

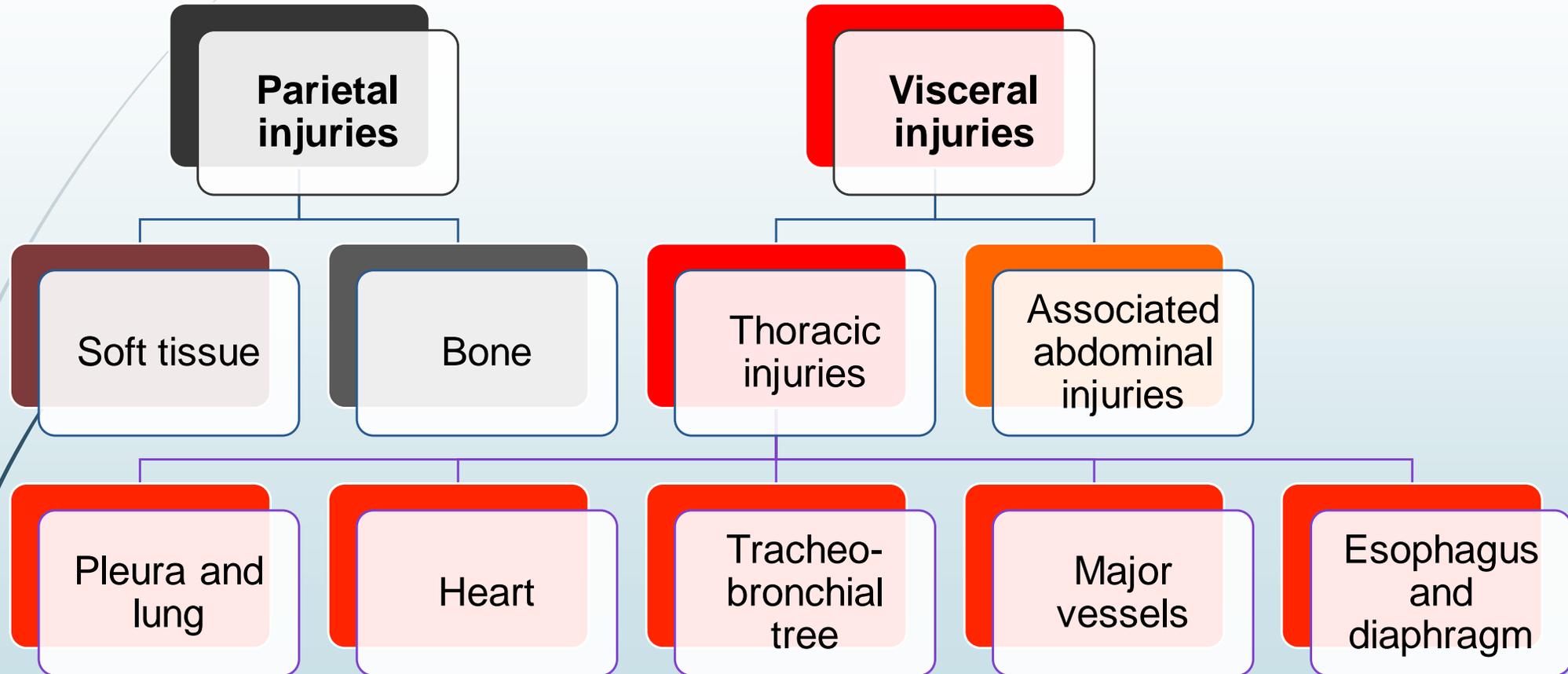
# THORACIC INJURY

► Supervised by  
Dr. Mohammed Al Sbou

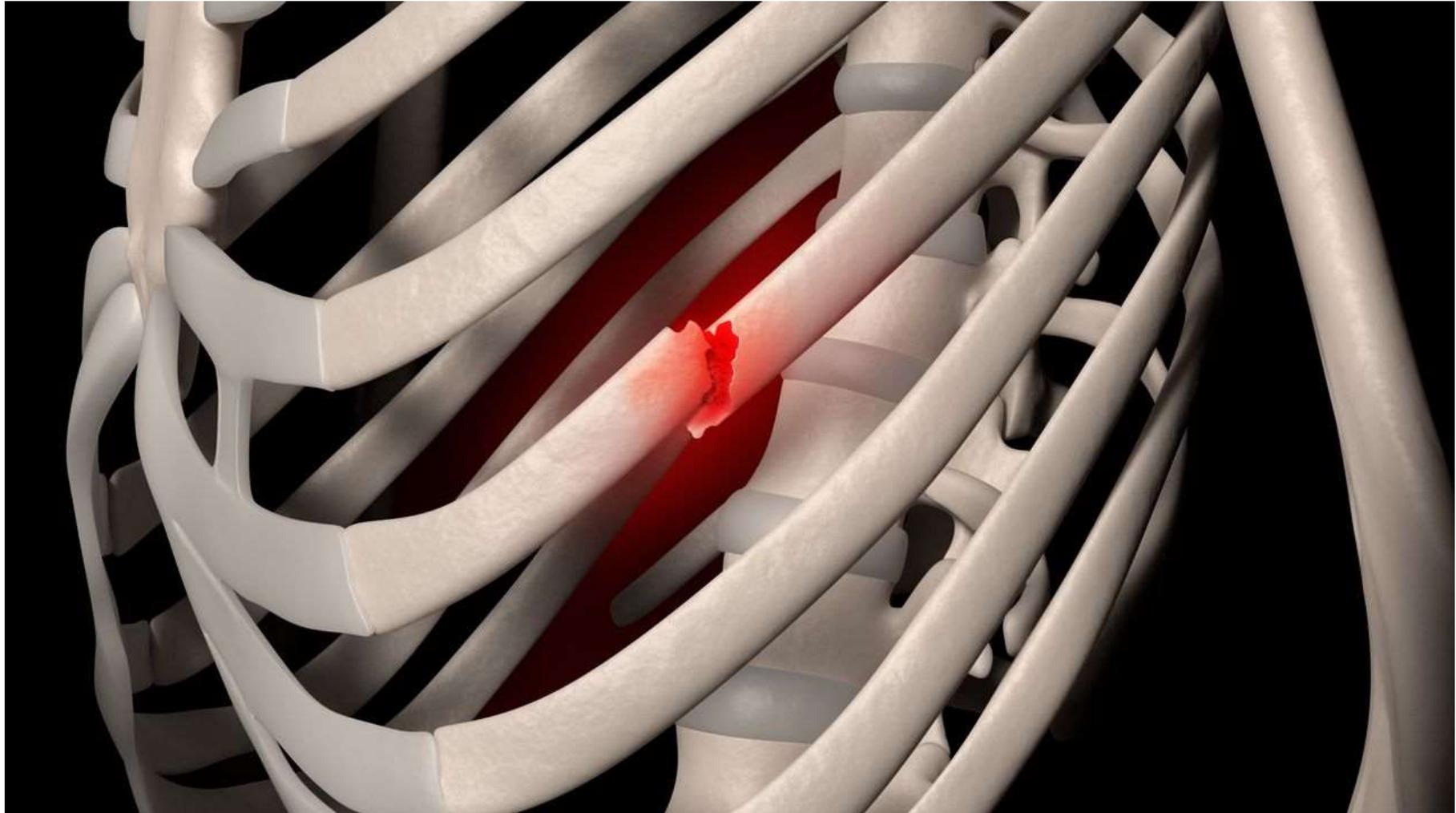
► Presented by  
Mhammad Al-dayyat  
Rou'a Shawamreh



# Complications and sequelae of chest trauma



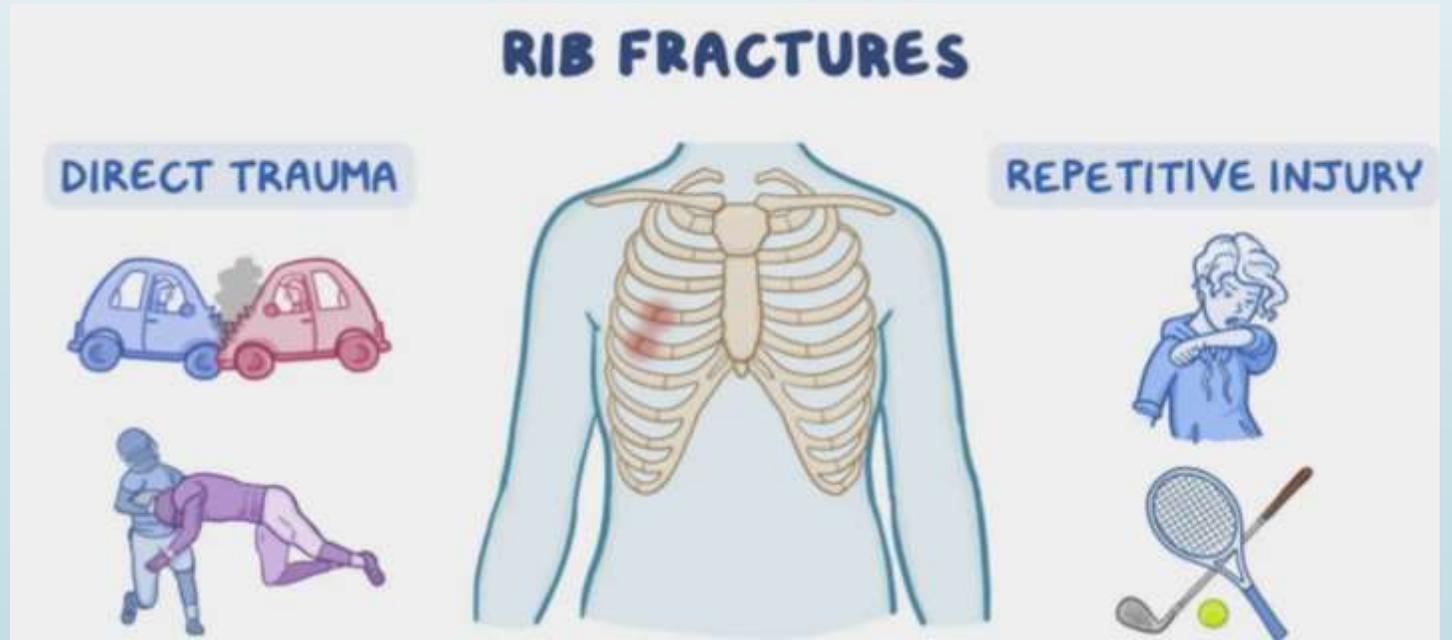
# Rib fractures



# Rib fractures

- Rib fractures are common injuries, which occur most often following blunt thoracic trauma but can also result from:
  - Severe coughing
  - Athletic activities
  - Nonaccidental trauma (e.g. child abuse)

- Complications can range from mild discomfort to life-threatening conditions, such as:
  - Pneumothorax
  - Splenic laceration
  - pneumonia



# MECHANISM OF INJURY

- ▶ It can occur from blunt (eg, motor vehicle crash) or penetrating (eg, gunshot) trauma.
- ▶ Traumatic fractures most often occur at the site of impact or the posterolateral bend.
- ▶ It could be pathologic, Cancers that metastasize to bone (e.g., prostate, breast, renal)
- ▶ If multiple fractures with different stages of healing:  
nonaccidental trauma.
- ▶ Stress fractures:  
Severe cough, athletes

# Clinical picture of thoracic injuries in general

- ▶ Shallow rapid breathing
- ▶ Severe pain and point tenderness or focal tenderness
- ▶ Bony crepitus and ecchymosis
- ▶ Diminished breath sounds if there is:
  - Pneumothorax
  - Pulmonary contusion

