

Chest Injuries

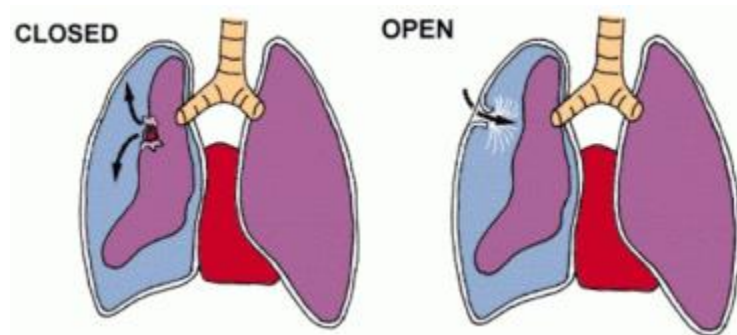
* **Incidence :**

- Chest injuries represent **20% of trauma** victims .
- Chest injuries represent the **commonest cause of death** between the accident and the emergency room .

* **Aetiology:**

A) **Closed injury:** Without a wound in chest wall e.g. car accident , blunt trauma to chest wall or falling from a height .

B) **Open injury:** With a wound in chest wall e.g. stab or bullet.



* **Complications & sequelae of chest trauma :**

A) **Parietal injury:** The following structures may be affected:

1. **Soft tissue :** Bruises, haematoma and surgical emphysema.
2. **Bones** → Fracture of ribs, sternum, clavicle and spines.

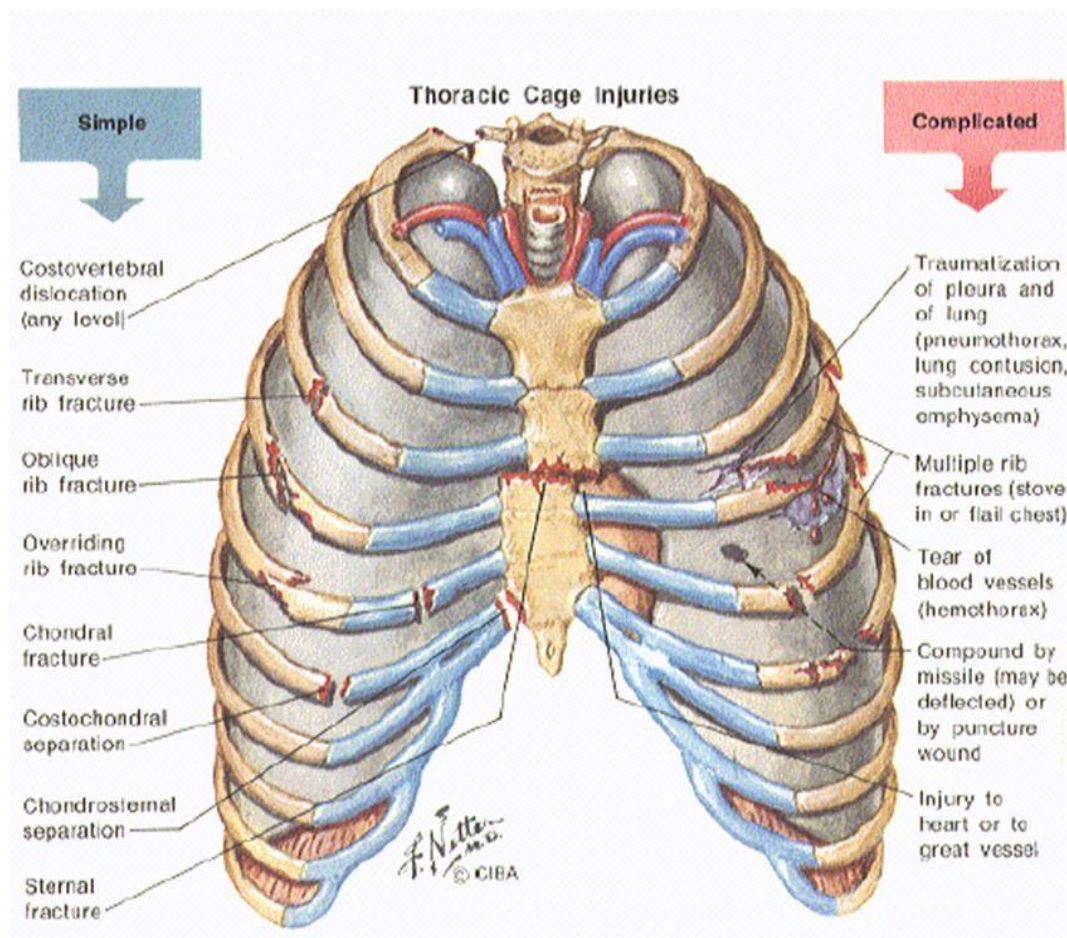
B) **Visceral injury:**

I- Thoracic injuries:

1. **Pleura & lungs** → contusion , laceration, haemothorax, pneumothorax or haemo-pneumothorax.
2. **Heart** → contusion , arrest , rupture, haemopericardium , cardiac tamponade & H.F.

3. **Tracheo-bronchial tree** → airway obstruction , wet lung , pneumothorax and haemokthorax.
4. Large **vessels** → fatal hemorrhage & haemokthorax .
5. Rupture **oesophagus or diaphragm**.

II - Associated abdominal injuries: Due to the trauma to the lower part of the thorax → injuries of liver , spleen or kidneys.



2

* **Clinical picture of chest injuries in general :**

❖ N.B: In any trauma victim , life saving measures i.e primary survey and resuscitation should be performed and have the first priority before taking any history , performing any exam. or investigation .

A) Symptoms:

- After a **history** of trauma there are **sudden or rapid onset** of one or more of the followings :
- **Chest pain , dyspnea , cyanosis ,cough or haemoptasis** (due lung or tracheo-bronchial injury) .
- **Abdominal** pain or other abdominal symptoms due to associated abdominal injuries if the trauma affecting the lower part of the chest .

B) Signs:

I) General:

a - Manifestations of internal Hge & hypovolaemic shock (Mention in short). **Haemothorax** & tension pneumothorax unlike other types of shock are associated with **cyanosis** due to lung collapse .

b- Examine for any **associated injuries** in the head, abdomen.....etc.

II- Local: May show one or more of the followings:

1- Rib Fractures

* **Incidence:** The commonest chest injury.

* **Aetiology:**

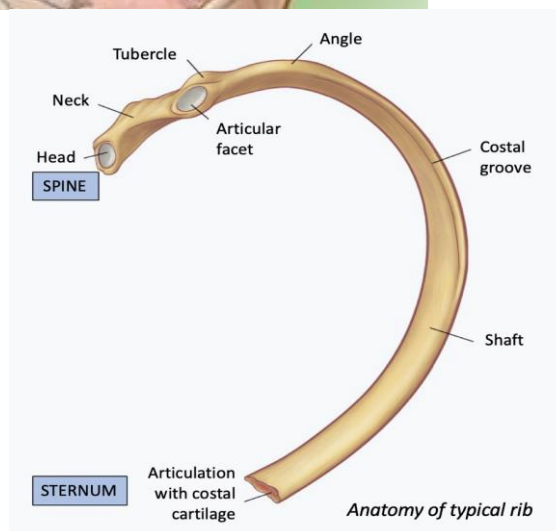
1. Direct trauma:

- Fracture occurs at the site of the trauma.
- Visceral injuries are common because the broken ends are driven inwards .

2. Indirect trauma:

- Antero-posterior compression of the ribs → fracture at the angle of the ribs.
- Visceral injury is rare because the broken ends are driven outwards .

3. **Muscular violence:** e.g. Severe coughing in osteoporotic old patient .

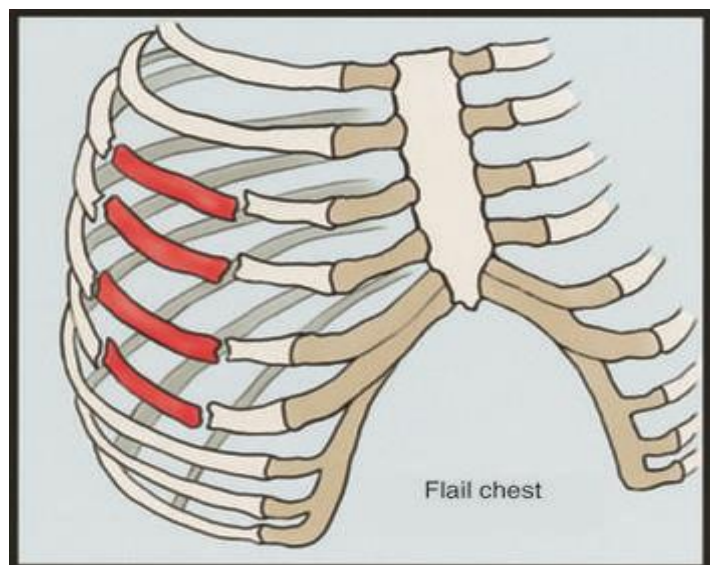
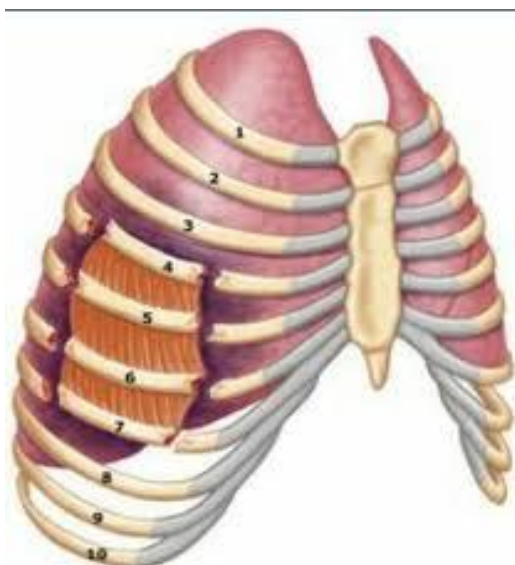


