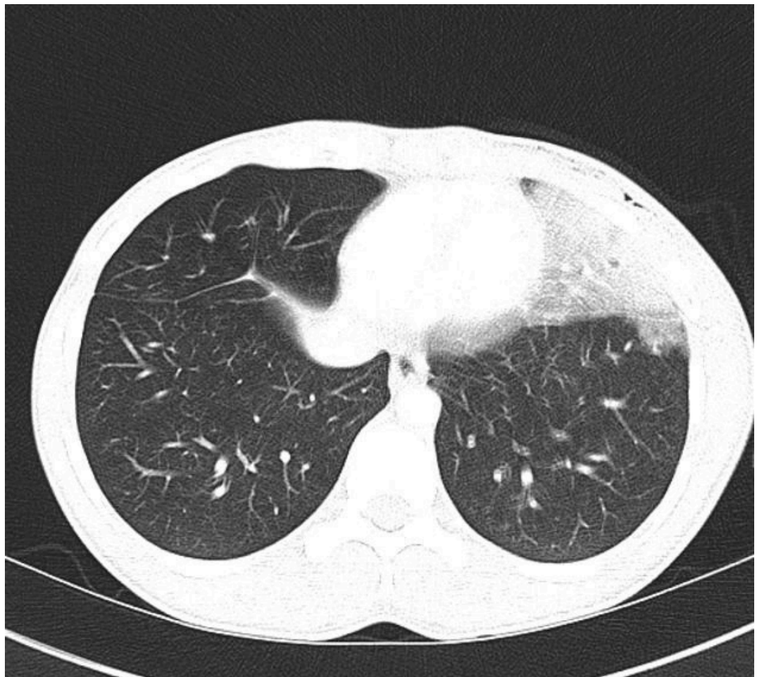
Chest x ray

- Patchy alveolar infiltrates
- White-out hemithorax or diffuse opacity

Chest CT

Gold standard shows focal areas of consolidation,often non-segmental





Treatment

The treatment of lung contusions is primarily supportive, with a focus on maintaining oxygenation and preventing complications like ARDS or pneumonia.

- **Supportive Care**: Includes oxygen therapy, pain management, and respiratory support as needed.
- **Fluid managment**
- **Mechanical Ventilation**: May be required in severe cases where respiratory function is compromised.
- **Monitoring**: Close observation for complications such as pneumonia or acute respiratory distress syndrome (ARDS) is essential.

Cardiovascular Injuries

are highly lethal and require rapid recognition and intervention. They can result from blunt trauma or penetrating trauma.

Myocardial Contusion

Great Vessel Injury (SVC, IVC, pulmonary arteries/veins)

Cardiac Tamponade

Aortic Injury

Coronary Artery Injury

1-Cardiac Tamponade

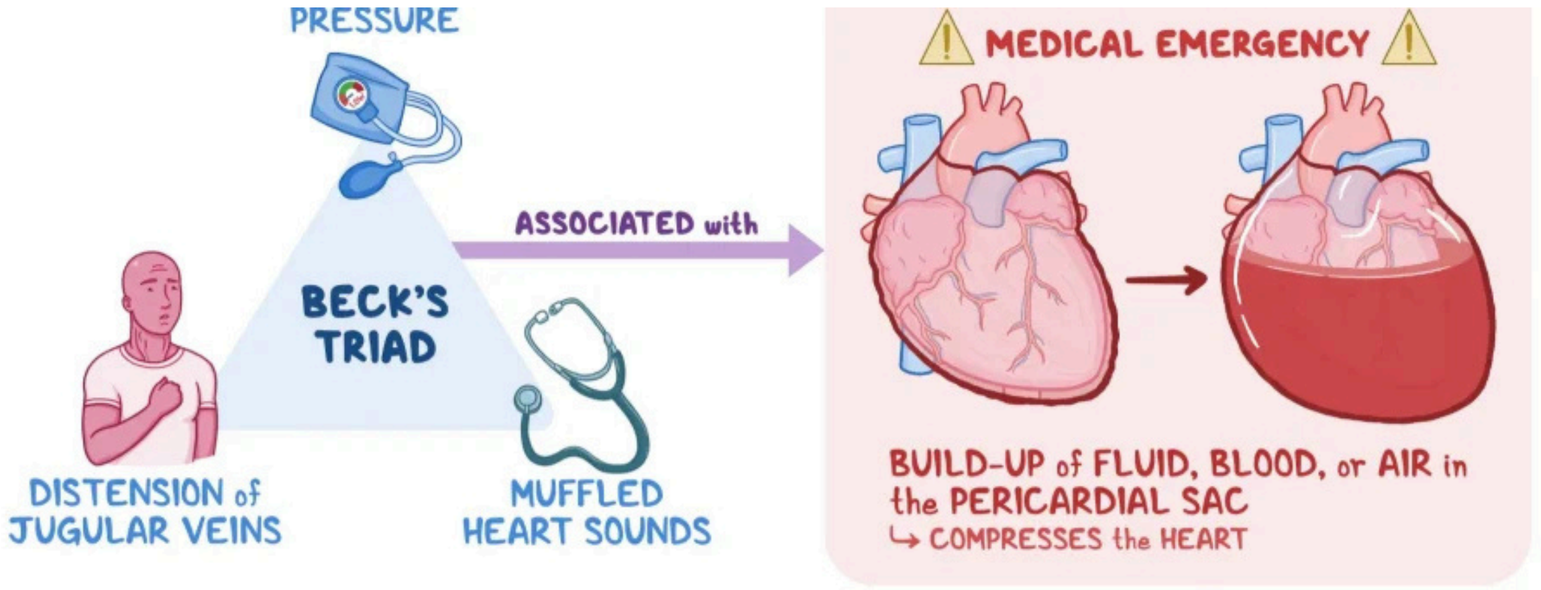
- Cardiac tamponade is a life-threatening condition where fluid accumulates in the pericardial sac, exerting pressure on the heart and impairing its function.