# Rib fractures can be divided into:

## A. Isolated simple rib fracture:

One or more ribs are fractured in a single site



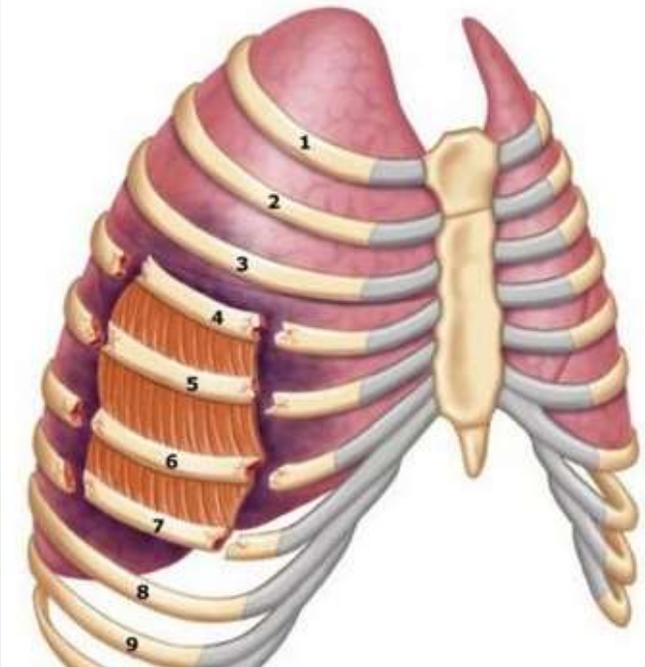
## B. Double rib fractures:

### 1. Flail chest

- fractures of 3 or more consecutive ribs in at least 2 places

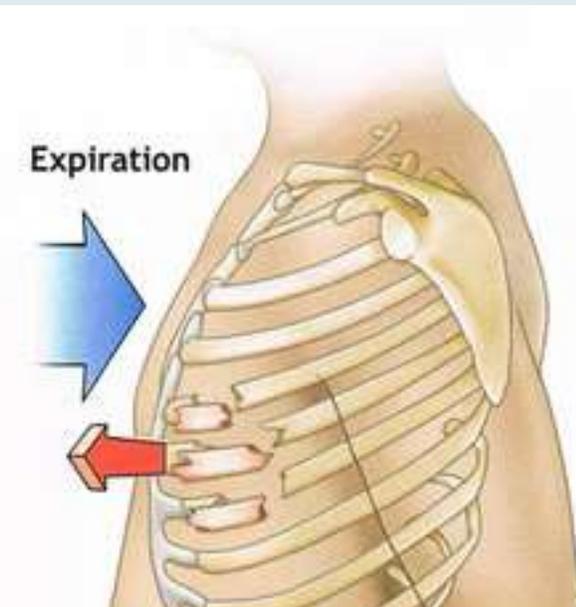
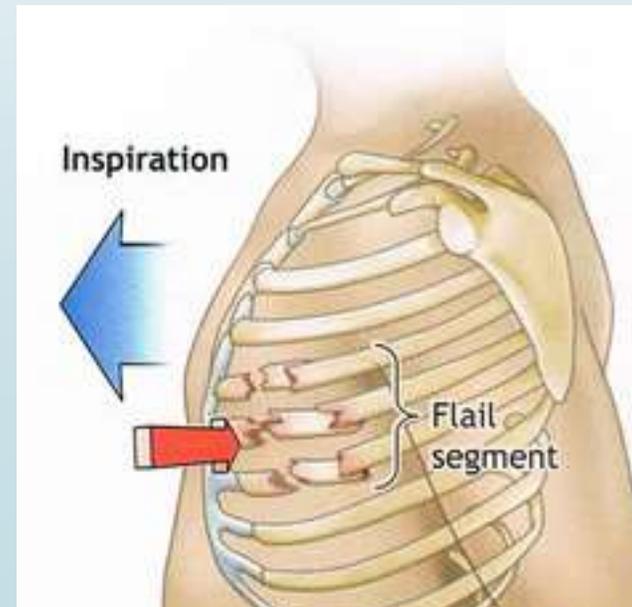
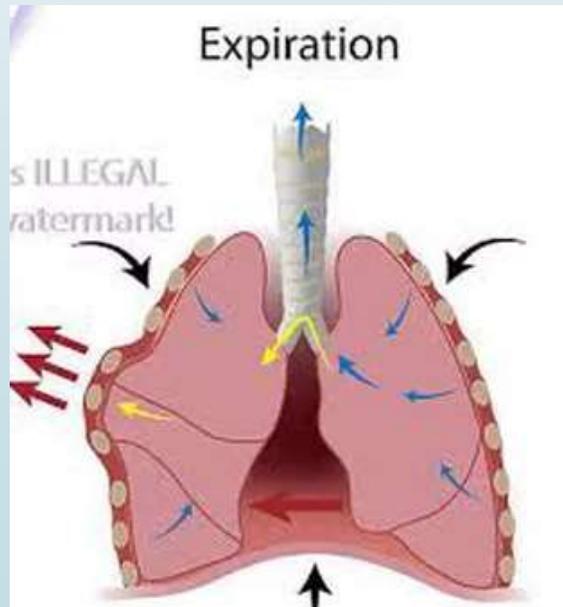
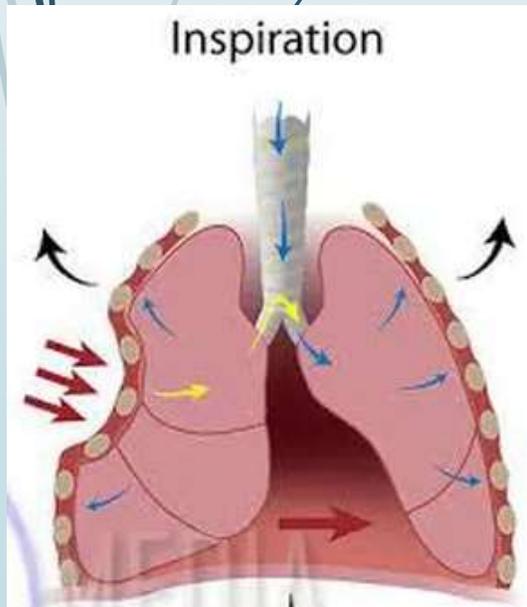
### 2. Stove-in chest

- Rare type of flail chest where the flail part collapses into the chest



# Effects of flail chest:

1. Chest wall movement in respiration → Paradoxical
2. Respiratory movement of the affected lung → Impaired
3. Breathing type → Pendulum
4. Mediastinum → Flutter
5. Circulation → Failure
6. Lung tissue → Contusion & laceration



# Management

## A. simple fracture

A. Pain relief by strong analgesics (e.g., NSAIDs), intercostal or thoracic epidural nerve block for severe pain

B. Mucolytics and expectorants

C. Chest physiotherapy

□ Indications for admission:

1. Age 65 years or older
2. Underlying pulmonary disease
3. Inability to cough
4. First and/or second rib fracture
5. Associated injuries

D. Surgical intervention:

**Rib fixation:** Rarely required but may be considered in **severe flail chest** or when **multiple rib fractures** cause significant pain or deformity.

# B. Flail chest

## A. Small flail segment

same as simple fracture + external fixation (by cotton pad and adhesive plaster)

## B. Severe cases

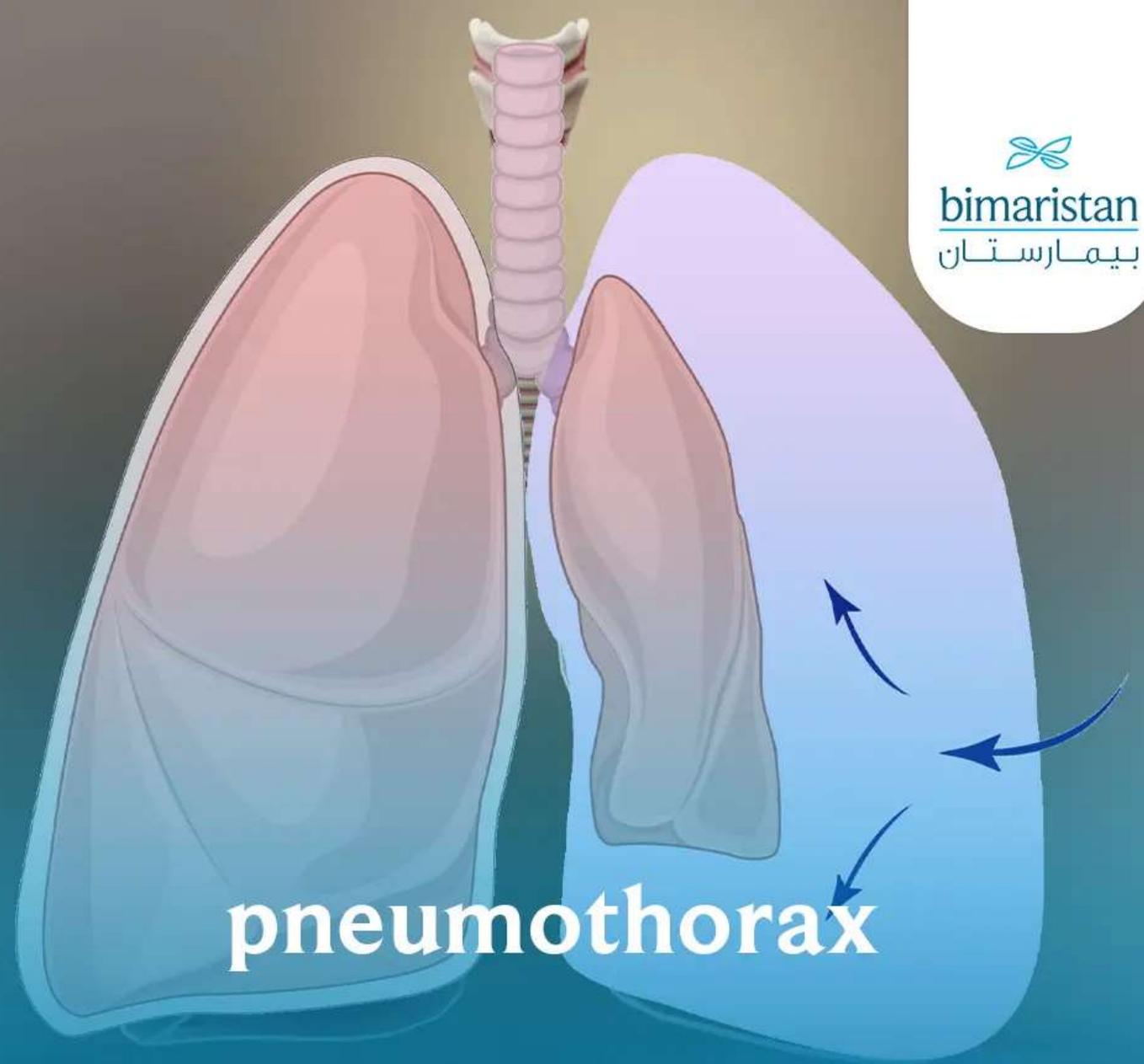
### I. Internal fixation of the flail segment

- By endotracheal intubation with intermittent positive pressure ventilation
- Indications:
  1. Disturbed level of consciousness
  2. RR > 35/min
  3. PaO<sub>2</sub> < 60 mmHg
  4. PaCO<sub>2</sub> > 50 mmHg
  5. Age > 50 year

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



# pneumothorax



# Definition:

the presence of air in the pleural space, which can lead to a partial or complete collapse of the lung on the affected side.

## Etiology:

### 1. Primary Spontaneous Pneumothorax (PSP):

without precipitating event in person doesn't have lung disease

### 2. Secondary Spontaneous Pneumothorax:

in individuals with pre-existing lung diseases, such as COPD, asthma, or cystic fibrosis.