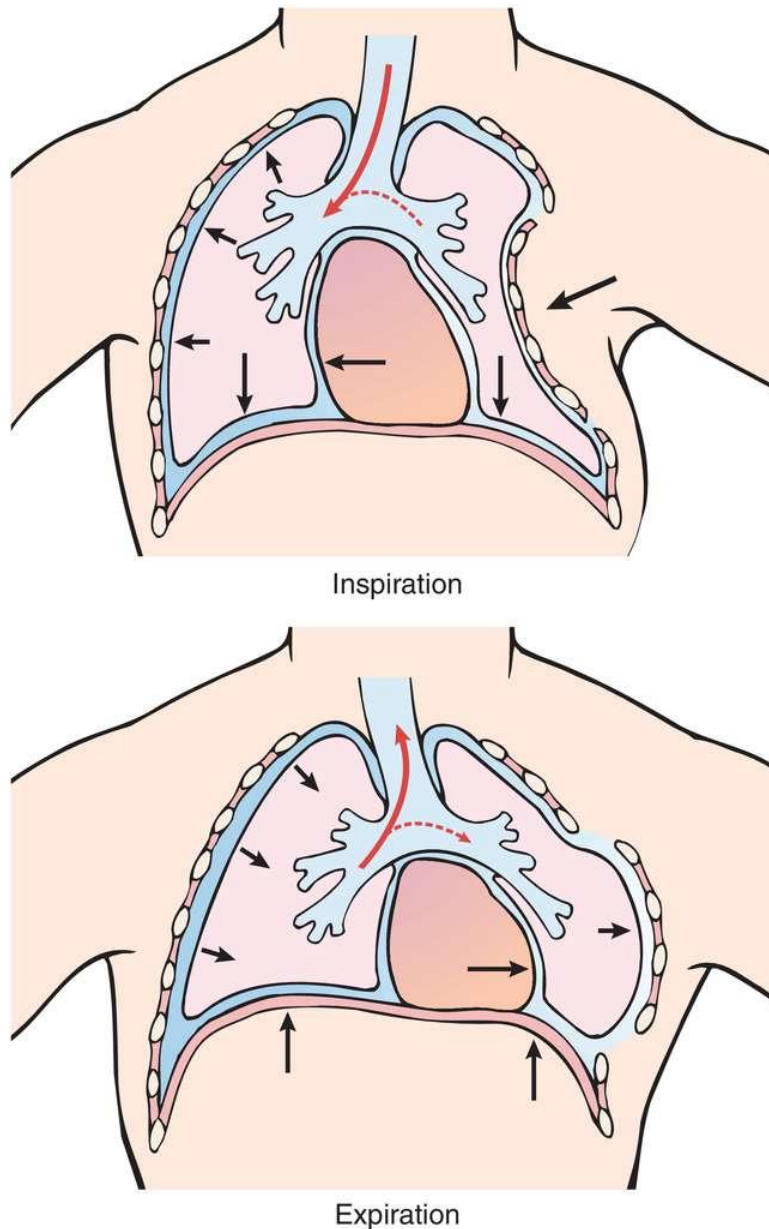
* **Pathology:** Rib fractures can be divided into:

- 1. Isolated simple rib fracture:** One or more ribs are fractured in a single site.
- 2. Double rib fractures:** Multiple fractures in multiple ribs. This lead to:

a- Flail chest:

- Very serious, **3 ribs or more** are fractured at 2 sites with a loose mobile part of chest wall which has the following effects:
 - The flail part moves **paradoxically with respiration** i.e during inspiration the flail segment retracted inwards and bulges outwards during expiration .
 - Interference with **respiratory movement** of the related lung as the flail part tends to neutralize any changes in the intrathoracic pressure.
 - Paradoxical movement of the flail part produce **pendulum respiration** (as in open pneumothorax) → impairment of gas exchange.
 - **Mediastinal flutter** (as in open pneumothorax).
 - Intrathoracic negative pressure is lost on the affected side → decrease of the **venous return** → decrease cardiac output → **circulatory failure**.
 - This patient usually have **underlying lung** contusion (leading to leakage of blood and edema fluid into the alveoli) & lacerations .





b- **Stove in chest:** is a rare type of flail **chest** injury where the flail segment collapses into the **chest**

* **Complications:** (mention in any chest injury)

1. Injury of chest structures intercostal & internal thoracic vessels, pleura and lung → pneumothorax, haemothorax, haemopneumothorax , surgical emphysema, hge and shock.

2. Injury of underlying **abdominal viscera** → rupture liver, spleen, kidney... etc.

3. Respiratory insufficiency in chest injuries may be due to :

- Respiratory **obstruction** by blood ,sections or foreign body .
- **Unstable** thoracic cage e.g. Flail chest .
- Interference with **respiratory movements** due to severe pain
→ collapse of lung , hypercarpia , hypoxia, accumulation of secretions & respiratory infections.
- **Lung collapse due to haemothorax or pneumothorax .**
- **Lung** contusion or laceration .
- **Diaphragmatic** rupture .
- Depression of **respiratory center** due to associated head injury .

* **Clinical picture:** (as any fracture)

1. **History** of trauma to the chest.
2. Severe **pain & tenderness** over the fracture **increased** by cough & breathing.
3. Shallow limited rapid respiratory **movements**.
4. **Crepitus** at the site of the fracture.
5. Evidence of underlying **chest injuries** (pneumothoraxetc.).
6. Evidence of associated **abdominal injuries** (liver, spleen or kidney).

* **Investigations:**

1. **Plain X-ray** show the fracture & associated injuries (see later),
2. Other investigations for associated **chest or abdominal** injuries (mention).

* **Treatment:**

A) Simple- fracture:

- **Relief pain** by strong analgesics & NSAID to allow free respiration & expansion of the lung.
- Intercostal nerve block or thoracic epidural nerve block may be needed to control severe persistent pain.
- **Mucolytics and expectorants** .
- Chest **physiotherapy** .

B) Flail chest:

1. Small flail segment:

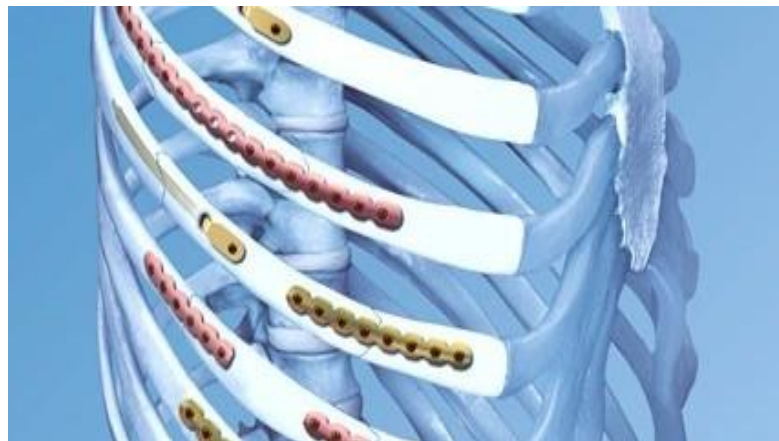
- **Relief pain** as in simple rib fracture .
- **External fixation** by a cotton pad & adhesive plaster is enough.

2. In severe cases:

a) Internal stabilization of the flail segment :

- **Indications :**
 - Disturbed or loss of consciousness .
 - Respiratory rate more than 35/min.
 - PaO₂ less than 60mm Hg .
 - PaCO₂ more than 50mm Hg.
 - Age above 50 years .
- **Method :**
 - Introduce **endotracheal tube** & start intermittent positive pressure breathing on **mechanical ventilator** . This provide pneumatic mattress which support the flail segment until healing occurs in **2-3 weeks** .
 - If mechanical ventilation is needed for **more than 10 days**, **tracheostomy** is done to avoid laryngeal stenosis due to prolonged endotracheal intubation.

b) If thoracotomy is indicated, **open reduction & internal fixation** by stainless steel wire sutures or special nails are used to accelerate recovery of the patient.



2- Pneumothorax

* **Definition** : Air in the pleural cavity .

* **Aetiology** :

1. Traumatic pneumothorax due to :

a- **Open** chest injury with a penetrating trauma.

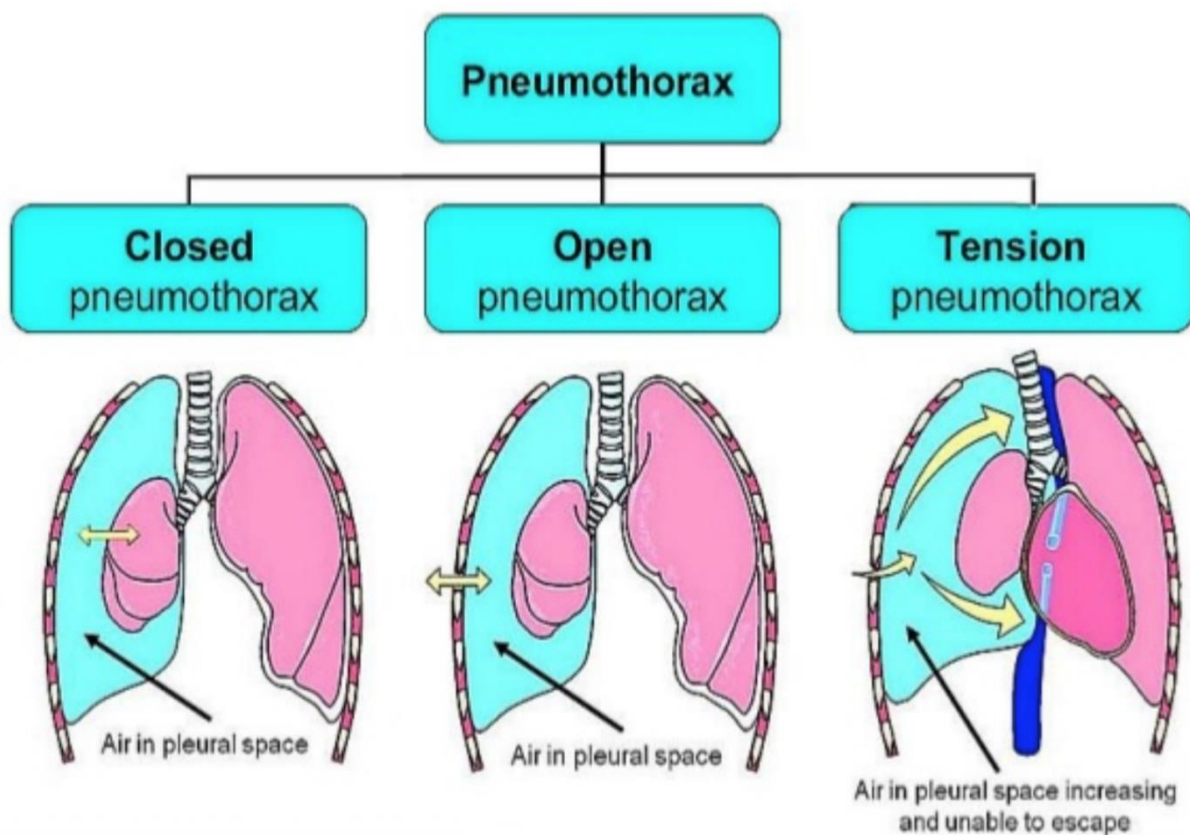
b- **Closed** chest injury due to blunt with lung or trachea-bronchial injury.

