# Thoracic Wall
# Chest Trauma

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Based on S. Khalid MD lecture
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- https://www.google.cz/search?q=chest+trauma&rlz=1C1AFAB_enCZ493CZ493&oq=chest&aqs=chrome.2.69i57j0j69i59j0l3.4158j0j7&sourceid=chrome&ie=UTF-8
- Blunt Chest Trauma: Background, Anatomy, Pathophysiology
  emedicine.medscape.com/article/428723-overview
- Chest injury - Wikipedia
  https://en.wikipedia.org/wiki/Chest_injury
- Management of chest trauma - NCBI - NIH
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5392544/

- Chest Injuries Trauma: Get the Symptoms and Types - eMedicineHealth
  https://www.emedicinehealth.com/...chest_injuries/article_em.htm
  TRAUMA.ORG: Thoracic Trauma
  www.trauma.org/archive/thoracic/CHESTintro.html

- [PDF] Chest Trauma

  https://sfgh.surgery.ucsf.edu/.../lecture%205%20chest%20trauma....
- Chest Trauma | CDEM Curriculum

  https://cdemcurriculum.com/chest-trauma/
- Chest trauma - SlideShare
  - https://www.slideshare.net/sadiaburkii/chest-trauma-38243444
- Thoracic Trauma - Life in the Fast Lane
  - https://lifeinthefastlane.com › Critical Care Compendium

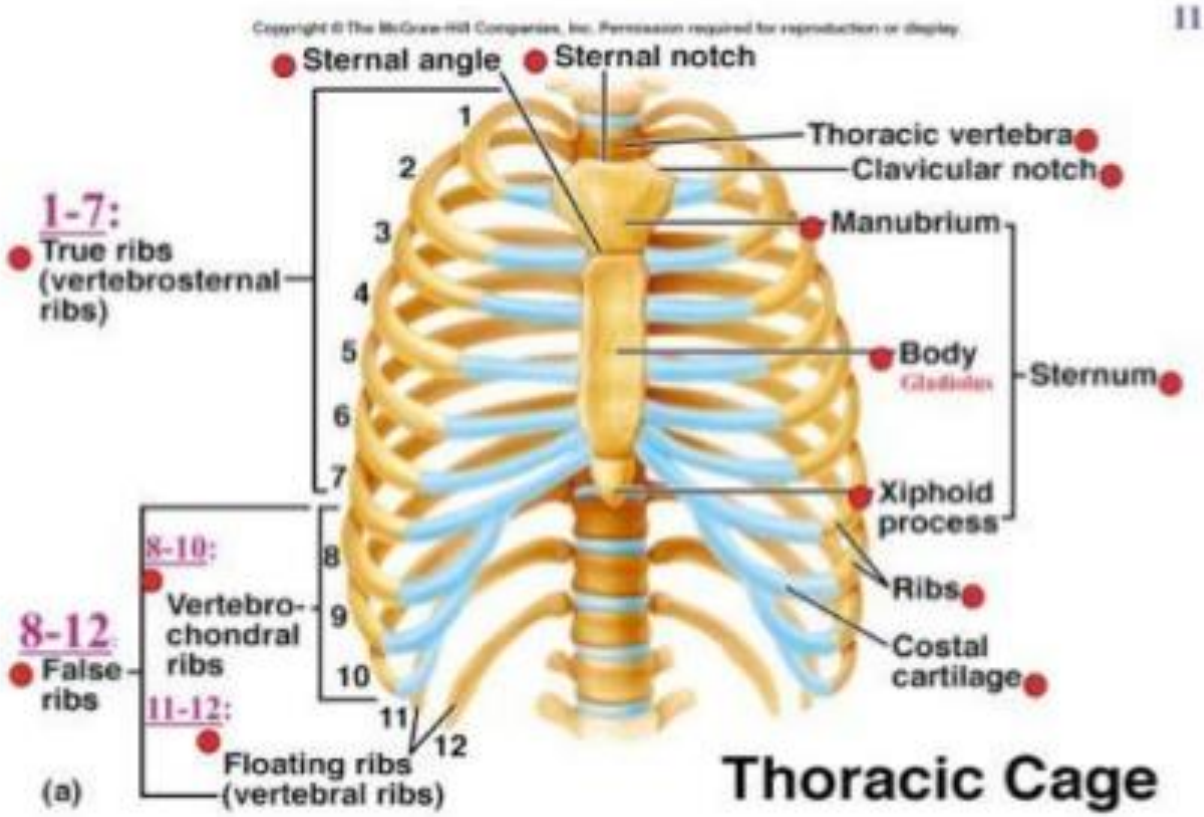
# Objectives

- Anatomy of Thorax
- Main Causes of Chest Injuries
- Different Types of Chest Injuries
- Treatments of Chest Injuries

# Anatomy of the chest

- **Thoracic Inlet..**

  Connects thoracic cavity to the root of the Neck.