- Most comonly caused by penetrating chest injuries.

Diagnosis

Clinical Evaluation:

- Beck’s Triad: Hypotension, muffled heart sounds, and jugular venous distension.
- Pulsus paradoxus: Abnormal large decrease in systolic blood pressure (>10mmHg)during inspiration.
- Tachycardia



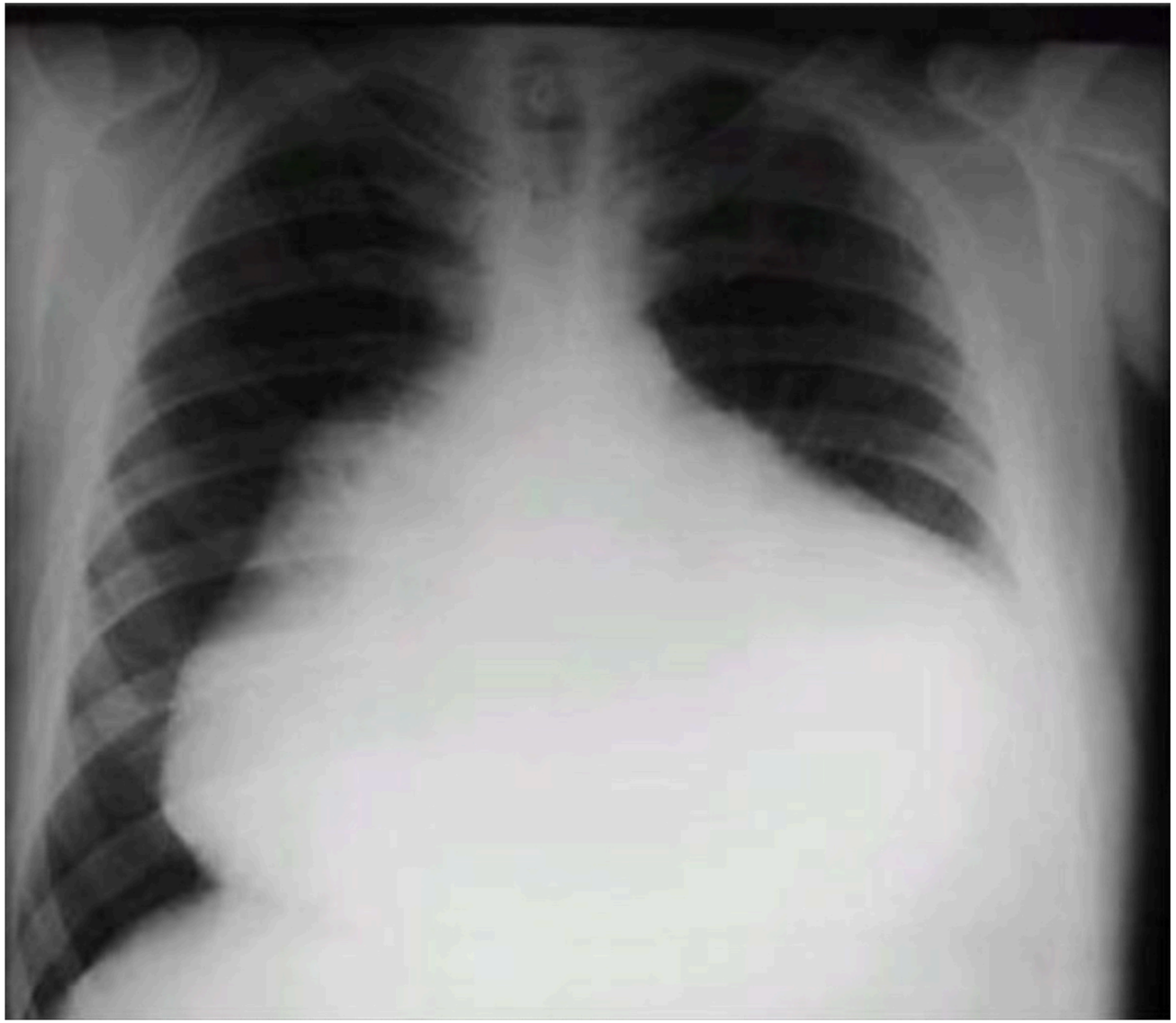
Imaging and Tests:

- Echocardiography: The gold standard for diagnosis ,(ECG)

Chest X-ray Findings

While not definitive, chest X-rays can provide supportive evidence:

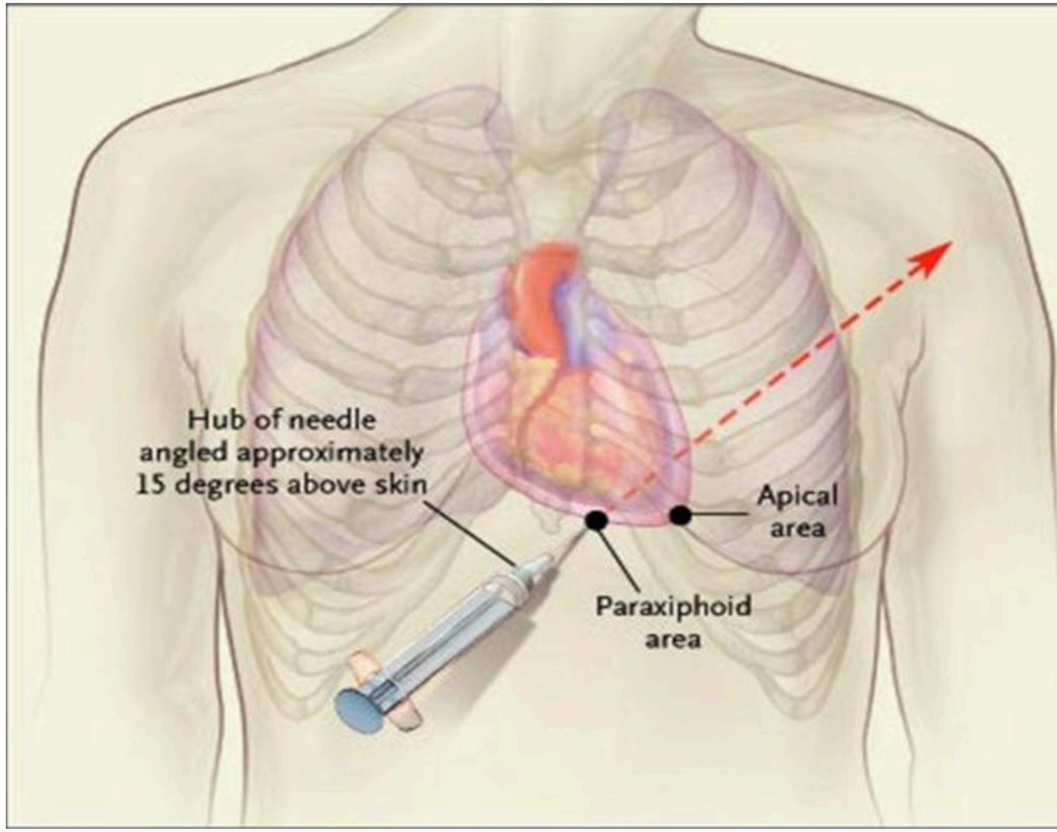
- Enlarged cardiac silhouette: Suggestive of pericardial effusion, especially when the cardiothoracic ratio exceeds 50%.
- *“Water bottle” heart shape*: A classic description of the globular appearance due to fluid accumulation.



Treatment

Immediate intervention is crucial:

- **Pericardiocentesis**: Percutaneous drainage of pericardial fluid to relieve pressure.
- **Surgical options**: Pericardial window or pericardiectomy in recurrent or loculated effusions.
- **Supportive care**: Administration of intravenous fluids and inotropic agents to maintain hemodynamics.