2. **Spontaneous** pneumothorax due to rupture of emphysematous bulla , lung cyst or T.B. cavity.

3. **Iatrogenic pneumothorax** e.g.

- Rupture alveoli in positive pressure ventilation.
- Chest or upper abdominal operation .
- During insetion of central venous line .

• **Types : traumatic pneumothorax may be:**



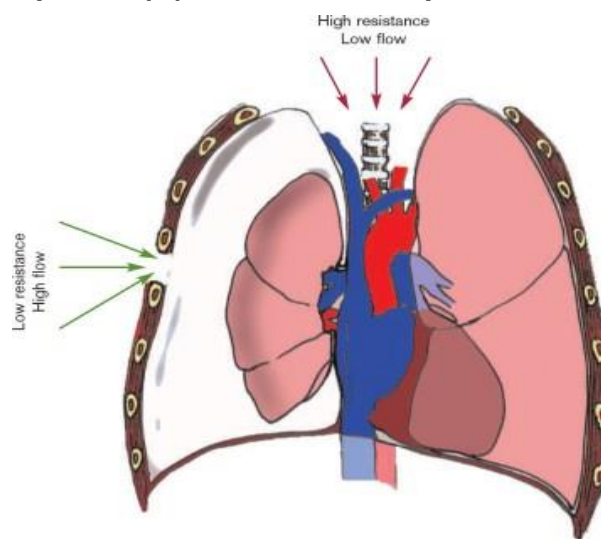
I. Simple pneumothorax:

- **Definition :** limited amount of air enter the pleural cavity with an intact chest wall.
- **C/P :** The condition may be symptomless or present by mild chest pain and mild dyspnea .
- **Exam. & plain x-rays** (as open pneumothorax)
- **Treatment :**

- Minimal amount of air **without dyspnoea** : spontaneous absorption of air takes place .
- **Marked dyspnoea** with lung collapse: insertion of intercostals tube until full lung expansion.

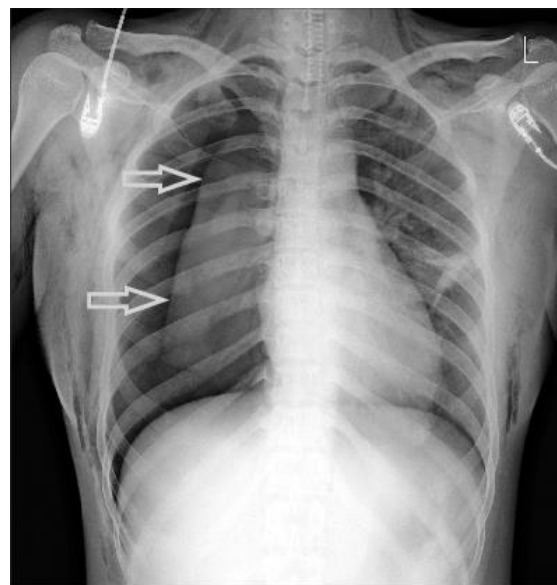
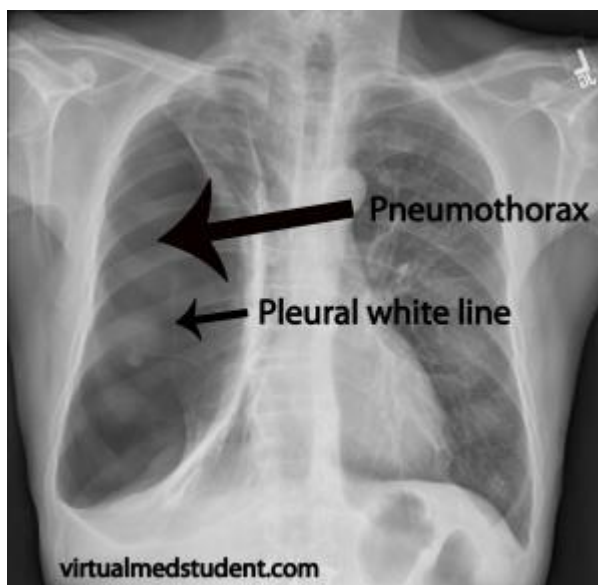
II. Open pneumothorax:

- **Definition:** The pleural cavity communicate freely with the atmosphere through a sucking wound .
- **Aetiology:** (as any pneumothorax)



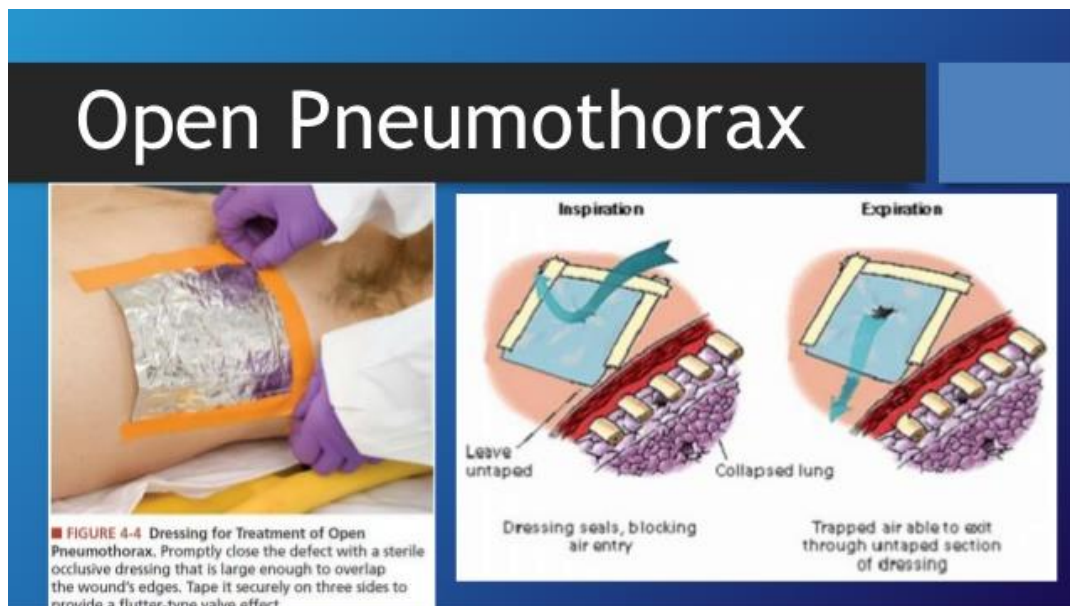
- **Pathology:** Impairment of **respiration & circulation** due to:
 - a – **During inspiration** , the negative intra-thoracic pressure starts to generate → air enters through the wound to the pleural cavity → partly reduce intra-thoracic negativity → reduce normal air flow through the trachea to the lung .
 - b- **Collapse** of the related lung which expands slightly during expiration and collapses more during inspiration (**paradoxical respiration**).
 - c- **Pendulum respiration** i.e. oscillation of air between the 2 lungs → the normal lung is always filled with air deficient in O₂ and loaded with CO₂ .

- d- **Mediastinal flutter** i.e. the mediastinum moves from side to side during inspiration & expiration.
- d - **Intrathoracic negative pressure** is lost on the affected side → decrease of the venous return → decrease **cardiac output** → circulatory failure.
- **C/P:** (Clinical picture of chest injuries in general as before) +
 - Open pneumothorax is diagnosed by the **sound** of the air passing through the sucking wound .
 - There moderate dyspnea & cyanosis .
 - Exam. reveals **diminish of air entry and resonance** on percussion.
 - There is **no tracheal or mediastinal shift** (to differentiate from tension pneumothorax).
 - **Investigations :**
 - **Plain x-ray** reveals translucency , absence of lung markings and the edge of the collapsed lung is visible .
 - Other investigations for chest injuries (See later) .



- **Treatment :**

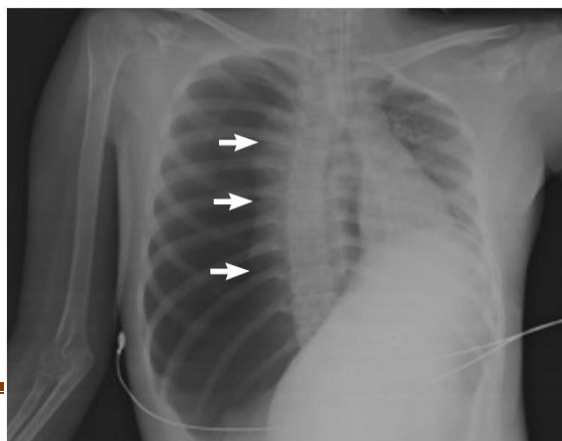
- **Intial treatment** is occlusive dressing fixed at 3 sides only.
- Once available, **definitive treatment** is insertion of **chest tube , in the 5th. intercostals space** just in front of mid-axillary line , connected to under water seal.