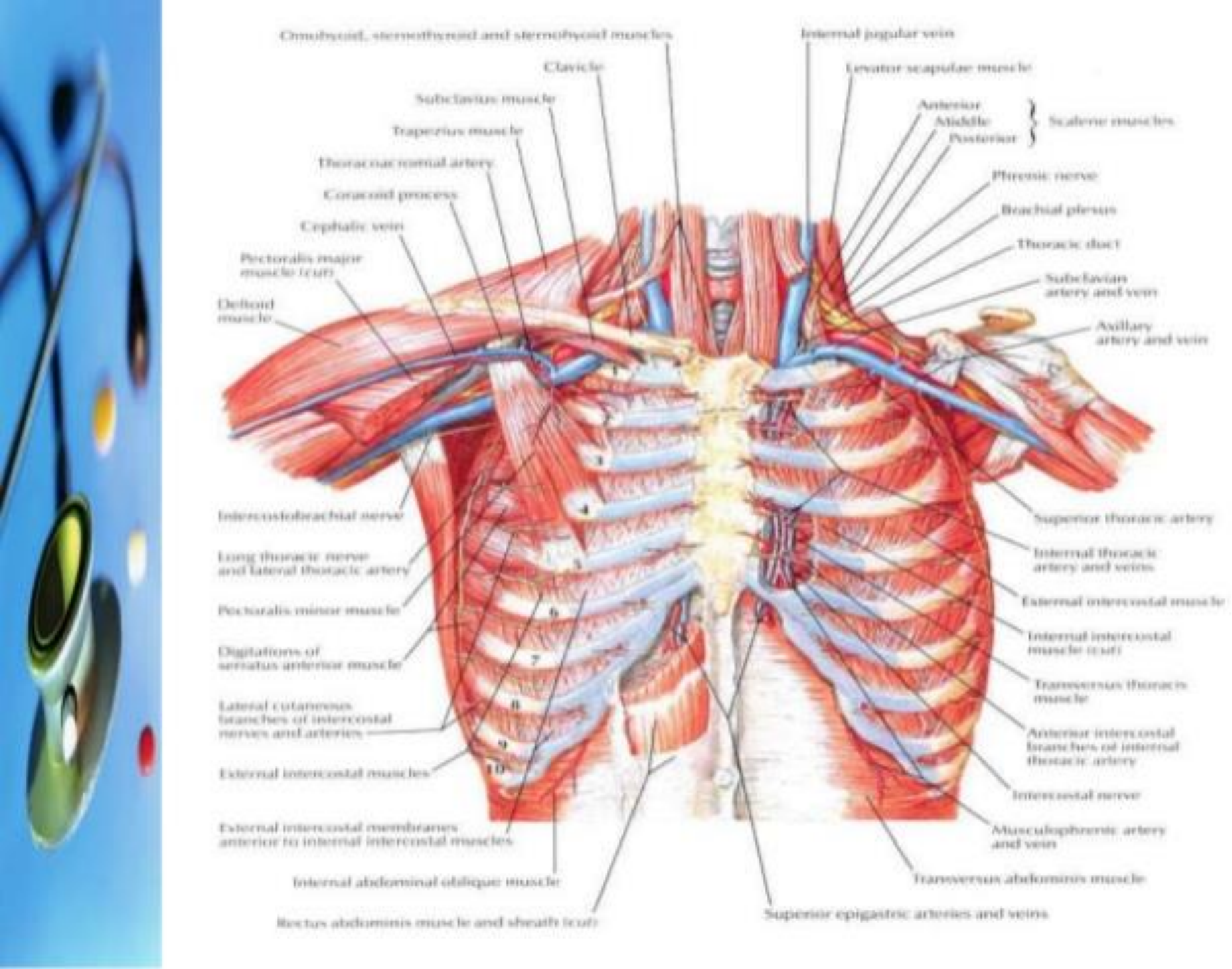
- **Thoracic Outlet…**

  Connects thoracic cavity with the Abdomen.