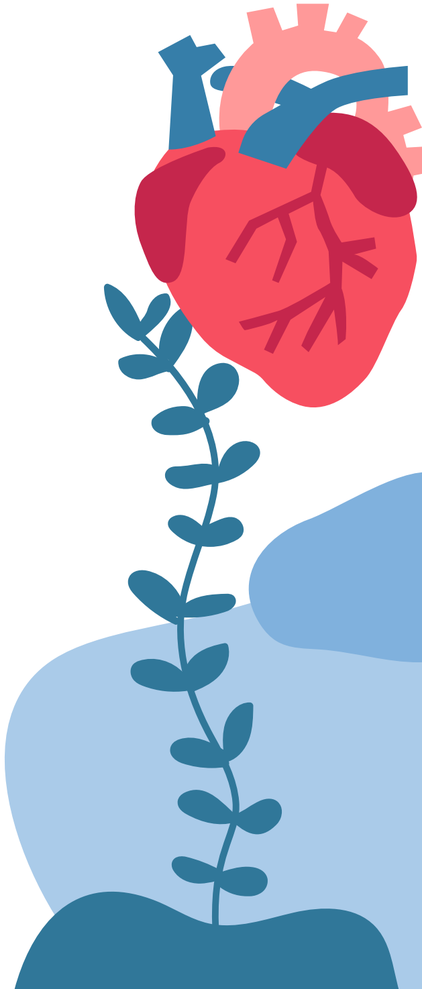
- **Postoperative Considerations:** Monitoring for recurrence of tamponade, infection, and cardiac function.
  Assessment of underlying causes to prevent future occurrences.

2-Myocardial Contusion

- Most common blunt cardiac injury
- Often affects right ventricle
- ECG: arrhythmias
- Troponin elevation
- Echocardiography may show wall motion abnormalities

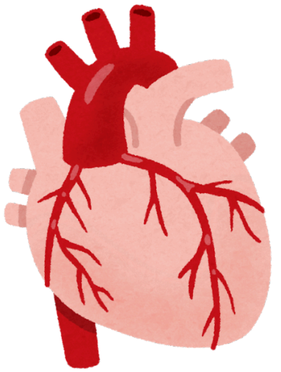
3-Aortic Injury

- Most lethal injury in blunt trauma
- Common site: aortic isthmus (ligamentum arteriosum)
- Rapid deceleration mechanism
- Signs: hypotension, upper limb hypertension, hoarseness, chest pain
- CXR: widened mediastinum, obscured aortic knob
- Gold standard: CT angiography



4-Coronary Artery Injury

- Rare but serious; can cause MI
- Usually from direct trauma
- Diagnosis: ECG, cardiac enzymes, angiography



5-Great Vessel Injury (SVC, IVC, pulmonary arteries/veins)

- Often fatal before hospital arrival
- Can cause massive hemothorax or air embolism
- Requires surgical intervention

Treatment	Injury Type
Monitor, manage arrhythmias	Myocardial contusion
Pericardiocentesis → surgical repair	Cardiac tamponade
BP control → TEVAR or open repair	Aortic injury
PCI or CABG depending on site	Coronary artery injury
Emergency thoracotomy, massive transfusion	Great vessel injury

Tracheobronchial injury

A tear in the tracheobronchial tree resulting from high-energy impact, decelerating forces, or a penetrating chest wall injury.

Clinical features:
Dyspnea ,Clinical features of pneumothorax,Sternal tenderness,Hamman sign,Subcutaneous emphysema,Hoarseness,Persistent air leak despite chest tube placement

Diagnosis:
CXR: subcutaneous emphysema, pneumomediastinum, pneumothorax.
Bronchoscopy: visualization of the lesion.

Definitive treatment: surgical repair.

Esophageal Injury

It’s a Rare but high mortality if missed.Often due to penetrating trauma; blunt trauma less common.

Clinical Signs:

- Chest pain, dysphagia, fever, subcutaneous emphysema.
- Hamman’s sign (crunching sound with heartbeat).
- Persistent pneumothorax or pneumomediastinum.

Diagnosis:

- Chest X-ray: Mediastinal air, pleural effusion.
- Contrast esophagography (Gastrografin → barium).
- CT chest with contrast.
- Esophagoscopy for direct visualization.

Management:

- IV antibiotics
- Surgical repair within 24 hrs = best outcome.
- Conservative treatment only for small, contained leaks.