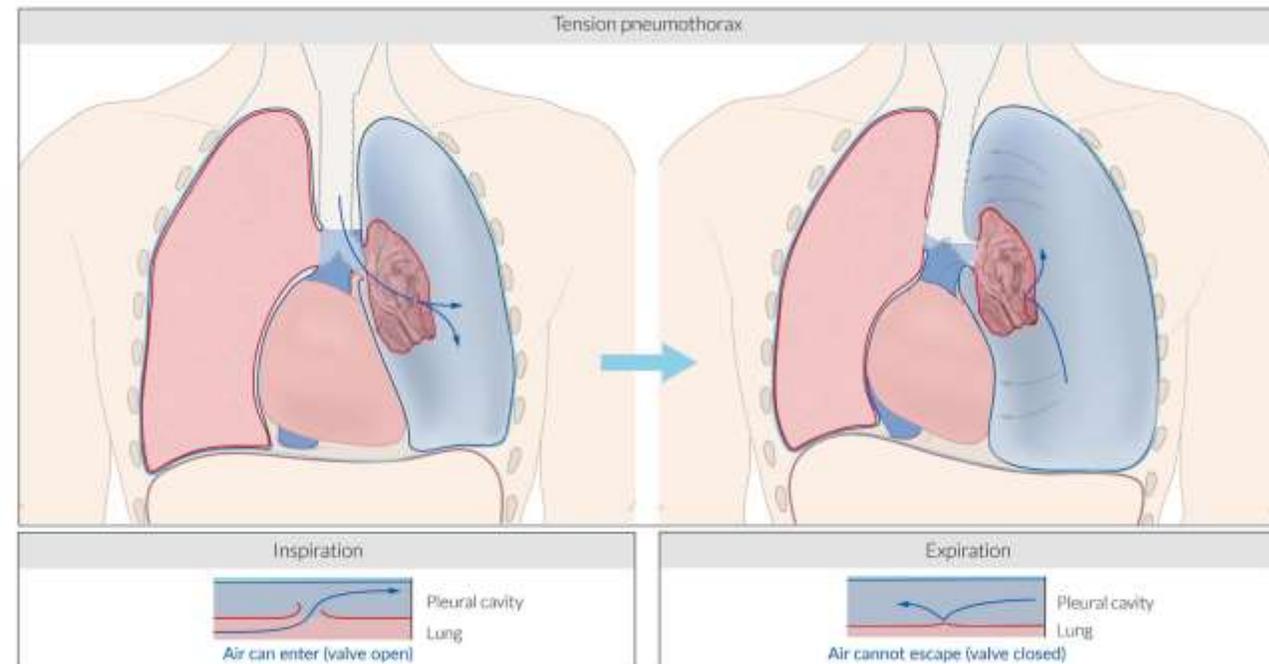
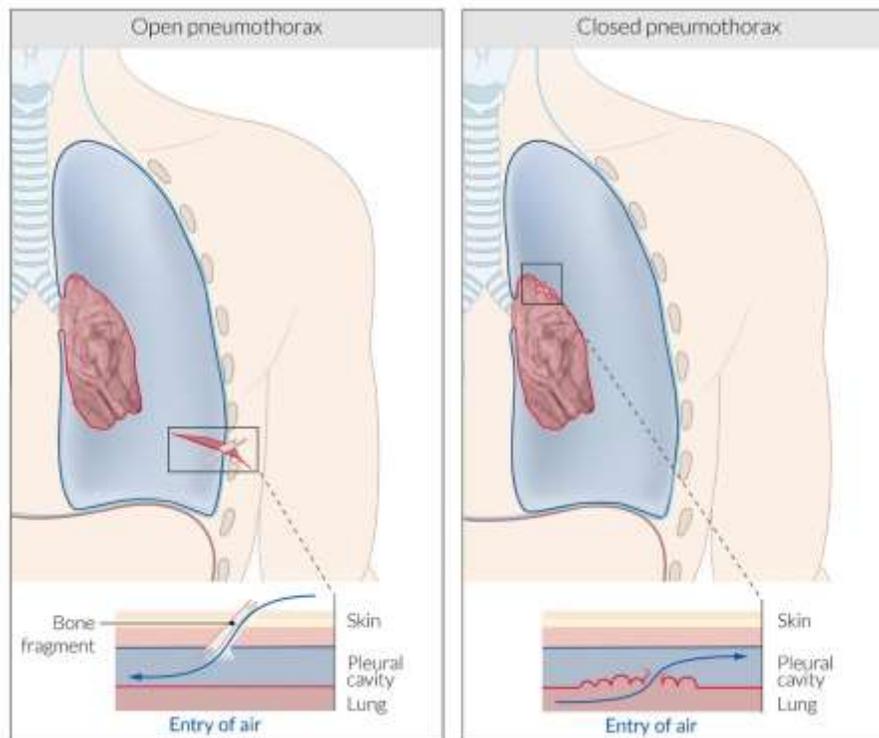
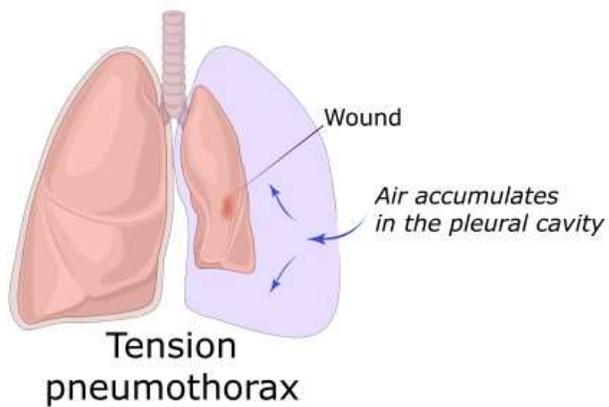
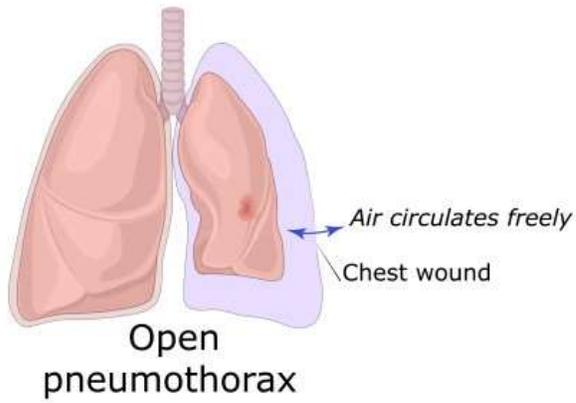
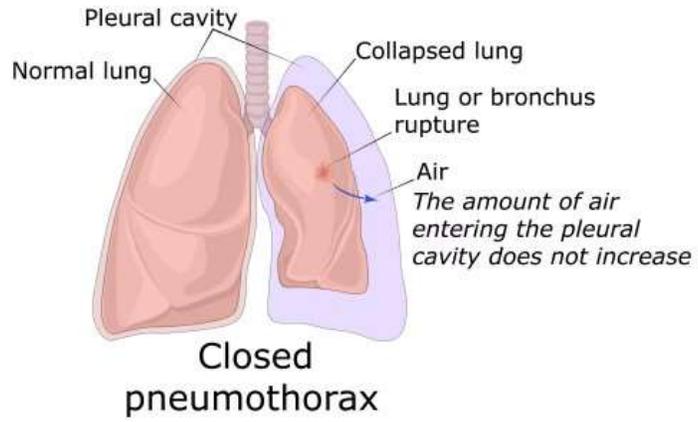
### 3. Traumatic Pneumothorax:

Results from blunt or penetrating trauma to the chest.

### 4. Iatrogenic Pneumothorax:

complication of medical procedures, such as chest tube insertion or mechanical ventilation.

# Types of pneumothorax

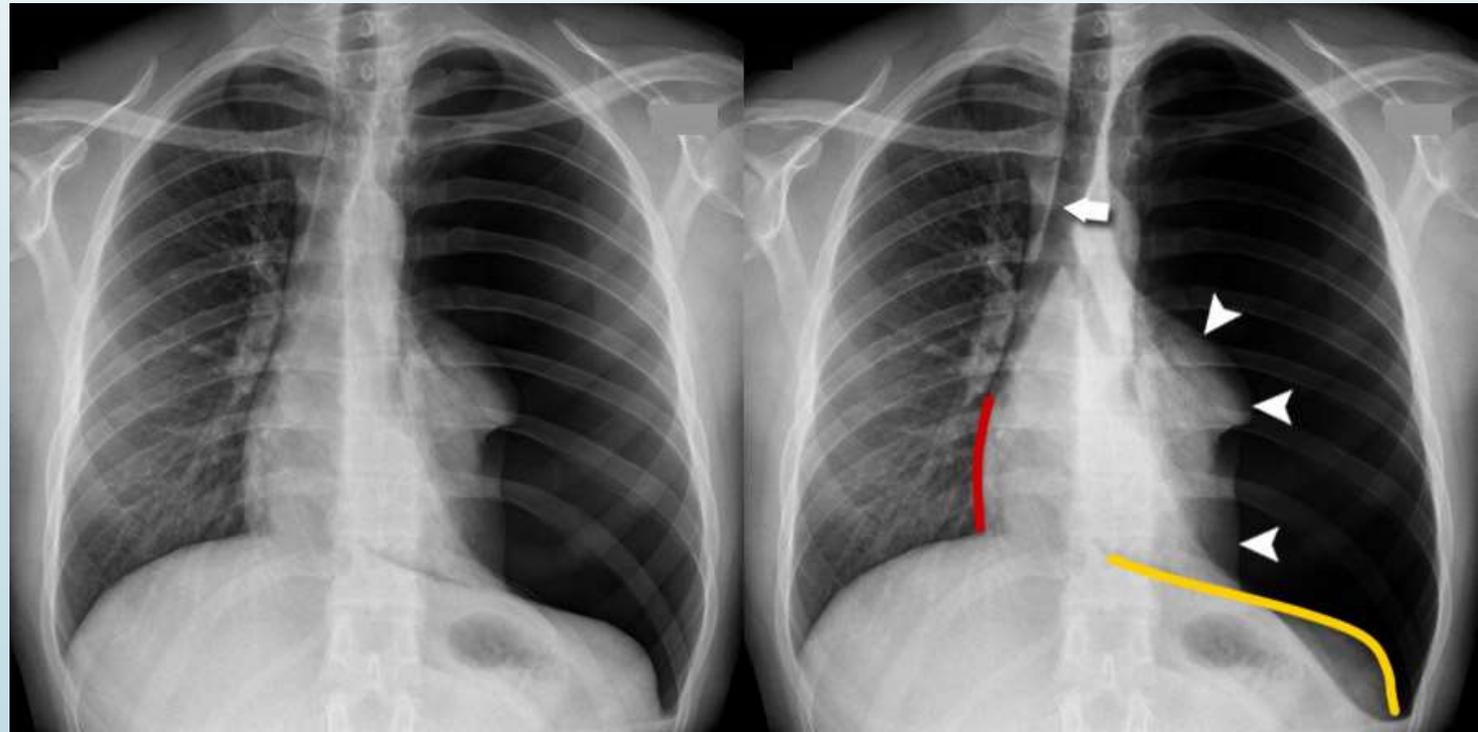
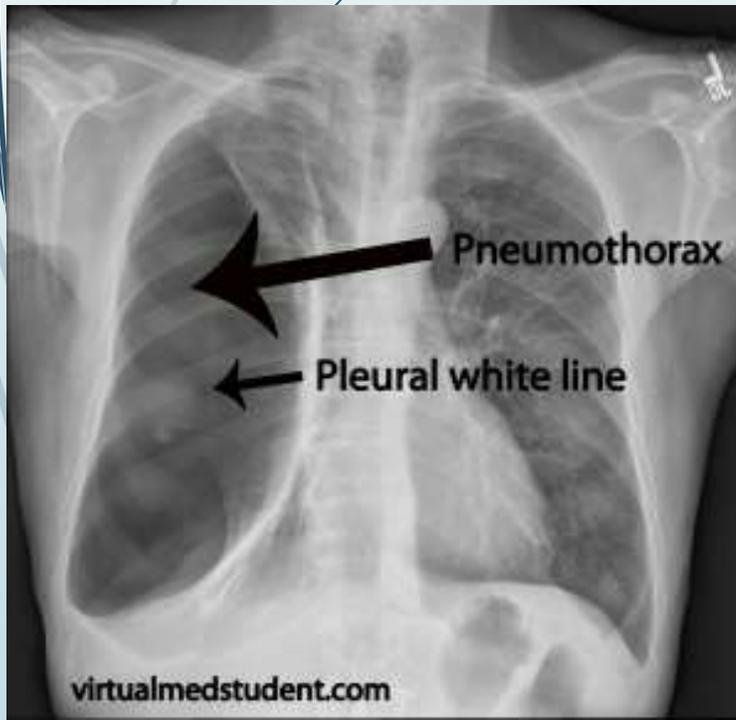