III. Tension pneumothorax:

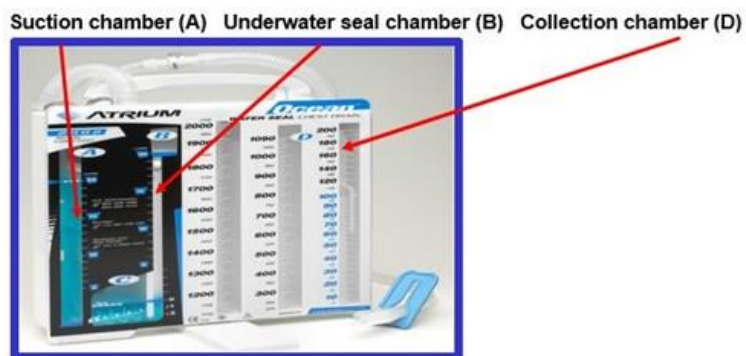
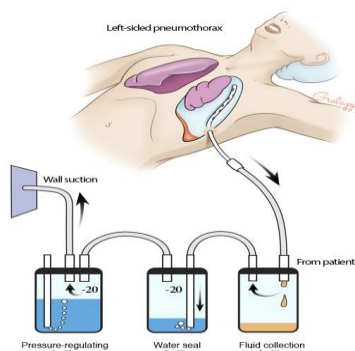
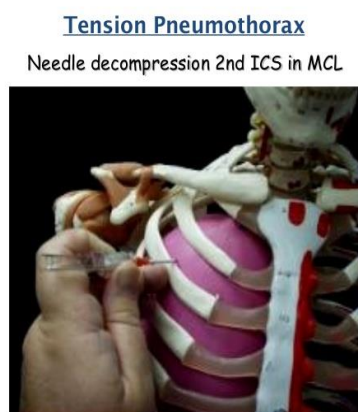
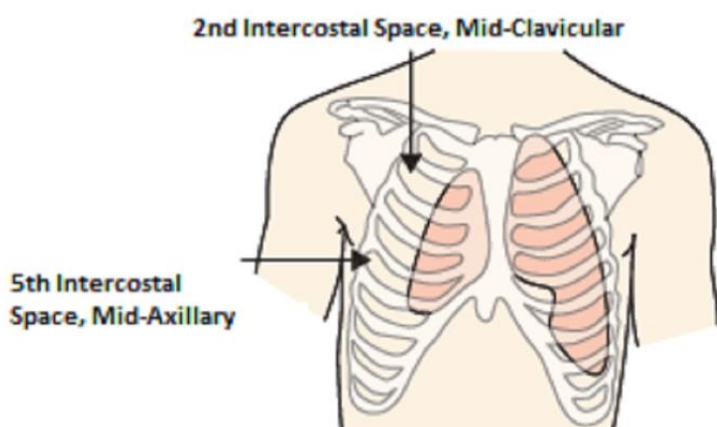
- **Definition:** Pleural cavity communicates with the atmosphere through a **valvular wound** which allows air to enter during inspiration but does not allow its exit from the pleural cavity during expiration .
- **Aetiology:** (As open pneumothorax).
- **Pathology :** Impairment of **respiration & circulation** due to:
 - a - **Collapse** of the related lung → impairment of gas exchange in the related lung .
 - b - The **mediastinum** is pushed to the opposite side → collapse of the other lung → impairment of gas exchange in the other lung.

- c - **Intrathoracic negative pressure** is lost → decrease of the **venous return** .
- d - **Collapse** of both lungs → increase of pulmonary B.P → **acute right ventricular failure.**
- **C/P:** (Clinical picture of chest injuries in general as before) +
 - Severe sharp and stabbing **chest pain** is the commonest presentation.
 - Severe progressive **dyspnea and cyanosis** followed by respiratory arrest.
 - There is **sound** of the air passing through the wound during inspiration.
 - Exam.reveals diminish chest **movements ,diminish of air entry and hyper-resonance** .
 - There is **tracheal & mediastinal shift** (to differentiate from tension open pneumothorax).
 - Engorged neck veins.
 - Severe progressive shock (mention).
- **Investigations : (after needle decompression)**
 - **Plain x-ray** reveals translucency, absence of lung markings and the edge of the collapsed lung is visible, mediastinal shift and depression of diaphragm.
 - Other **investigations for chest injuries** (See later) .



•**Treatment :**

- Tension pneumothorax is surgical **emergency** , once diagnosed clinically , **immediate** insertion of wide bore **needle in the 2nd intercostals space** in the **mid-clavicular** line to decompress the chest (**life saving**) . It is temporary measure until the definitive treatment is available.
- Then **investigations** can be done.
- After complete evaluation of the patient, the **definitive treatment is insertion of chest tube** in the 5th. intercostals space in the midaxillary, line ,connected to under water seal .
- **Continuous** bubbling of air through the intercostal tube indicate broncho-pleural **fistula** which need **thoracotomy** to close it.



Old & Recent Under Water Seal

3-HAEMOTHORAX

* **Definition:** Collection of blood in the pleural cavity.

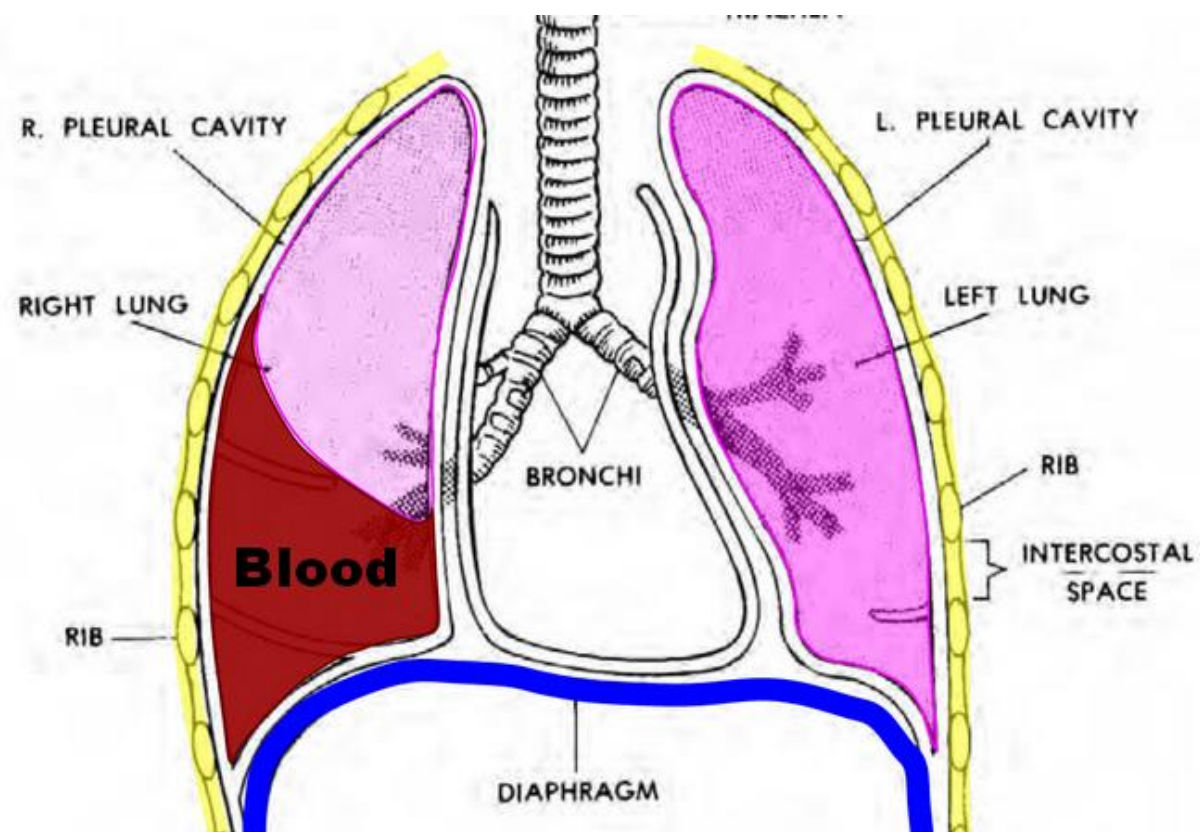
* **Aetiology:** (as pneumothorax)

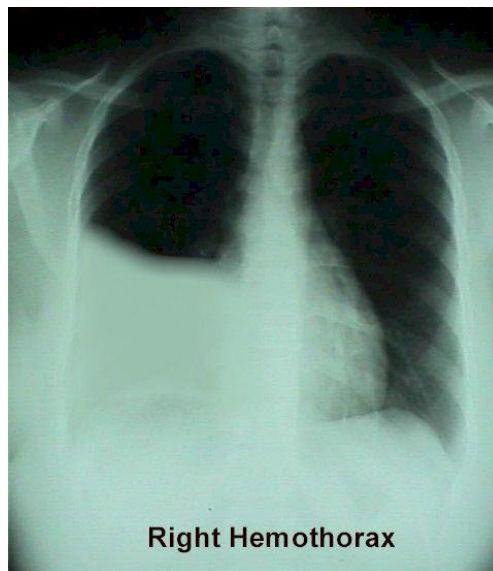
1. Traumatic injury:

- **Bleeding usually from** intercostal or internal thoracic vessels .
- **Bleeding from the lung is not profuse** (low pressure in pulmonary circulation & development of haemothorax compress the lung & bleeding vessels) .This bleeding also **stop spontaneously** when the lung inflate by treatment .
- **Persistent traumatic hemothorax** usually from internal thoracic or from aorta and its branches .

2. **Iatrogenic** following pulmonary, cardiac , oesophageal operations or insertion of central venous line .

3. **Spontaneous** due to blood diseases, tumours or leaking aortic aneurysm.





* **Pathology:**(As tension pneumothorax), It may be associated with pneumothorax i.e. haemo-pneumothorax.

* **Complications and sequelae :**

- Haemothorax is never absorbed spontaneously and if untreated it undergoes the following changes:

1 - **Defibrination** by diaphragmatic , heart and lung movements
→ blood remain fluid for many days.

2 – **Clot** formation → difficult drainage .

3 - **Irritation** of pleura with formation of effusion rich in fibrin.

4 - In neglected cases , **fibrosis** of the pleura:

➤ **Parietal** pleura → frozen chest , deformity of chest wall and crowding of ribs .

➤ **Visceral** pleura → prevent lung expansion and lung collapse

5 - **Infections** → acute empyema which may be followed by chronicity .

* **C/P:** (As chest injuries in general) + the followings

1- Hypovolaemic **shock** .

2- Diminish chest **movements** & **dullness** raised to the axilla .

3- In massive haemothorax , **shift** of trachea and mediastinum to opposite side .

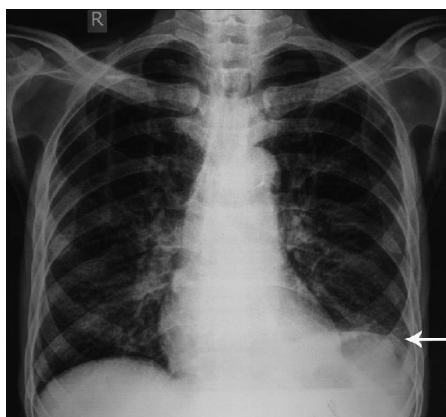
* **Investigations :**

1- Plain x-ray reveals

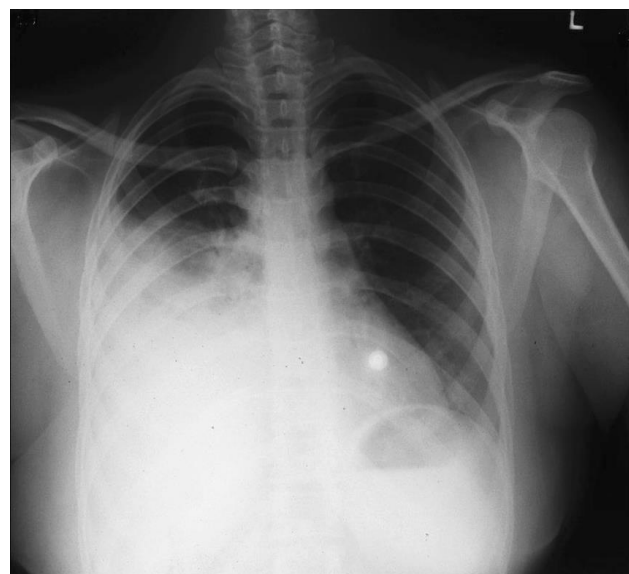
- Haemothorax less than **500** ml lead to obliteration of **costo-phrenic angle** .
- **Marked** haemothorax leads to **opacity raised to the axilla** .
- **Haemo-pneumothorax** show transverse **air-fluid level** and collapse of the lung .
- **Mediastinal shift** .