Diaphragmatic Injury

- Often missed in acute trauma.Left-sided injuries more common (liver protects right side).Can be blunt or penetrating.

Clinical Signs:

- Chest or abdominal pain, dyspnea,Bowel sounds in chest,Respiratory distress,Herniation of abdominal contents → strangulation risk.

Diagnosis:

- Chest X-ray: Elevated hemidiaphragm, bowel in thorax.
- CT scan: Best imaging in trauma setting.
- Diagnostic laparoscopy/thoracoscopy: Definitive in uncertain cases.

Management:

- Surgical repair (always required).
- Laparotomy preferred in blunt trauma due to other injuries.
- Thoracotomy may be used in isolated chest injuries.

Intervention	Indications	Procedure Overview	Benefits
Chest X-ray / eFAST	Initial screening in trauma; unstable patients	Rapid, bedside evaluation using plain radiographs or ultrasound to detect gross abnormalities such as pneumothorax or hemothorax	Quick assessment, guiding further imaging; minimal delay in unstable patients
CT Scan	Stable patients; when occult or complex injuries are suspected	Advanced imaging using multidetector CT to generate high-resolution images that can be reformatted into multiple planes for detailed evaluation of injuries	High sensitivity; detailed mapping of injuries useful for comprehensive trauma management
Needle Decompression	Tension pneumothorax with signs of respiratory and circulatory compromise	Insertion of a large-bore needle (often in the 2nd intercostal space at the mid-clavicular line) to rapidly vent air from the pleural cavity	Immediate reduction of intrathoracic pressure; stabilizes the patient pending definitive chest tube placement
Chest Tube Insertion	Pneumothorax, hemothorax, or when air/fluid accumulation is clinically critical	Placement of a tube (typically in the 4th or 5th intercostal space along the mid-axillary line) into the pleural space to continuously evacuate air or blood	Definitive removal of air/fluid, lung re-expansion, and ongoing drainage to prevent recurrence

Complications

Long-Term Complications of Chest Trauma

Chest trauma can lead to a wide range of long-term complications affecting the lungs, heart, nerves, and musculoskeletal system. These complications may arise weeks to months after the initial injury and can significantly impact a patient's quality of life, respiratory function, and overall recovery. Below is an overview of the most important long-term effects to consider.

1. Chronic Pain (Post-thoracotomy or Post-traumatic Pain Syndrome)

- Nerve damage from rib fractures or chest wall injury can cause intercostal neuralgia, leading to pain that lasts months or years, often worsened by movement or breathing.

2. Restrictive Lung Disease

- Multiple rib fractures, flail chest, or surgical repair can result in reduced chest wall compliance, limiting lung expansion and causing a restrictive pattern on spirometry.

Complications

3. Bronchiectasis or Chronic Infections

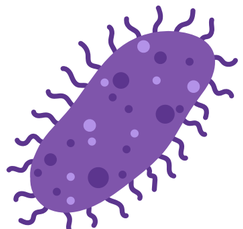
- Lung trauma, especially when complicated by pneumonia or retained secretions, may cause bronchial wall damage, resulting in chronic cough, sputum production, and recurrent infections.

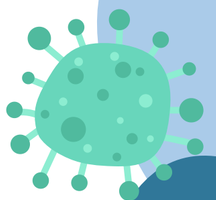
4. Pleural Effusion or Empyema

- Hemothorax or chest infection may result in fluid accumulation or infected pleural collections, which can become chronic and sometimes require surgical intervention

5. Pulmonary Fibrosis or Scarring

- Lung contusions and inflammation may heal with fibrotic tissue, reducing gas exchange and oxygenation.





Complications

6. Diaphragmatic Dysfunction

- Injury to the phrenic nerve or diaphragm muscle can lead to dyspnea (especially on exertion) and reduced lung volumes.

7. Cardiac Tamponade or Constrictive Pericarditis (Rare)

- Trauma to the heart can cause pericardial bleeding or scarring, resulting in chronic constriction of the heart and impaired cardiac function.

8. Thoracic Outlet Syndrome

- Fractures of the first rib or clavicle may damage nearby nerves or vessels, compressing the brachial plexus or subclavian vessels, and causing numbness, weakness, or swelling in the arm.

Complications

9. Chronic Pleural Thickening or Calcification

- Hemothorax or infection may cause the pleura to become fibrotic or calcified, limiting lung expansion.

10. Psychological Effects

- Persistent symptoms, pain, or disfigurement may lead to anxiety, PTSD, or depression.

11. Cosmetic Deformities

- Improper healing of ribs or sternum may result in visible chest wall deformities, affecting body image and function.

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The end