# Clinical features:

- Sudden, severe, and/or stabbing, ipsilateral pleuritic chest pain and dyspnea
  - Reduced or absent breath sounds, hyper resonant percussion, decreased fremitus on the affected side
  - Subcutaneous emphysema
  - Distended neck veins and hemodynamic instability (tachycardia, hypotension) may indicate tension pneumothorax
  - Tension pneumothorax can cause obstructive shock by mechanically preventing venous return to the heart, leading to reducing cardiac output.
- ✦ **P-THORAX:** **P**leuritic pain, **T**racheal deviation, **H**yperresonance, **O**nset sudden, **R**educed breath sounds (and dyspnea), **A**bsent fremitus, **X**-ray show collapse.

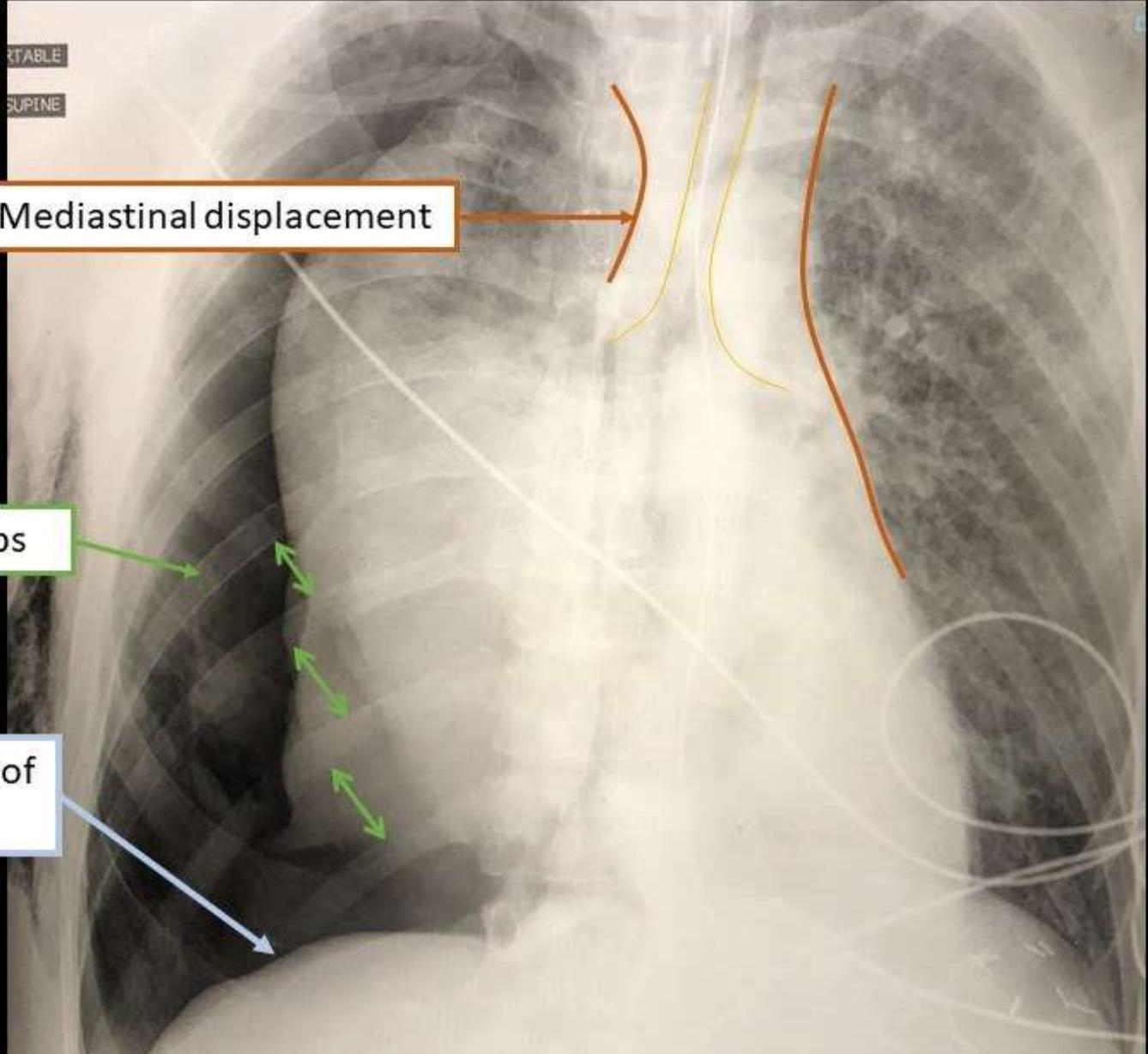
# Diagnosis:

- **Chest x-ray:** white visceral pleural line, **Deep sulcus sign**, Inspiratory and expiratory films have equal sensitivity, tracheal deviation toward the contralateral side may indicate tension pneumothorax.
- **CT scanning** is generally not performed unless abnormalities are noted on the plain chest radiograph or underlying lung disease is suspected



60yo man develops hypoxemia and shock after achieving ROSC following multiple rounds of CPR

What is your overall interpretation?



Contralateral Mediastinal displacement

Spreading of ipsilateral ribs

Flattening and depression of ipsilateral diaphragm

# MANAGEMENT

- If the patient is stable and the pneumothorax is small (distance between the lung and the chest wall is  $\leq 3$  cm on radiograph:

**Supplemental oxygen and observation**

- Stable patient with large pneumothorax:

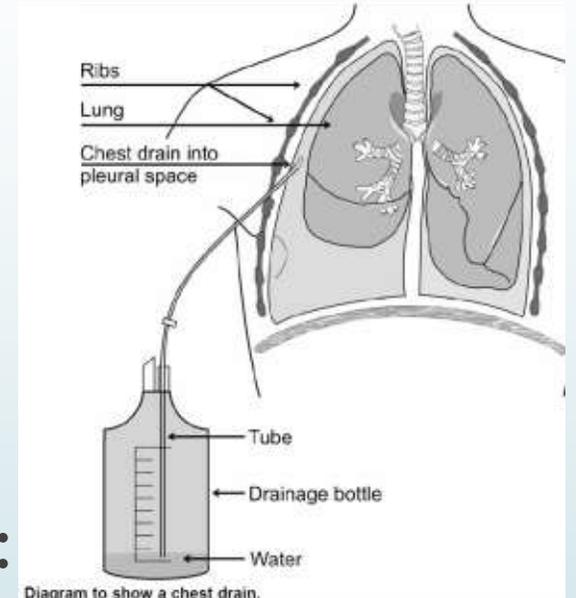
**Pleural aspiration**

- If aspiration fails, patient is unstable or there is recurrence:

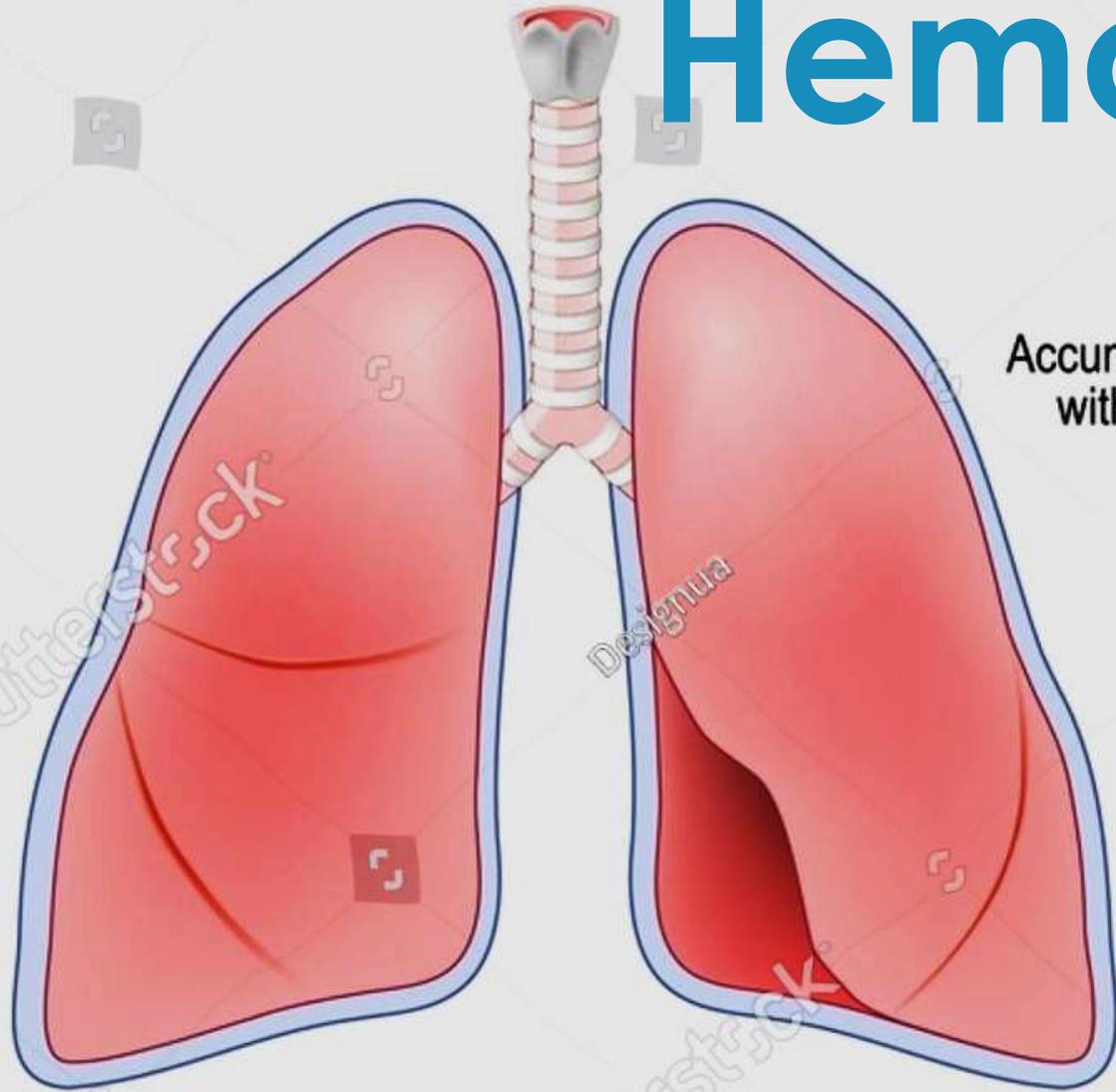
**Chest tube** (connected to a water seal device, with or without suction)