2- Diagnostic intercostals aspiration reveals blood. Free flow of non-clotted bright blood denotes excessive haemothorax. It assesses the severity of bleeding (mild = less than 300 ml, moderate = 300-1500 ml and massive = more than 1500 ml.).

3- Other investigations for chest injuries (See later).



Obliteration of costo-phrenic angle



Opacity raised to the axilla



Figure 1: Left side hemothorax

Transverse air-fluid level and collapse of the lung

*** Treatment:**

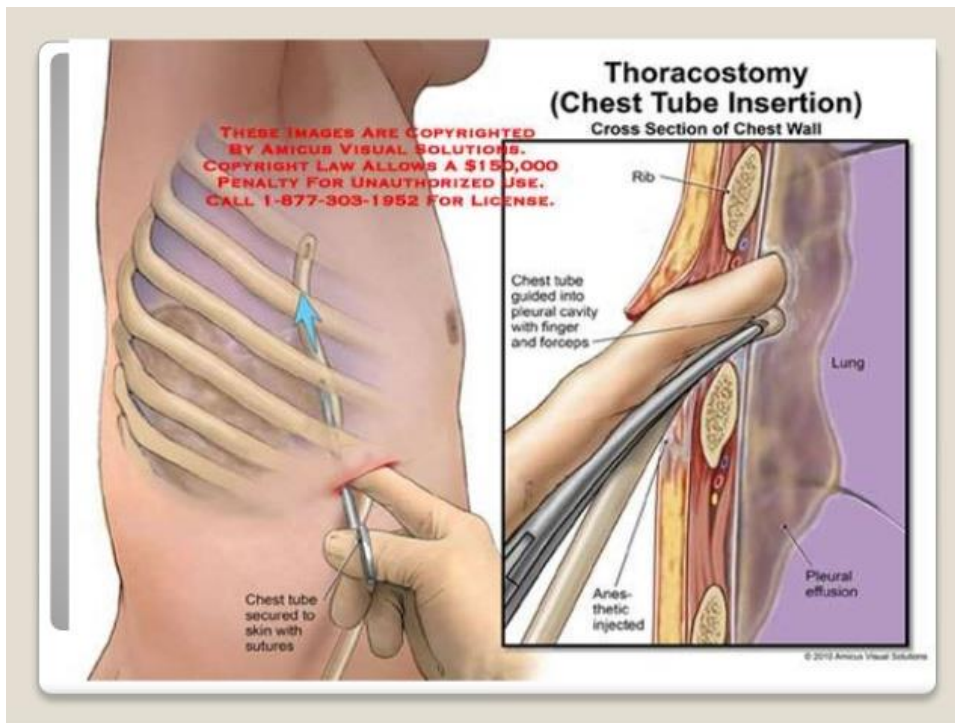
- **Anti-shock** measures , **analgesics** and prophylactic **antibiotics** .
- Haemothorax should be **evacuated completely** (confirmed by a chest x-ray and re-expansion of the lungs) to avoid complications.

A) The standard **main** definitive treatment is **intercostal tube drainage** , **inserted in** the 5th. intercostals space just anterior to the mid-axillary line , the tube should be **positioned posteriorly and superiorly** in the pleural cavity to allow maximum drainage in the supine position

- Finally , the tube is connected to **underwater seal** .
- The tube is kept until **no more drainage** & the **lung** is fully expanded.

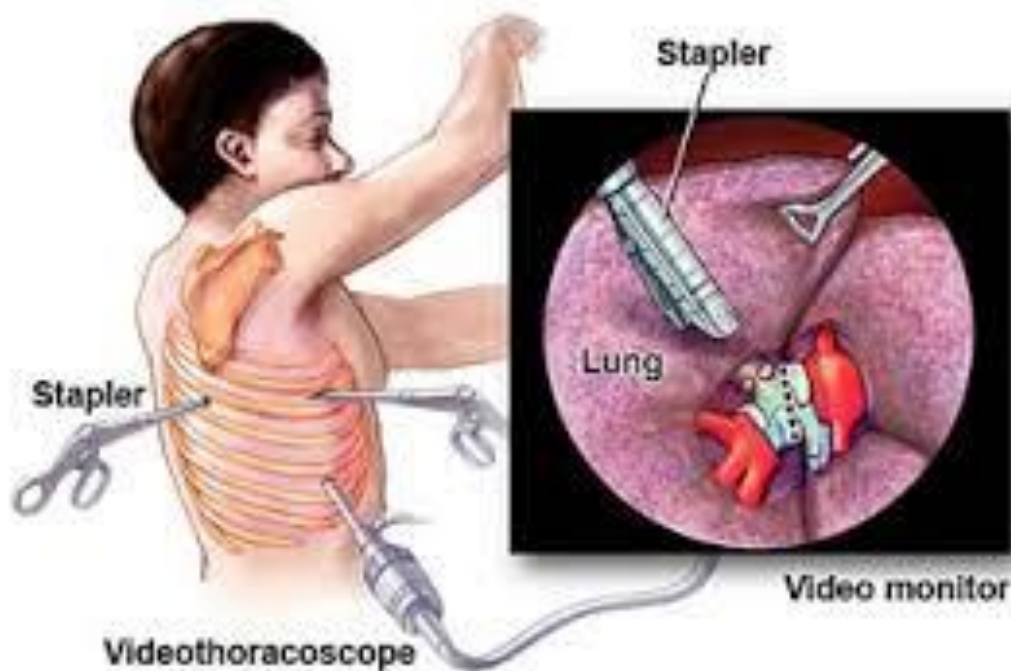
❖ Please watch the following excellent video :

<https://www.youtube.com/watch?v=qR3VcueqBgc>



B) Recently , **Video-Assisted Thoracoscopy (VAST)** if available , is recommended for all cases of hemothorax more than 300 ml .

- **Advantage** : VAST allows complete vision of entire pleural cavity , control of bleeding , removal of retained clots or foreign body and correct position of the chest tube .



C) CT scan with contrast guided arterial embolization if available in selected patient to control bleeding.

D) Thoracotomy :

▪ **Indications :**

♣ **Early :**

- Chest x-ray show complete opacity of the **hemithorax** .
- Haemothorax more than **200 ml/hour** for more than 3 successive hours
- Drainage of more than **1500 ml. in 24 hours** after insertion of the tube
- **Associated injury** requiring surgery (e.g. cardiac tamponade or injury of esophagus) .

♣ **Delayed :**

- **Clotted** haemothorax , **fibrothorax** or presence of **foreign bodies**.

▪ **Method :** (mention the operation in management of chest injuries).

4- Lung Injuries

* **Aetiology , complications & sequels** : (as chest injuries in general) .

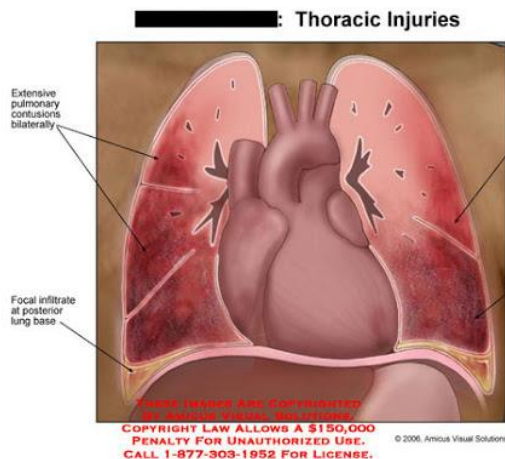
* **Types** : lung hematoma , contusion , laceration or blast injuries .

* **Clinical picture** :

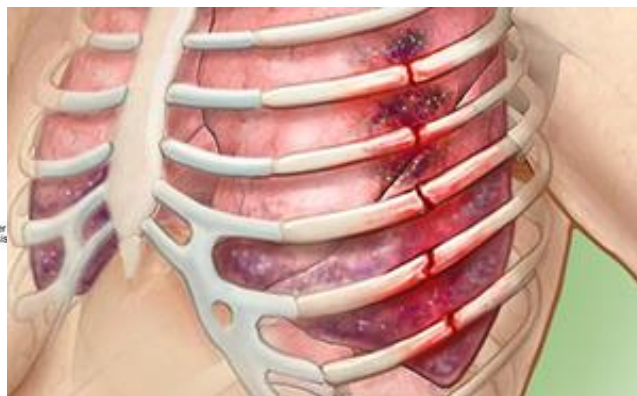
1-Lung injuries are **suspected in** high energy trauma , sternal or multiple rib fractures and presence of flail segment .

2-Clinical picture of chest injuries **in general** with associated hemothorax or pneumothorax .

* **Investigations & treatment of chest injuries in general**



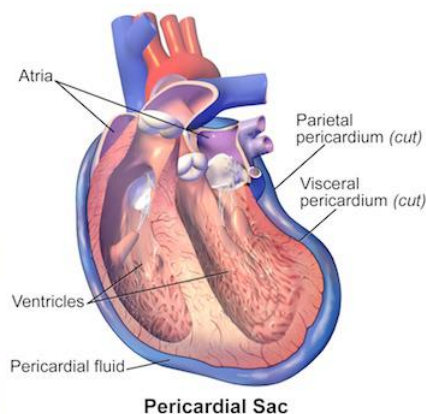
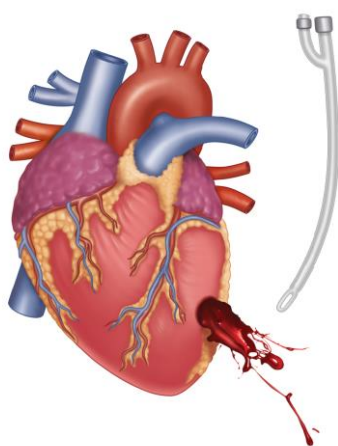
Lung contusion



Lung Laceration

5- Cardiac Injuries

* **Aetiology** : Penetrating injuries (**90%**) or blunt trauma to sternum .