- If chest tube insertion is delayed :

**Decompression** performed by advancing a standard 14 gauge **intravenous catheter** into the pleural space at the junction of the midclavicular line and the second or third intercostal space

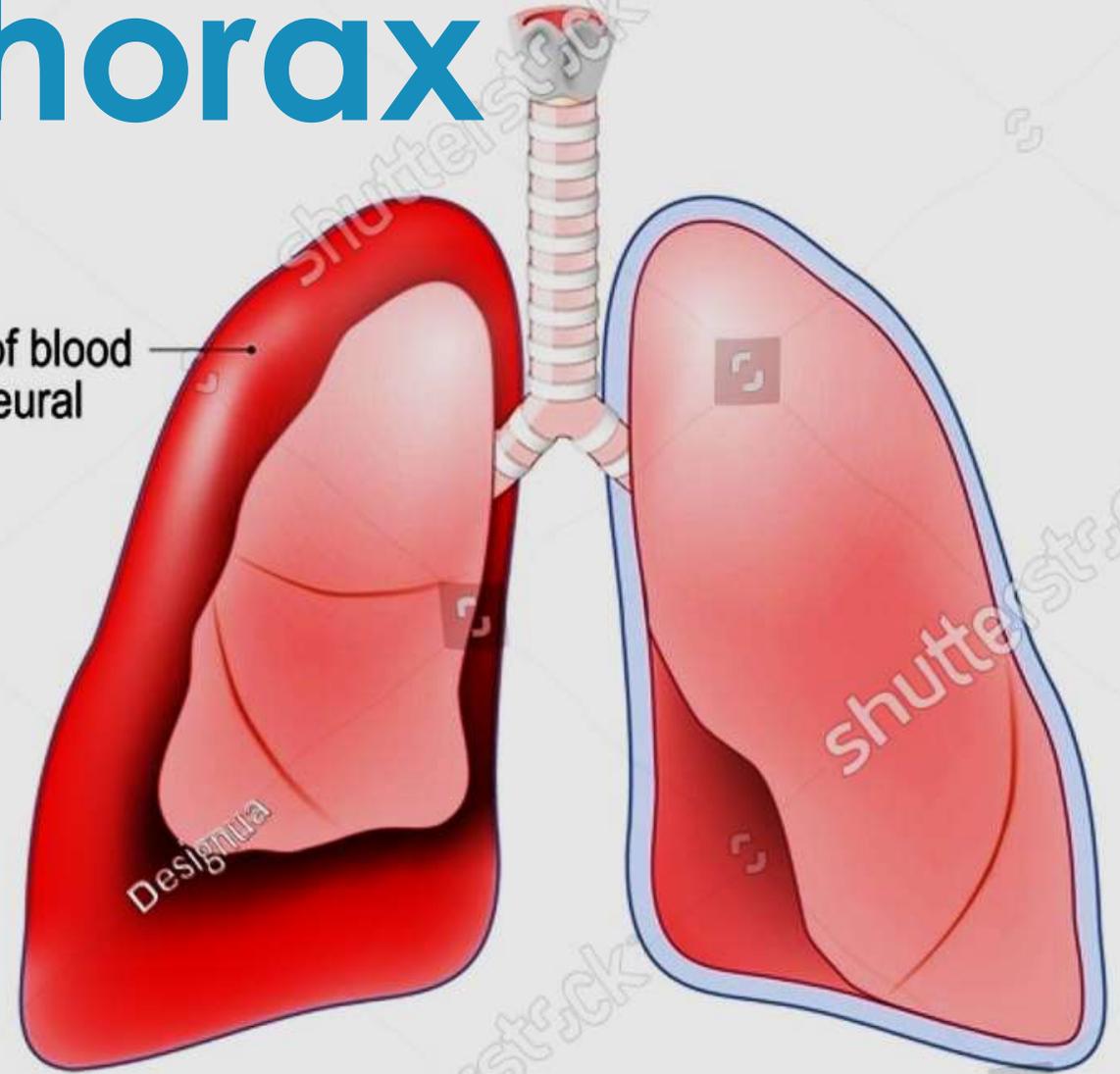


# Hemothorax



Normal

Accumulation of blood  
within the pleural  
cavity



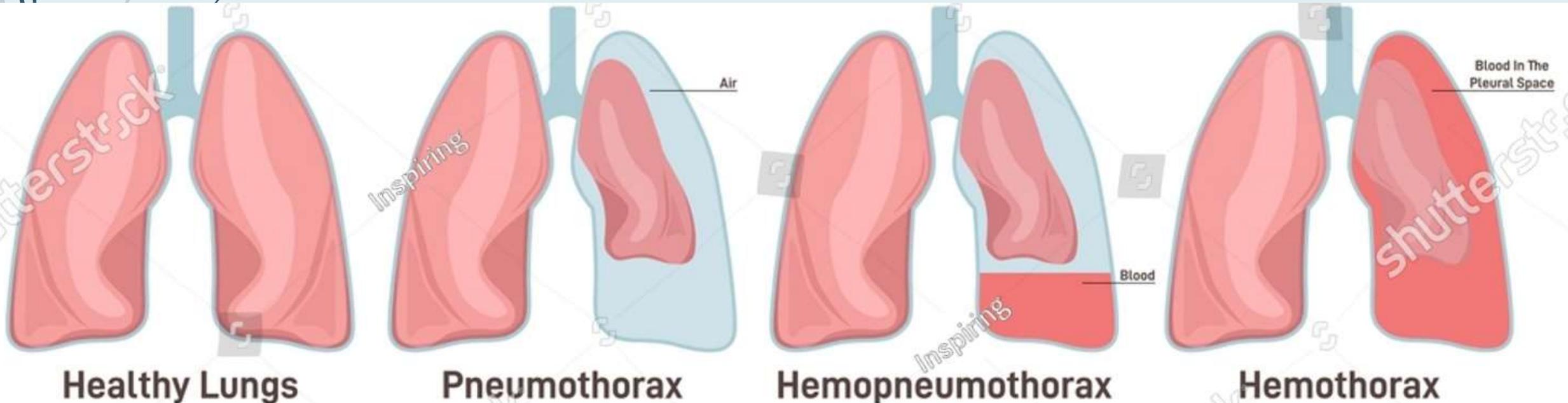
Hemothorax

# Definition

- ▶ Collection of blood in the pleural cavity
- ▶ May be associated with pneumothorax

# Etiology:

1. Traumatic
2. Spontaneous
3. Iatrogenic



## Clinical features:

1. Chest pain
2. Respiratory distress
3. Hemorrhagic shock (e.g. hypotension/ tachycardia)
4. Diminished or absent breath sound
5. Decrease tactile fremitus
6. Dullness on percussion
7. Flat neck veins

## Associated conditions:

A. Patient have paradoxical chest movement, chest wall deformity:

**Flail chest**

B. Patient have subcutaneous emphysema:

**pneumothorax**

# Diagnosis

## ❖ Upright CXR:

### ➤ Small hemothorax:

Unilateral blunting of the costophrenic angle

### ➤ Large hemothorax:

Complete lung opacification, Mediastinal shift, Tracheal deviation away from the effusion

❖ **eFAST:** hypoechoic or anechoic collection in the Costo diaphragmatic recess

❖ **CT chest with IV contrast:** can detect hemothoraces not detected on CXR and additional injuries



# Management

▶ IVF, prophylactic antibiotic and analgesia

▶ Small (< 300 mL) or occult hemothorax:

**Chest tube insertion or conservative management**

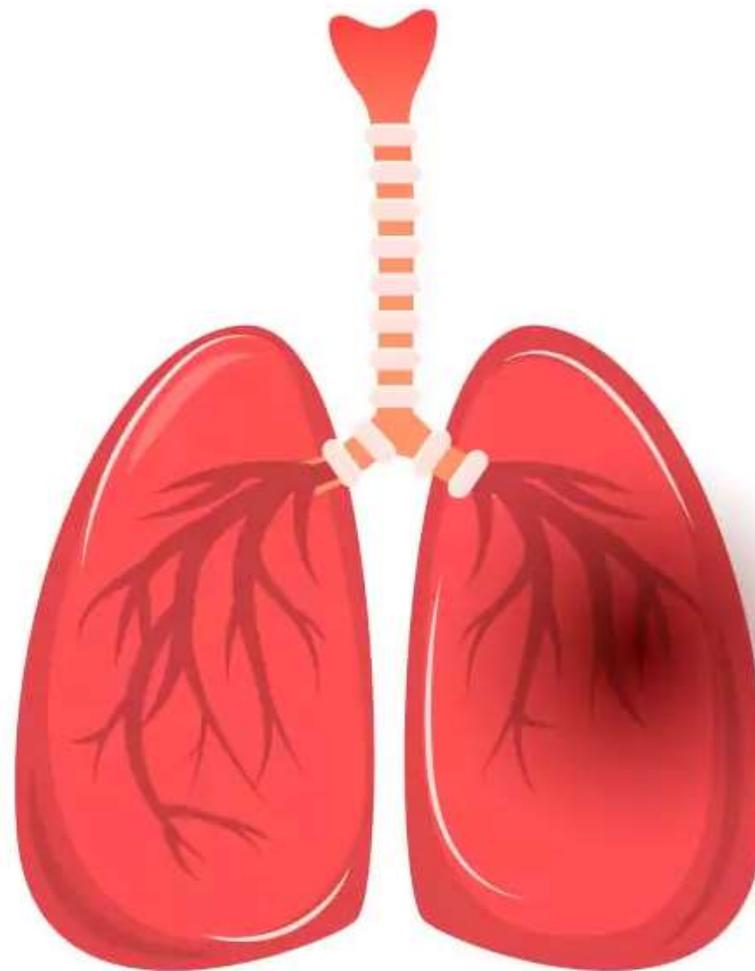
▶ moderate or large hemothoraces or those undergoing positive pressure ventilation:

**Chest tube insertion**

▶ Massive hemothorax (injury to large intrathoracic vessels, present with Hemorrhagic shock, Chest tube output  $\geq 1500$  mL immediately upon placement or  $\geq 200$  mL/hour for 2–4 hours )

**Urgent thoracotomy**

# Lung injuries

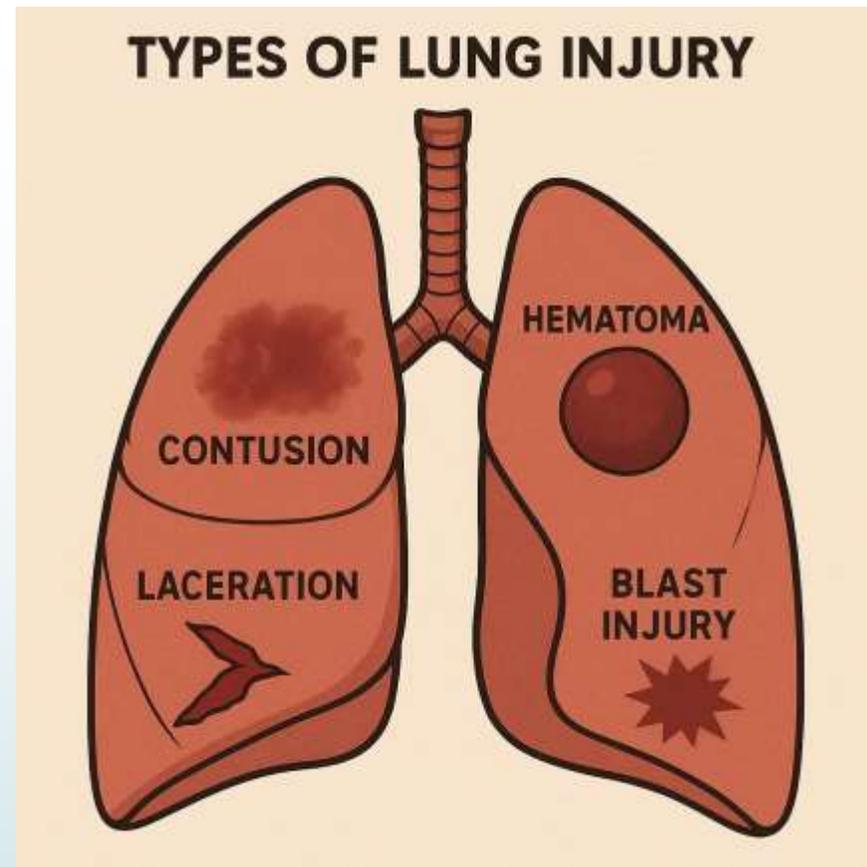


## Types:

1. Hematoma
2. Contusion
3. Laceration
4. Blast injury

## Clinical features:

- Respiratory distress (dyspnea, tachypnea, cyanosis)
- Hypoxia
- Tachycardia
- Chest pain



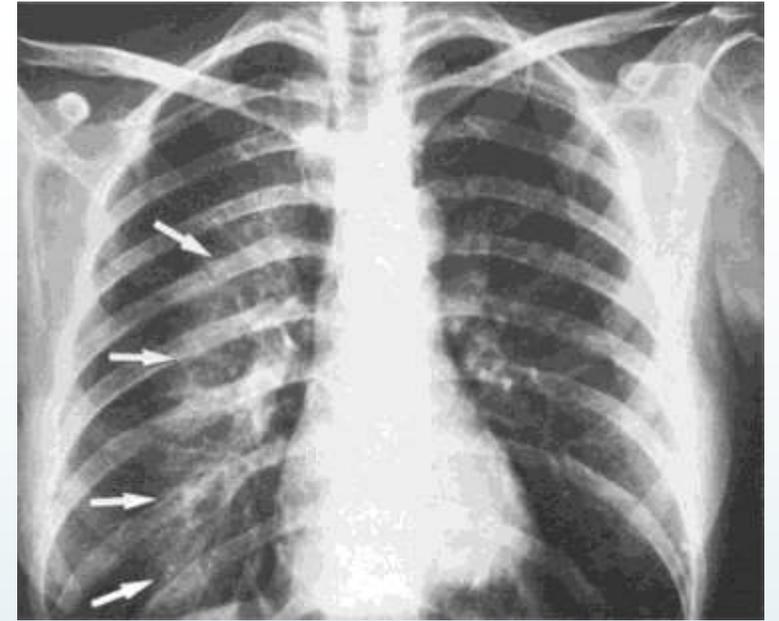
## Diagnosis:

### 1. CXR:

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

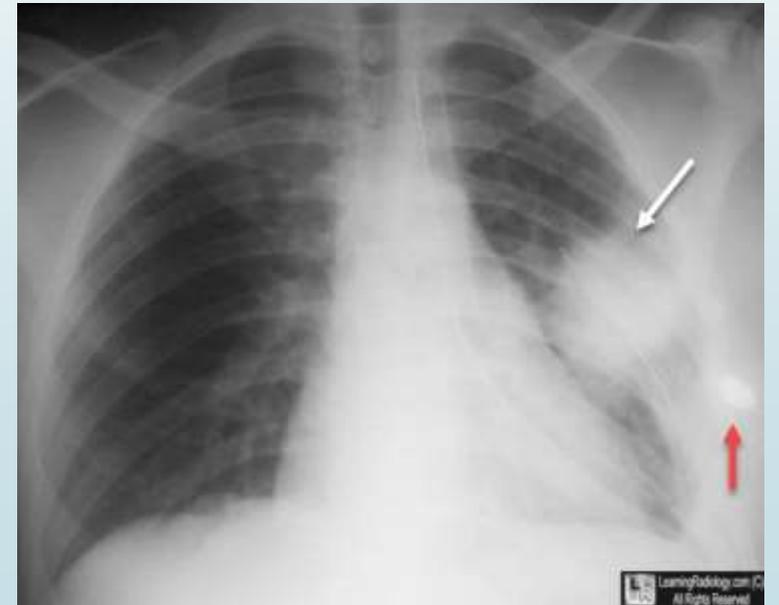
### 2. Chest CT:

If CXR is inconclusive

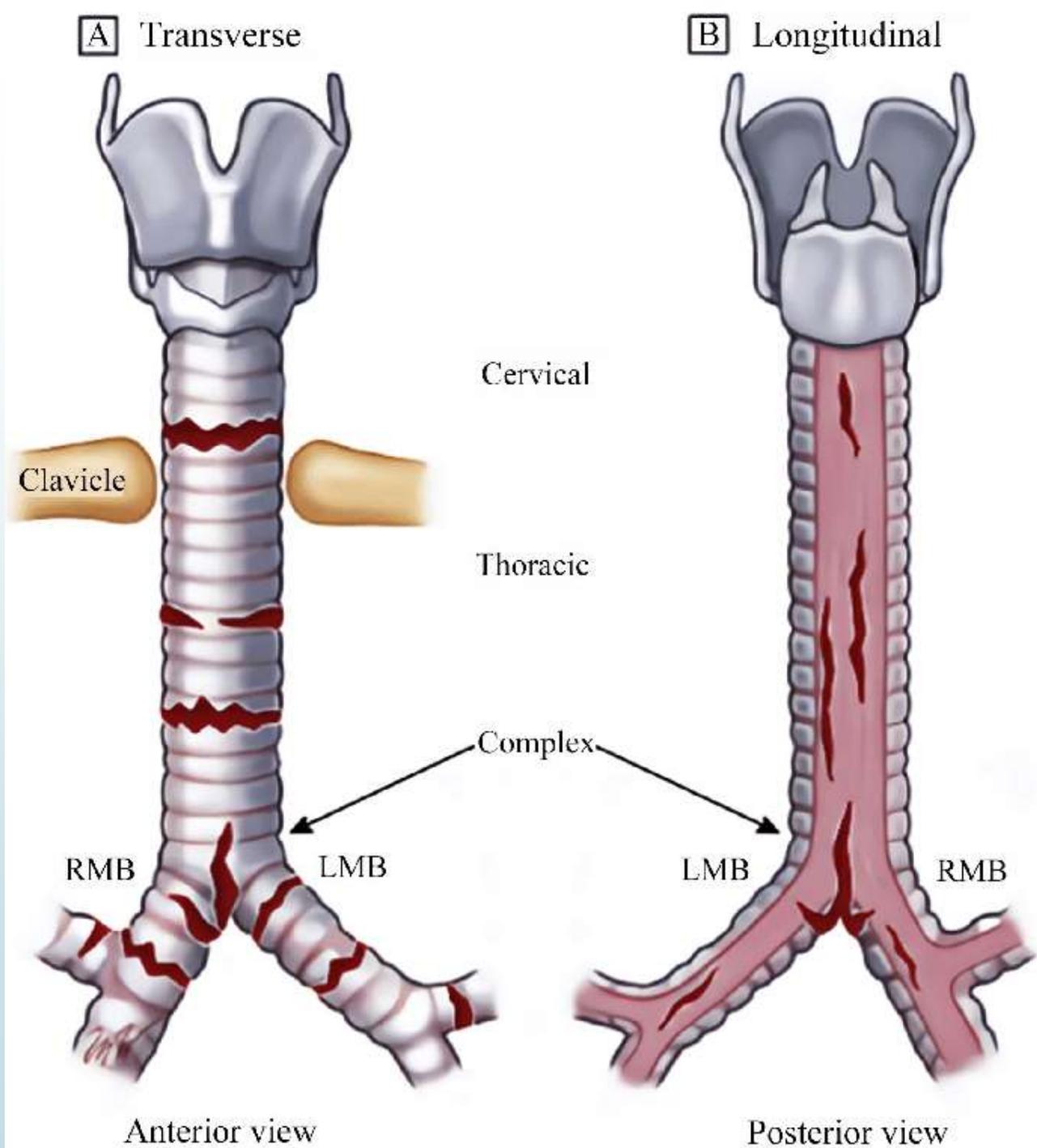


## Management:

1. Respiratory support (oxygen, positive pressure ventilation)
2. Maintain euvolemia and avoid excessive IVF resuscitation
3. Monitor respiratory insufficiency, e.g. repeated ABGs



# Tracheobronchial injuries



## Definition &

### Etiology:

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

## Clinical features:

- Dyspnea
- Sternal tenderness
- Subcutaneous emphysema
- Clinical features of pneumothorax:
  - Hamman sign (crunching, rasping sound in sync with the heartbeat)
  - hoarseness

## Diagnosis:

### ► CXR:

Subcutaneous emphysema, pneumomediastinum, pneumothorax.

### ► Bronchoscopy:

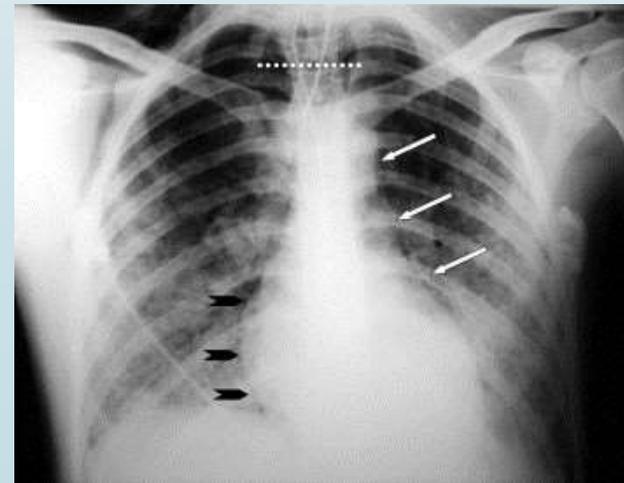
Visualization of the lesion

## Management:

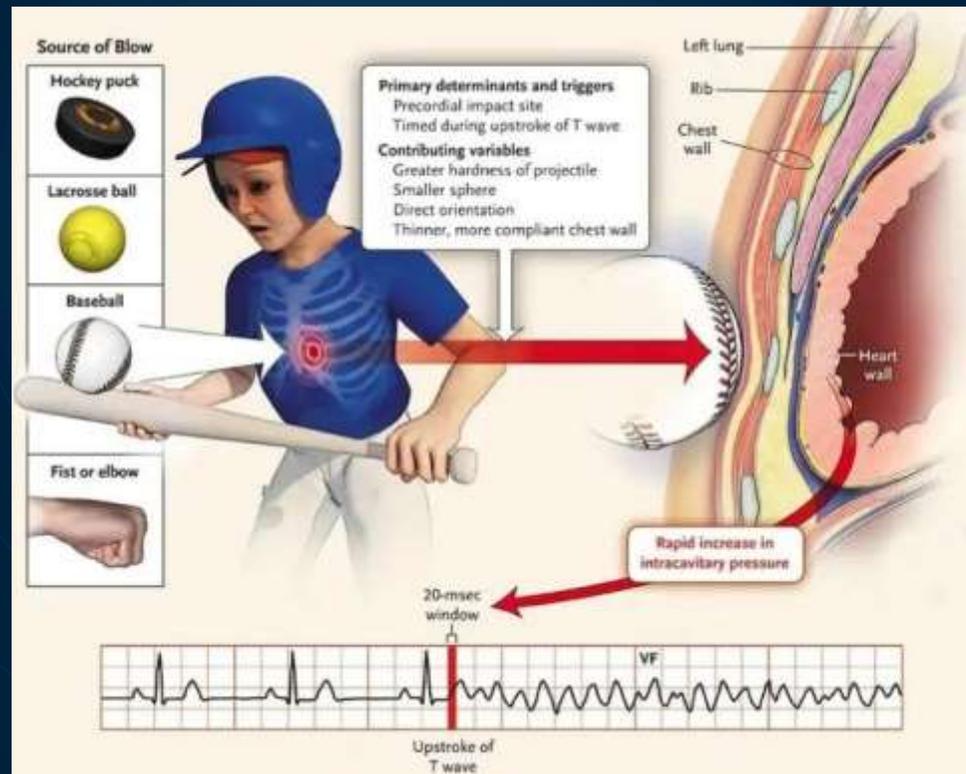
Surgical repair (open repair using a thoracotomy, or video-assisted surgery)