* **Types complications & sequels** :

1- Myocardial **contusion** which may leads to **mural thrombosis** .

2- Myocardial contusion & laceration heal by **fibrosis** which may leads later on to cardiac **aneurysm** which may rupture .

3-Myocardial laceration leads to **hemopericardium** and cardiac **tamponade** .

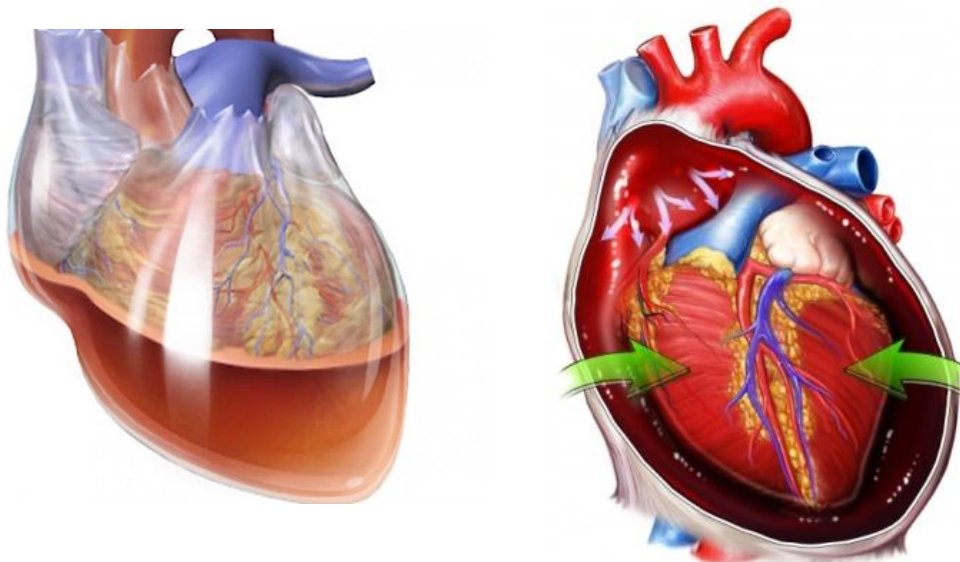
4-Cardiac trauma may lead to **heart failure** or **cardiac arrest** .

5-Rarely rupture of a valve or interventricular septum .

6-Cardiac rupture lead to **fatal hemorrhage** .

Cardiac Tamponade

- **Definition:** Cardiac **compression** by haemopericardium → impairment of cardiac filling → decrease cardiac output .The **rate** of accumulation of is more important than the amount , **rapid** accumulation of 150 ml may be **fatal** .



- **Clinical pictures :**

I. Massive rapid haemopericardium → death.

II. Survivors will show:

1) Dyspnea and cyanosis .

2) Severe cardiogenic shock.

3) Beck's triad :

- **Persistent low B.P** despite proper I.V fluid & blood transfusion.

- Congested **neck veins** .
- Distal , weak or inaudible **heart sounds**

4) Low cardiac output symptoms.

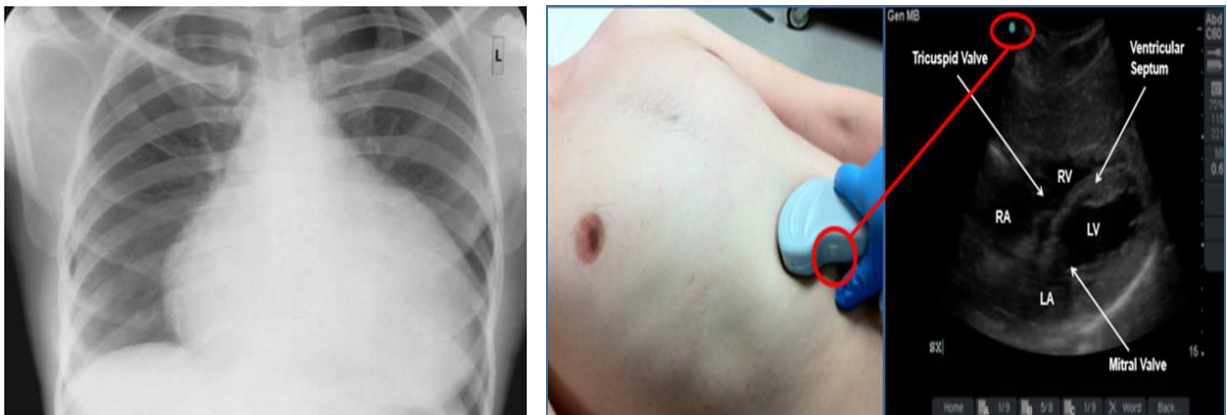
5) High venous pressure.

6) Weak apex.

7) Dullness outside the apex.

• **Investigations :**

- 1) **ECG** : low voltage , extra-systoles or A.F.
- 2) Plain **chest x-ray**: Large flask shaped cardiac shadow.
- 3) **Echocardiography** is the main investigation.
- 4) **EFAST** with subxiphoid view.

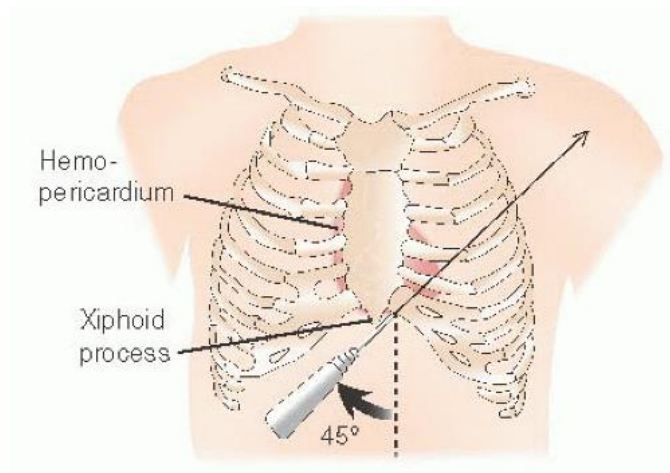
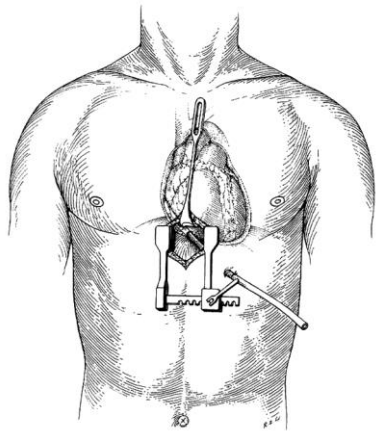


• **Treatment :**

▪ **Temporary relief of cardiac compression :**

- 1) **Pericardiocentesis**: A cannula is introduced in the subxiphoid area with 45° angle from the skin and 45° angle laterally towards the left mid-clavicle .

2) Subxiphoid pericardiotomy .



- **Definitive treatment:** Thoracotomy and pericardiotomy to repair the injury.

6- Oesophageal Injuries

* **Aetiology :**

- 1-The **commonest** cause is **iatrogenic** , during **endoscopic dilatation** of a stricture .
- 2- **Swallowing** connoisives or foreign bodies .
- 3-**Penetrating** or blunt injuries to neck or chest .
- 4-During severe **vomiting** (Boerhaave's syndrome) .

- * **Complications : Mediastinitis** , septic shock and rapidly fatal if not urgently treated .

* **Clinical picture :**

- 1-Sudden onset of **pain** at the site of the injury followed by fever , tachycardia and hypotension .
- 2-Mediastinal **emphysema**.
- 3-Pneumothorax and pleural effusion .

* **Investigations :**

- 1- **Plain x-ray** show mediastinal emphysema & hydropneumothorax .
- 2- **Water soluble swallow** : show the perforation

* **Treatment :**

1-Nothing is taken **orally** & never try to pass **nasogastric** tube .

2-**Anti-shock** measures .

3-I.V **antibiotic**

4- Cervical perforation :

➤ **Early** detection: Surgical closure and drainage .

➤ **Late** detection : External drainage and parenteral nutrition .

5- Thoracic perforation :

➤ **Early** detection: Surgical closure and chest drainage .

➤ **Late** detection : Chest drainage and feeding jejunostomy .Later oesophageal reconstruction .

6- **Abdominal perforation :** Usually detected **early** and treated by surgical repair .

* **Investigations for chest injuries:**

❖ **Since associated injuries are very common , therefore investigations and treatment for pneumothorax (or haemothorax) & its associated injuries are the following:**

1. Arterial **blood gases** , oxygen oximetry , Capnography (confirm respiratory insufficiency & need for mechanical ventilator).

oxygen oximetry



Capnography



2. HB %, haematocrit decreasing in **progressive hemorrhage**.
3. Urine & blood sugar and HBA1c for **D.M.**
4. Blood urea & creatinine for **renal functions** .
5. ECG and echocardiography .
- 6. Chest X-ray:** May show F.B., fracture rib, mediastinal shift, pneumothorax, haemothorax, haemopneumothorax, (see before) or air under the diaphragm due to perforated hollow abdominal viscera.
7. **EFAST** : Detect cardiac tamponade or associated abdominal injuries .
8. **C.T. scan & CT angiography** : (In stable patient only)
 - They can show occult hemothorax not seen in plain x-ray , vascular or visceral injuries and rib or vertebral fractures .
9. **Catheter angiography** is main investigation for **aortic** injury .
10. **Diagnostic needle aspiration** for suspected haemothorax or cardiac tamponade.
- 11. Recently Video-Assisted Thoracoscopy (VAST)** surgery can be used for the diagnosis and treatment of intra-thoracic injuries. VAST allows complete vision of entire pleural cavity , control of bleeding , removal of retained clots , persistent pneumothorax or hemothorax , chest wall bleeding, mediastinal or oesophageal injuries & pericardial window for cardiac tamponade .

❖ **N.B.:** *Investigations from 1-9 should be done in any head, chest or abdominal injury.*

* **Treatment of chest injuries:**

I) Primary survey and resuscitation :

- **(ABCDE)**(As before in multiple injuries).
- Urgent treatment of **5 threatening thoracic conditions :**
 - 1- Open pneumothorax :**
 - ♣ **Intial treatment** is occlusive dressing fixed at 3 sides only .