## Complications:

1. Pneumothorax with persistent air leak
2. Airway obstruction
3. Bronchopleural fistula
4. mediastinitis



# cardiac injuries



**Etiology:**

**Penetrating injury**

**Blunt injury to sternum**

- Blunt Cardiac Injury (BCI) refers to a range of heart-related damage caused by blunt trauma to the chest. The severity can vary widely — from minor, unnoticed irregular heart rhythms to life-threatening conditions like rupture of the heart wall.
- The most frequent form of BCI is a cardiac contusion, which is essentially bruising of the heart muscle (myocardium). However, diagnosing this condition is challenging due to the lack of a universally accepted definition and no definitive test to confirm it.
- When evaluating blunt cardiac trauma, it's important to be aware of several potential complications, such as:
  - Arrhythmias (abnormal heart rhythms)
  - Abnormal heart wall motion, which can worsen into cardiogenic shock (when the heart can't pump enough blood)
  - Structural damage, including rupture of valves, the septum, or the atrial or ventricular walls
- Causes of BCI are most commonly:
  - 1\_Motor vehicle collisions (MVCs)
  - 2\_Falls
  - 3\_Crush injuries
- These incidents typically involve rapid deceleration, which is the primary mechanism behind the trauma.
- A rare but serious form of BCI is Commotio Cordis, where a sudden, low-impact blow to the chest — often during sports — triggers sudden cardiac arrest, even though there may be no visible injury.

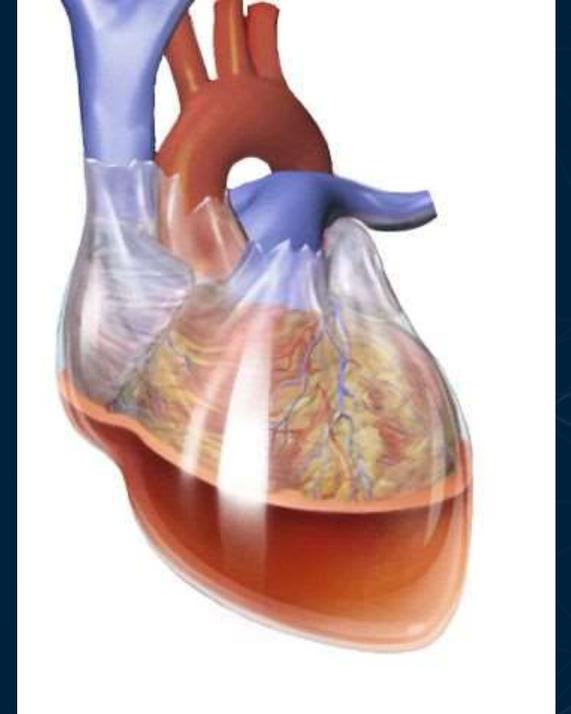
# Complications of BCI:

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- Complications of BCI:
- Arrhythmias (most common; may be transient or life-threatening)
- myocardial fibrosis and aneurysm
- Cardiogenic shock (due to impaired cardiac function)
- Myocardial rupture (ventricular or atrial wall)
- Valvular rupture or dysfunction , Septal rupture (interventricular or interatrial)
- Pericardial effusion or tamponade
- Thrombus formation (intracardiac clot)

# Hemopericardium

- Hemopericardium is the presence of blood within the pericardial sac (the space surrounding the heart). It often arises due to trauma, malignancy, or rupture of a heart structure, such as after a myocardial infarction or invasive cardiac procedures.
- If not addressed quickly, the accumulating blood can cause cardiac tamponade — a dangerous condition where increased pressure around the heart prevents it from filling properly, severely reducing cardiac output.



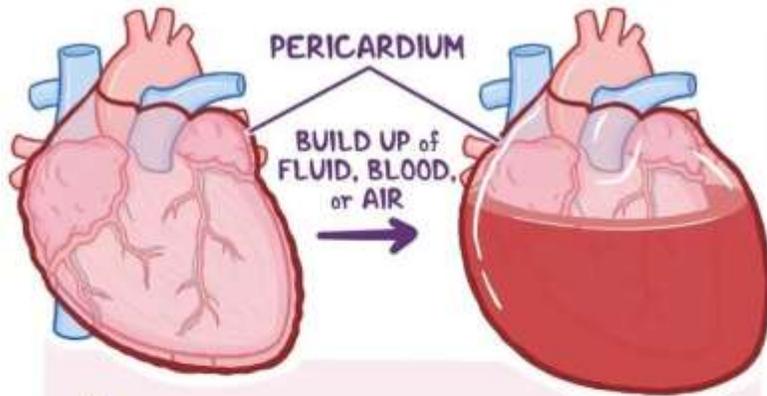
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- Common Causes:
  - Blunt or penetrating chest trauma
  - Myocardial rupture (often post-infarction)
  - Complications from cardiac interventions or surgeries
  - Invasive tumors involving the heart or pericardium

- **Physiological Effects:**
- **Rising intrapericardial pressure limits the heart's ability to relax and fill during diastole**
- **This leads to reduced cardiac output, hypotension, and shock**
- **Investigation:**
- **ECG**
- **Chest X-ray**
- **Echocardiography**
- **EFAST**



- **Classic Symptoms and Signs:**

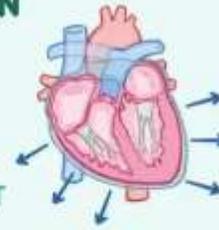
- This condition typically presents with Beck's triad:
- Hypotension – due to reduced cardiac output
- Distended neck veins – from impaired venous return (jugular venous distension)
- Muffled heart sounds – from fluid dampening the sound of the heartbeat
- Other signs may include tachycardia, pulsus paradoxus, and dyspnea
- sinus tachycardia, even in the absence of frank hypotension, may indicate significant hemodynamic compromise from cardiac tamponade and serve as an indication for immediate pericardiocentesis.
- Kussmaul's sign (the absence of an inspiratory decline in jugular venous pressure) is not usually seen in cardiac tamponade.
- Pulsus paradoxus — Pulsus paradoxus, defined as an abnormally large decrease in systolic blood pressure (>10 mmHg) on inspiration,
- Pericardial rub — A pericardial rub may be heard in patients with cardiac tamponade due to inflammatory pericarditis



⚠️ **CONSIDERED a MEDICAL EMERGENCY**  
**CAN PROGRESS to CIRCULATORY SHOCK and CARDIAC ARREST**

## PERICARDIAL EFFUSION

- PERICARDIAL FLUID BUILDS up SLOWLY OVER TIME
- ↳ ALLOWS PERICARDIUM to STRETCH OUT to ACCOMMODATE BIGGER VOLUMES of FLUID w/o COMPRESSING HEART



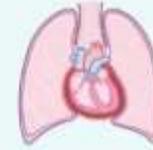
### SYMPTOMS



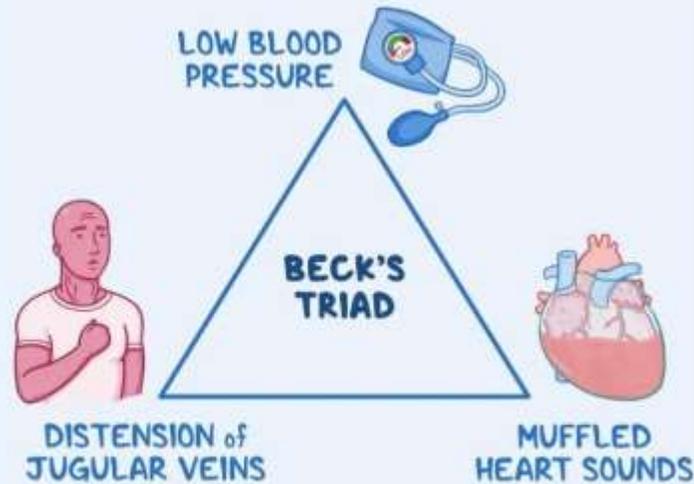
CHEST PAIN



SHORTNESS of BREATH



COMPRESSION of NEAR STRUCTURES



## ACUTE PERICARDIAL TAMPONADE

- SUDDEN FLUID ACCUMULATION
- PERICARDIUM CANNOT ADJUST
- ↳ DRAMATIC INCREASE in PRESSURE INSIDE PERICARDIAL SAC

### CAUSES



CHEST TRAUMA



RUPTURED AORTA



RUPTURED of VENTRICLE AFTER a HEART ATTACK

## Diagnostic Tools:

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- ECG (Electrocardiogram): May show low voltage QRS complexes or electrical alternans
- Chest X-ray: Can show an enlarged, globular-shaped cardiac silhouette if the effusion is large
- Echocardiography: The most useful tool; identifies pericardial effusion and signs of tamponade physiology (e.g., right atrial or right ventricular diastolic collapse)
- Extended Focused Assessment with Sonography for Trauma (eFAST): Rapid bedside ultrasound used especially in trauma settings to detect pericardial effusion quickly

## **Surgical Management**

### Indications for Surgery:

- 1\_ Persistent hemodynamic instability despite fluid resuscitation.
- 2\_ Large volume of fluid causing significant pressure on the heart.

### **Surgical Techniques:**

#### **1\_ Pericardiocentesis:**

- 1\_ Initial, less invasive procedure for diagnostic and therapeutic purposes.
- 2\_ Involves inserting a needle into the pericardial space to drain fluid.
- 3\_ Can be performed under ultrasound guidance.

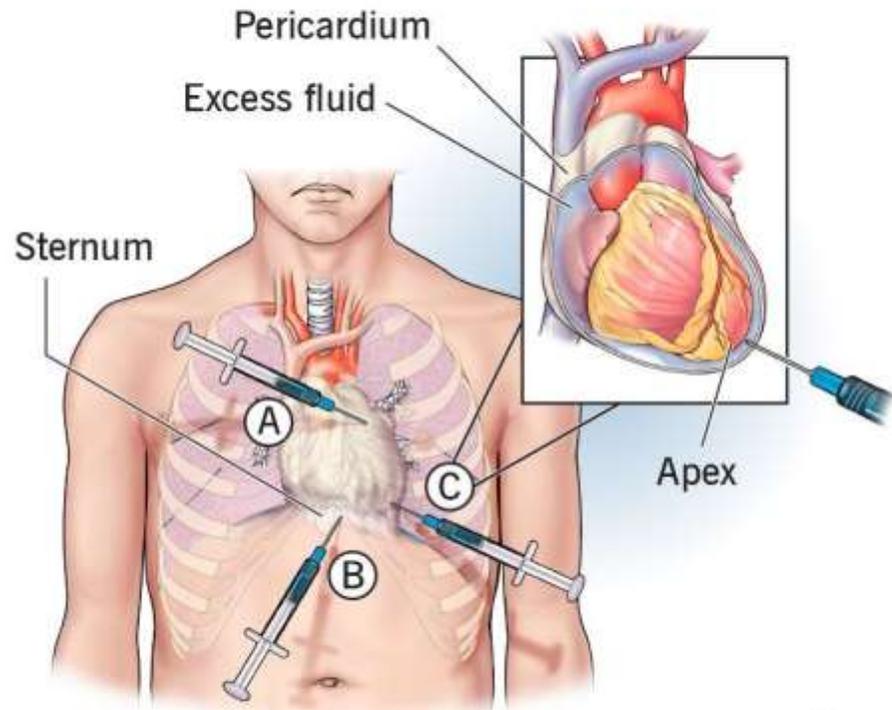
#### **2\_ Thoracotomy or Subxiphoid Pericardial Window:**

- 1\_ Indicated if pericardiocentesis is unsuccessful or if there is a need for more extensive drainage.
- 2\_ Allows for direct visualization and evacuation of fluid.
- 3\_ A subxiphoid approach is often preferred for emergency situations.

#### **3\_ Postoperative Considerations:**

- 1\_ Monitoring for recurrence of tamponade, infection, and cardiac function.
- 2\_ Assessment of underlying causes to prevent future occurrences

## Pericardiocentesis



A. Parasternal B. Substernal C. Apical

## Cardiac Tamponade



# Esophageal injuries,

- Esophageal injuries, whether due to trauma, medical procedures, or chemical ingestion, are serious and can result in high rates of morbidity and mortality if not promptly recognized and treated. Early surgical repair is often necessary to prevent severe complications such as mediastinitis, a life-threatening infection of the mediastinum.
- Types of Esophageal Injuries:
  - Penetrating trauma: Commonly caused by stab wounds or gunshots, leading to direct esophageal damage.
  - Blunt trauma: Usually from compression injuries or rapid deceleration (e.g., car accidents), which may cause rupture or contusion.
  - Iatrogenic injury: Occurs as a complication of surgical or endoscopic procedures, such as esophagoscopy or intubation.
  - Chemical or foreign body ingestion: Damage from corrosive substances (acids or alkalis) or sharp foreign objects swallowed accidentally or intentionally.



## Diagnostic Imaging:

**Contrast-enhanced CT scan:** A key tool for detecting esophageal leaks, assessing the extent of injury, and evaluating adjacent structures like the mediastinum and pleura.

**Endoscopy:** Enables direct visualization of the esophageal lining, helping confirm the diagnosis and, in some cases, guiding therapeutic interventions

## Complications of Esophageal Injury:

**Mediastinitis**

**Septic shock**

**Pneumothorax**

**Mediastinal emphysema**

## Clinical Presentation:

**Sudden, severe pain** Fever, tachycardia, and hypotension ,Dysphagia, Signs of

**sepsis,Odynophagia,Subcutaneous emphysema (crepitus) or mediastinal crunch (Hamman's sign) in some cases**



- **Treatment:**
- NPO, IVF, IVA and never try to pass a NG tube
- Depends on site of perforation and time of detection:
- **1\_ Early detected cervical and thoracic perforation**
- Surgical closure and drainage
- **2\_ Late detected cervical perforation**
- External drainage with parenteral feeding
- **3\_ Late detected thoracic perforation**
- Drainage with feeding jejunostomy
- **4\_ Abdominal perforation**
- Surgical

- **Surgical Management**

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- **Indications for Surgery:**

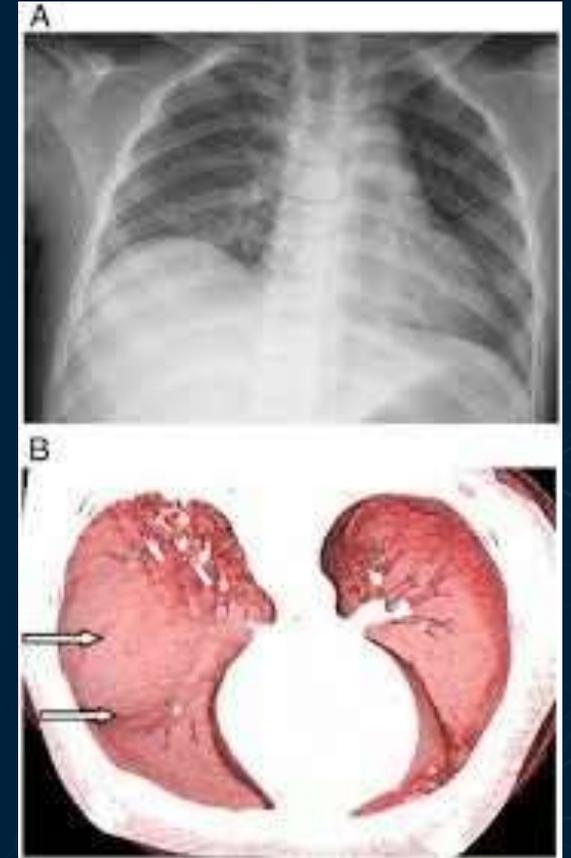
- 1\_Evidence of perforation or significant laceration.
- 2\_Signs of mediastinitis or significant contamination.

- **Surgical Techniques:**

- **1\_Primary Repair:** Indicated for small, clean perforations. Involves suturing the esophagus.
- **2\_Resection:** Esophagectomy may be necessary for extensive injuries or if the esophagus is severely compromised.
- **3\_Esophagostomy:** In cases where primary repair is not feasible, creating an external stoma may be required.
- **4\_Reconstruction:** May involve using adjacent tissue (like gastric or colonic flaps) for repair

# Diaphragmatic Injury

- Diaphragmatic injuries are relatively rare, accounting for less than 1% of all traumatic injuries. They often occur in conjunction with injuries to thoracic or abdominal organs, making diagnosis more challenging.
- A high degree of clinical suspicion is crucial, as these injuries are frequently missed initially. If not identified and treated promptly, delayed diagnosis can lead to herniation of abdominal contents into the chest cavity. This may result in organ strangulation, a life-threatening complication requiring emergency surgical intervention.



- **Mechanism of Diaphragmatic Injury:**

- Diaphragmatic injuries can occur through direct or indirect trauma:

- Direct injury happens when a penetrating object (e.g., knife, bullet, or other impalement) passes through the diaphragm, either from the abdomen into the chest or vice versa. These typically result in small, localized tears, often matching the size of the object. Because these defects can be subtle, penetrating injuries are more likely to go unnoticed during initial assessment.

- Indirect injury usually results from blunt trauma, such as in motor vehicle collisions. A sudden spike in intra-abdominal pressure can cause the diaphragm to rupture. This mechanism typically produces large, radial tears due to the force exceeding the diaphragm's tensile strength

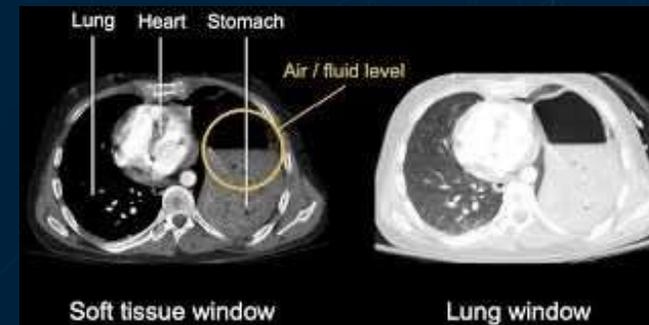
- **Clinical Evaluation:**

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- During assessment, the chest and abdomen should be carefully examined for signs of trauma such as contusions or ecchymoses, which may indicate exposure to significant blunt force
- Although normal diaphragmatic movement can vary depending on factors like body habitus, posture, and lung volume, it's important to maintain a high index of suspicion in cases involving penetrating trauma. Specifically, any stab or gunshot wound between the T4 and T12 dermatomes (roughly from the nipples to the umbilicus on the torso) has the potential to injure the diaphragm, and such injuries should not be overlooked.

- **Diagnostic Approach:**

- While a chest X-ray is routinely performed during the primary survey in trauma cases, it may not always reveal a diaphragmatic injury. If the mechanism of injury or clinical findings raise suspicion, further imaging is often necessary.
- In many cases, diaphragmatic injuries are diagnosed incidentally during a CT scan, which is typically performed to evaluate for other serious conditions such as traumatic aortic injury. CT imaging provides better visualization of the diaphragm and surrounding structures, making it a valuable tool in identifying otherwise occult or missed diaphragmatic tears.



- **Chest radiograph** — The chest radiograph is the most commonly obtained imaging study used for the evaluation of trauma patients. Diagnosis of diaphragmatic injury on chest radiograph can be as obvious as visualization of the stomach or other abdominal organs in the chest, or suggested by subtle signs including elevation of the diaphragm, basilar atelectasis, lack of clarity of the hemidiaphragm, abnormal nasogastric tube positioning, or even hemothorax from bleeding in the abdomen (eg, splenic injury)

- **Computed tomography** — Following blunt thoracoabdominal trauma, computed tomography (CT) is often performed as part of the initial trauma evaluation or based upon findings of a chest radiograph. CT is most commonly used in hemodynamically stable patients as a means to rule out solid organ and hollow viscus injuries
- CT can detect diaphragm injury and is more useful for assessing the posterior lumbar elements of the diaphragm (crura and arcuate ligaments) compared with the anterior leaflets
- Laparoscopic or thoracoscopic exploration

# Findings on CT scan suggestive of diaphragm injury include:

- Discontinuous diaphragm sign
- Diaphragm thickening
- Organ herniation sign
- Dangling diaphragm sign
- Collar sig
- Hump signs



# COMPLICATIONS OF DIAPHRAGMATIC INJURY

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- Herniation
- Diaphragm paralysis
- Pulmonary complications
- Biliary fistula
- **Surgical Intervention:**
- Most diaphragmatic injuries require surgical repair. This is often done via:
- **Open Surgery:** Through a thoracotomy or laparotomy, depending on the injury's location.
- **Laposcopic Repair:** In select cases, minimally invasive techniques may be use

# Other chest wall injuries



clavicular fracture

Sternal fracture



scapular fracture

# clavicular fracture

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- mostly affects the middle part
- Can be treated conservatively in most cases by:
  - Figure of 8 dressing
  - Clavicle strap or sling
- treatment
  - Conservative management (majority of cases):
    - Arm sling or figure-of-eight bandage
    - Pain control (NSAIDs, analgesics)
    - Physical therapy after initial immobilization (typically 2–4 weeks)

Surgical intervention (open reduction and internal fixation – ORIF) indicated if:

Severely displaced or comminuted fracture

Neurovascular compromise

Open fracture

Nonunion or symptomatic malunion

Shortening >2 cm, especially in young, active patients

# Sternal fracture

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- Usually seen in RTA
- Mostly transverse and affecting the middle and upper part of sternal body
- Up to 2/3 of patients have also associated thoracic and head injuries
- Non-displaced fractures:
- Conservative treatment:
- Pain management
- Monitoring for underlying cardiac or pulmonary injury (e.g., ECG, echocardiogram)
- Observation for signs of sternal hematoma or mediastinal injury

Surgical repair (rare) may be needed for:

Displaced fractures

Persistent pain or instability

Sternal nonunion

Associated cardiac or great vessel injury

# scapular fracture

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- Indicates sever force of impact
- Carries very high risk of associated injuries
- Non-operative management (in most cases):
  - Immobilization in a sling
  - Ice, analgesics
  - Early passive and then active range-of-motion exercises within 1–2 weeks
- Surgical treatment (ORIF) if:
  - Intra-articular fracture involving the glenoid
  - Significant displacement (e.g., >5 mm step-off)
  - Scapular neck fractures with >40° angulation or >1 cm translation
  - Open fractures or associated neurovascular injury