2-Tension pneumothorax:

- ♣ Immediate **decompression** by insert a needle in **2nd intercostal** space in the mid-clavicular line.

3-Haemothorax:

- ♣ A **chest tube** connected to under water seal(as before) .

4-Flail chest :

- ♣ Immediate stabilization of flail segment by cotton gauze and adhesive bandage.

5- Cardiac tamponade :

- ♣ **Urgent** decompression by needle **pericardiocentesis** .

II) After 1ry. survey and stabilization of patient condition , proceed to **secondary survey** and meticulous **chest exam.** including the followings :

- 1- Inspection :** Wound and chest expansion .
- 2- Palpation :** for tenderness , surgical emphysema & tracheal position .

3- Percussion :

- ♣ Resonance :Pneumothorax .
- ♣ Hyper-resonance : Tension pneumothorax .
- ♣ Impaired note : lung collapse .
- ♣ Dull : Hemothorax .

4- Auscultation : for air entry & cardiac sound .

III) Definitive treatment:

A) Conservative:

- **Indications:** Minor closed or uncomplicated open injury.
- **Methods:**
 1. **Any wound** is excised and closed.
 2. **Endotracheat tube** with positive pressure ventilation for respiratory insufficiency or flail chest but if mechanical ventilation is required for **more than 10 days, tracheostomy** will be needed to avoid the risk of laryngeal stenosis .
 3. **Pneumothorax:** A chest tube connected to under water seal is inserted in the 5th space , just anterior to the midaxillary line & directed superiorly towards the apex of thorax.
 4. **Haemothorax:** Should be evacuated completely (as before).
 5. **Wet lung:** Encourage **cough** (analgesics and expectorants) and bronchoscopic **aspiration** or bronchial aspiration through a tracheostomy and the patient is put on a **mechanical ventilator**.
 6. **Antibiotics & tetanus prophylaxis.**
 7. Observation: (as any shock) + amount of intercostals drain .

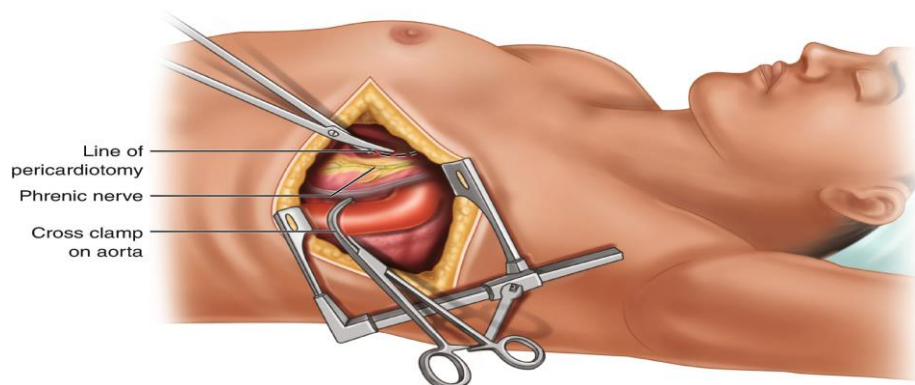
B) Recently Video-Assisted Thoracoscopy (VAST) surgery can be used (as before in investigations) .

C) Open Surgery : (Thoracotomy)

- **Indications:** Severe or complicated injuries as the followings:
 - Severe chest wound with exposed viscera .
 - Chest x-ray show complete opacity of the hemithorax .
 - Haemothorax more than 200 ml/hour for more than 3 successive hours
 - Drainage of more than 1500 ml. in 24 hours after insertion of the tube
 - Clotted hemothorax or Presence of foreign bodies.
 - Associated injury requiring surgery (e.g. cardiac tamponade or injury of trachea-bronchial tree or esophagus) .

• **Methods:**

- ✦ Accident **wound** is excised and used for thoracotomy if at a suitable site.
- ✦ **Antero-lateral thoracotomy** incision is made in the 5th or 6th intercostal space with the patient in the supine position .

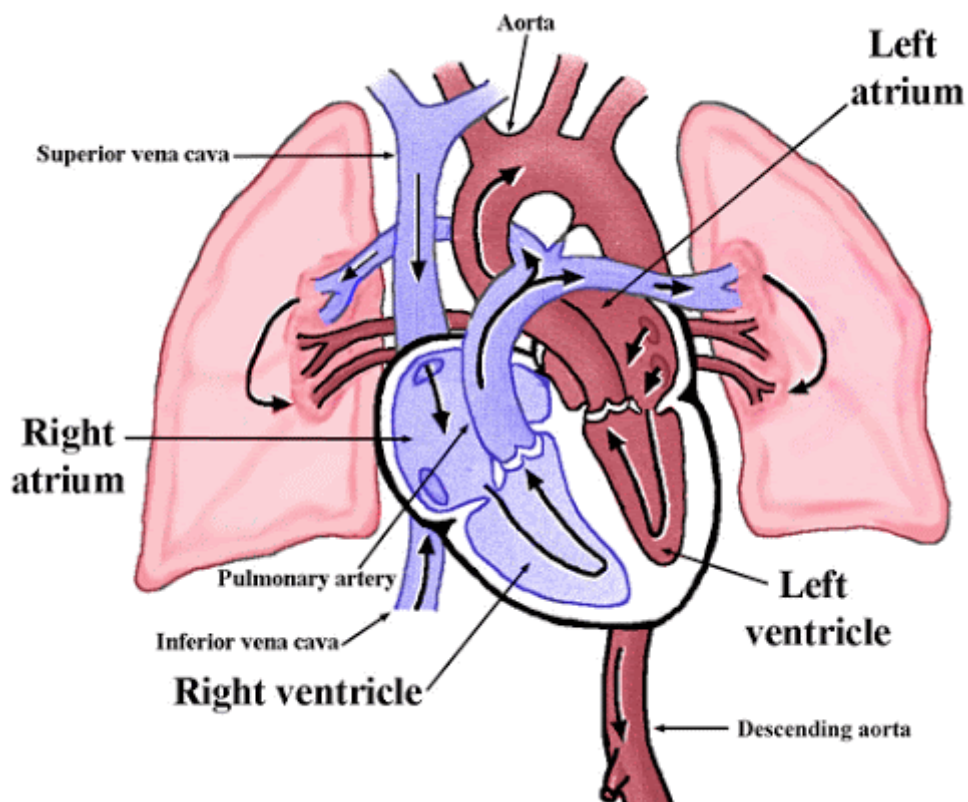


- ✦ **Bleeding** intercostal or internal thoracic vessels are ligated.
- ✦ **Small lung tear** is repaired.
- ✦ **Severe lung damage:** Segmentectomy, lobectomy or pneumonectomy according to extent of injury .
- ✦ **Tracheo-bronchial** tear is repaired .

- ♣ **Haemo-pericardium:** Pericardotomy , heart is explored and any cardiac or vessel tear is repaired.
- ♣ Any **foreign body** is removed.
- ♣ If **diaphragm** is injured, thoracotomy incision is usually extended medially across the costal margin to become thoraco-abdominal and the diaphragm is opened to explore the abdomen and to deal with any abdominal injury.
- ♣ Finally **diaphragm** is repaired.
- ♣ **Absolute hemostasis** .
- ♣ Close **thoracotomy wound** with an **intercostals tube** drainage through a separate stab in the **5th space** in the mid-axillary line.

Cardiac Arrest

- * **Definition:** Sudden failure of the heart to maintain adequate circulation.



* **Aetiology : (3A - 4D - 5T- 7H)**

- 2 main factors predispose to cardiac arrest:

A) Myocardial depression : This may be due to:

1. Myocardial **h**ypoxia due to respiratory obstruction , asphyxia , shock , **t**hrombo-embolic (coronary & pulmonary) , myocardial infarction or massive lung collapse.
2. Respiratory **a**rrest by respiratory obstruction , CNS depression (by deep anesthesia, head injury or **t**oxicity by sedatives or narcotic).
3. **A**cidosis: Due to CO₂ retention.
4. **H**yper or **h**ypokalaemia , **h**yper or **h**ypocalcaemia,
5. **H**ypothermia.
6. Vagal stimulation.
7. Irritating **d**rug e.g. chloroform, cyclopropane , adrenaline.... etc.
8. Myocardial **d**iseases which lowers the vitality or conductivity of myocardium.
9. **T**rauma e.g. chest injuries or coarse manipulation of heart during operation.
10. Electric shock

B) Severe reduction of venous return or cardiac output: due to

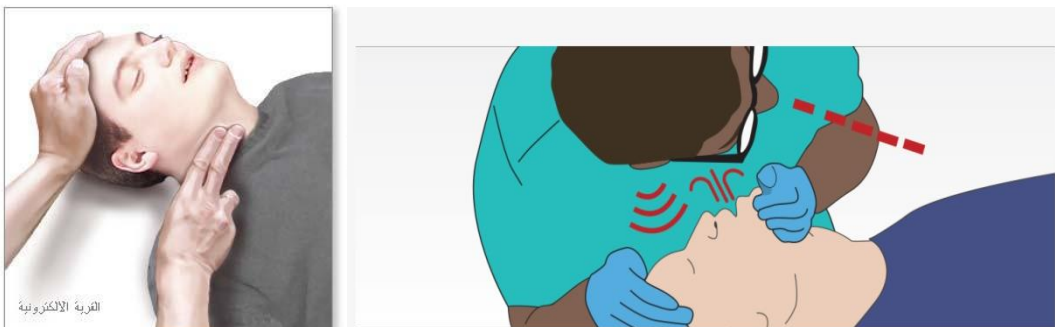
1. **H**ypovolaemia (**A**cute hemorrhage).
2. Failure of cardiac filling : Massive pulmonary embolism , cardiac **t**amponade , **t**ension pneumothorax .
3. Severe peripheral vasodilatation : e.g. after spinal anesthesia .

- * **Pathogenesis:** Nowadays cardiac arrest is classified according to the need for defibrillation and ECG into:

1. **Shockable rhythm:**(The commonest) Ventricular tachycardia & ventricular fibrillation.(shockable rhythm in equal or more than 180 beat/ min) .
2. **Non-shockable rhythm** : Cardiac asystole & pulseless electric activity (ECG show electric activity but the pulse is absent and not felt).
 - **These types are differentiated by: E.C.G. or Exposure of the heart.**

* **Diagnosis:**

1. Sudden loss of **consciousness**.
- 2- Absence of **carotid** pulse
- 3- Assess for **grasping noisy or absent respiration** :
 - **Look** for normal chest movements , **listen** for normal breathing sounds & **feel** breath against your face .
 - Perform this for no more than **10 seconds** , if no normal breathing we should start CPR .



- 4- Bilateral dilated **pupils**.
5. **Pallor** passing to cyanosis.
6. In the **operating theater:** ECG monitor show arrest with sudden arrest of bleeding in the surgical field.

❖ **N.B: Stethoscope has no rule in diagnosis of cardiac arrest . Once carotid pulse is not felt , CPR should be started immediately .**

* **Management:**

- **The** brain can only tolerate 3-10 minutes of complete circulatory arrest therefore the circulation should be restored within this period to avoid any neurological damage if the patient survive .

- **Remember DR'S ABCD**

- 1) **Danger** : First look around carefully to be sure that area is safe for yourself and for the others .
- 2) **Response** : shake the patient gently by his shoulder and ask him lightly are you alright .

- 3) If no response **shout or send** for help as any assistant will be helpful. Call the emergency center for medical help and be sure that the ambulance in its way.

D **DANGER**
Check for danger - ensure scene is safe

R **RESPONSE**
Check for response - ask name, squeeze shoulders

S **SEND**
Send for help - call Triple Zero (000) for an ambulance, or ask a bystander to make the call

A **AIRWAY**
Open mouth - look for foreign material and maintain the airway

B **BREATHING**
Check for breathing - look, listen, feel

C **CPR**
Start CPR - 30 compressions : 2 breaths
If unwilling or unable to perform breaths, perform chest compressions only (100/min)

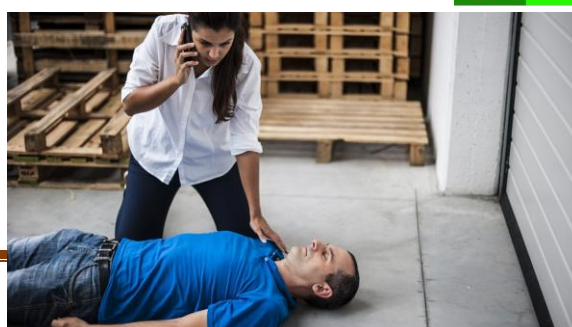
D **DEFIBRILLATION**
Apply Defibrillator (AED) as soon as available
Follow the voice prompts



CHECK RESPONSE

- Approach safely
- Check response**
- Shout for help
- Open airway
- Check breathing
- 30 chest compressions
- 2 rescue breaths

Deepa Arora, Kurudose



4) Pre-hospital management :

- **Cardio-pulmonary resuscitation :(CPR)**

- This should be started at once **aiming** to provide **artificial respiration and circulation** to keep the patient alive until ambulance arrive .

- **Method :**

- Put the patient on a **hard flat surface** with **raising his lower limbs**
- Clear the patient's **airway** by pulling his tongue and extending his neck by one hand and close the nostrils by the other hand.

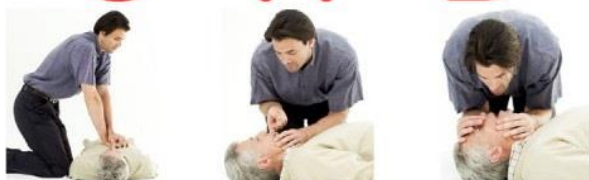


© MASHI EDUCATION FOR MEDICAL EDUCATION AND RESEARCH, ALL RIGHTS RESERVED

- By assistant mouth to mouth **breathing** at a rate of **15** times/minute alternatively with chest compression .The use of special bag is preferable to avoid cross infection .

CPR is as easy as

C - A - B



- **External (close) cardiac massage:** Interlock the fingers of the 2 hand & compressing the heart between the lower 1/2 of sternum and spines at a rate of 100-120 times / minute with the palms of both hands .The elbow should be straight and chest wall is compressed for 4-5 cm . (C)



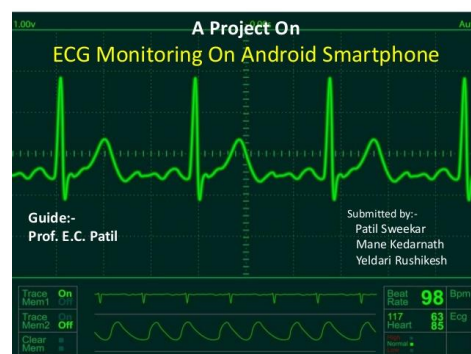
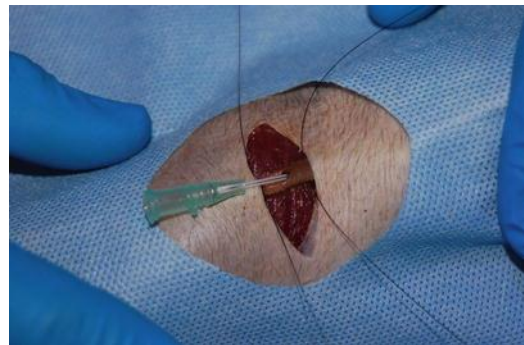
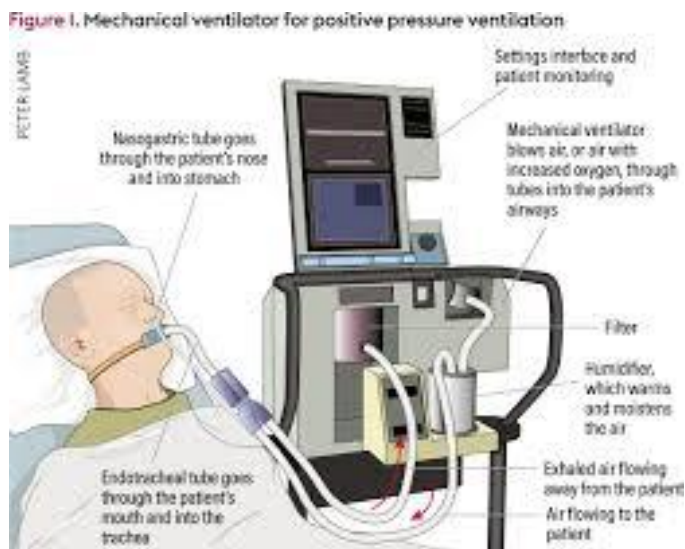
- The **efficiency** of external cardiopulmonary resuscitation is evaluated by other assistant observing femoral pulse & chest expansion .
- Cardiopulmonary resuscitation are **continued until** vital signs spontaneously recur or until the patient is transferred immediately to the hospital.
- External **defibrillation** should be applied once available .

❖ **If medical facilities are not available , CPR is performed for 20 minutes , if no response the victim is considered dead .**

B) Hospital management :

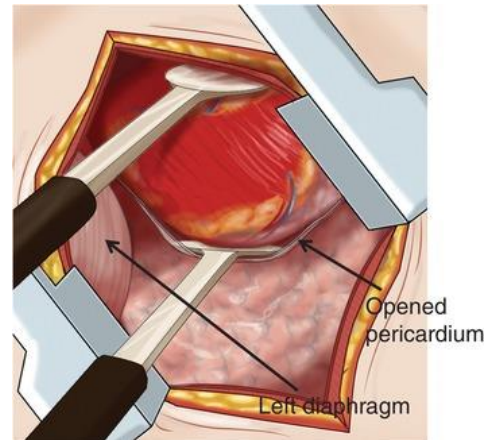
- **Aim :** restore normal cardiac rhythm .
- **Method :** Once the patient reaches the hospital, as an emergency the followings should be performed :

1. **Endotracheal tube** is passed and **mechanical ventilation** with pure O₂ is applied (AB).



2. **Venous cut down** and suitable infusion (C) .
3. **E.C.G.** monitoring to differentiate shockable from unshockable cardiac arrest . (C) and accordingly restore normal cardiac rhythm by the followings :
 - **Unshockable cardiac arrest** : Cardiac massage is continued , I.V or intra-cardiac injection of adrenaline and calcium chloride I.V. leading to one of the followings :
 - a) Restoration of **normal** cardiac rhythm or
 - b) Ventricular **fibrillation** occur .
 - **Shockable cardiac arrest** : Normal rhythm is restored by electric defibrillation which may be :
 - a) **External defibrillation**: Using the electrodes on the chest.

b) **Internal defibrillation:** Using electrodes on exposed heart.



External defibrillation

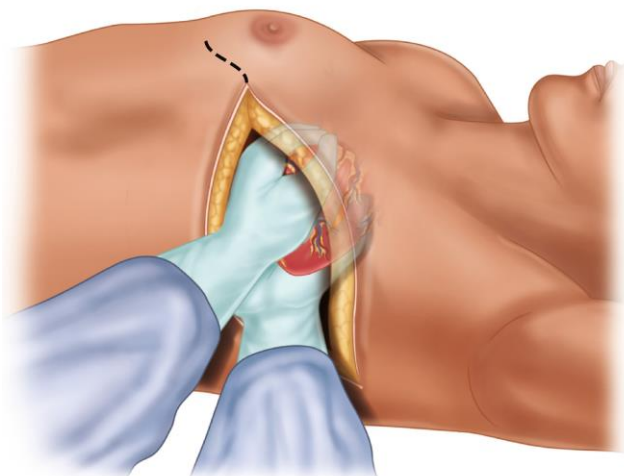
Internal defibrillation

4. Open cardiac massage:

- **Indication:** The chest is already opened during chest operation or failure of closed massage.
- **Method :** Through thoracotomy in the left 5th space, the pericardium is widely opened to permit bimanual massage with one hand above and the other below the ventricles at a rate of 60 - 80 / minute until the cardiac tone return to normal (the heart becomes smaller, firmer and pinker).

Bimanual cardiac massage
(without pressing fingertips)

Open cardiac massage



C) **Subsequent treatment;** (In ICU).

1. The **cause** of cardiac arrest should be investigated and managed.
2. **B.P.** is kept over 90 mmHg by vasopressors and transfusion.
3. **O₂** inhalation.
4. If the **chest is opened**, heart is watched for 1/2 an hour before closure.
5. **Cardiac stimulants** e.g. adrenaline, calcium chloride and digitalis needed.
6. Correct **metabolic acidosis** by sodium bicarbonate infusion .
7. Correct **hyperkalaemia** which is usually present by glucose insulin I.V. drip.
8. **Anuria** and renal damage are expected and managed.
9. Continuous **observation** for pulse, temp., B.P., respirationetc.