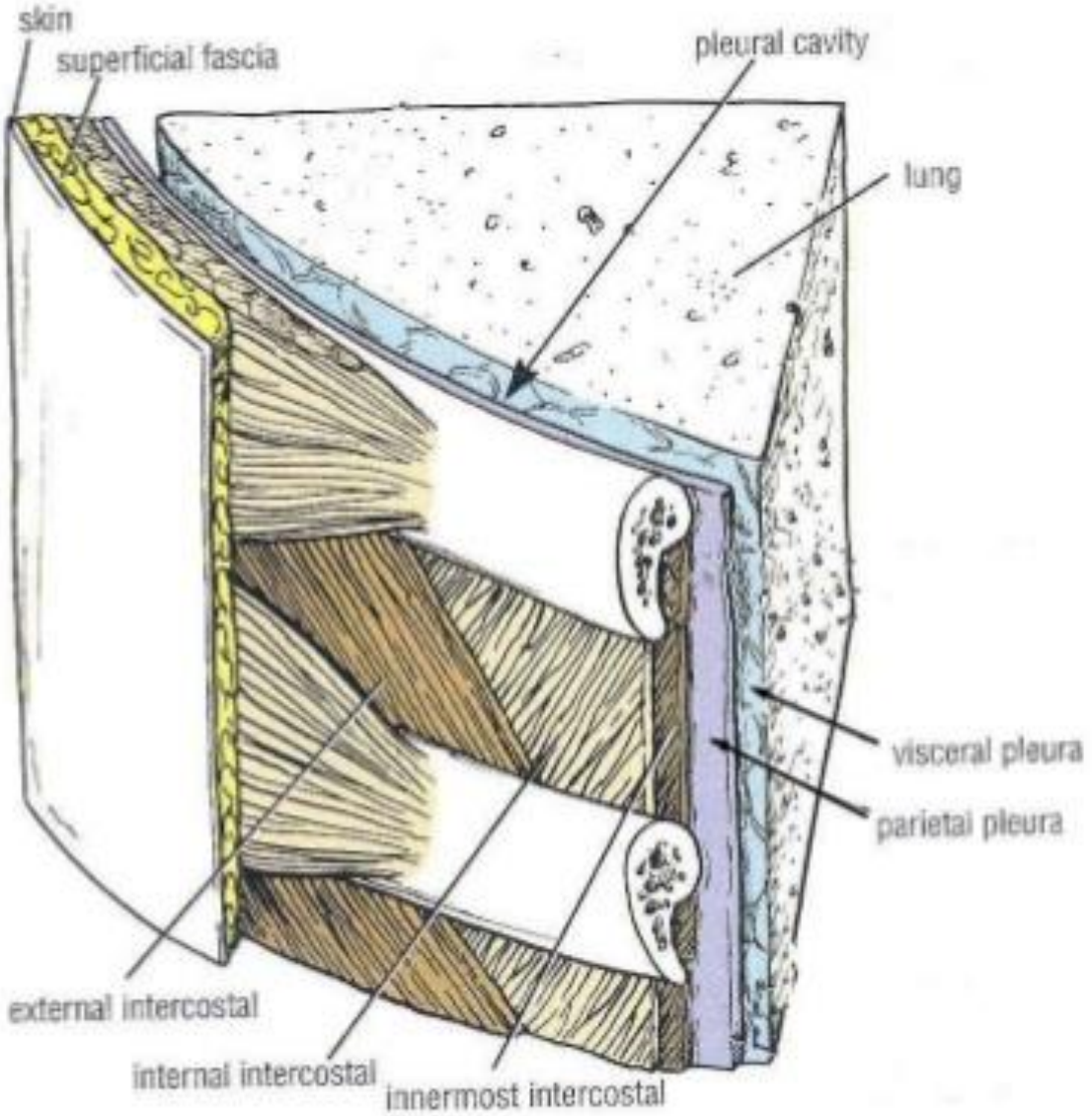
  Closed by Diaphragm.

# Thoracic Wall

- **Posteriorly…** Thoracic vertebrae 12.
- **Anteriorly…** Sternum and Costal Cartilages.
- **Laterally…** Ribs and Intercostal spaces.

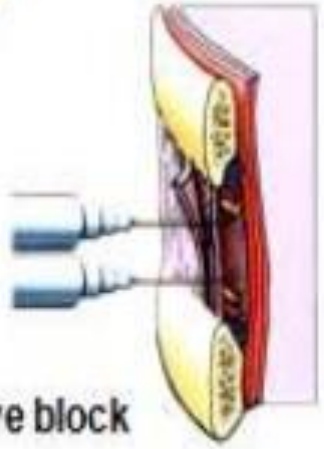

Omohyoid, sternothyroid and sternohyoid muscles
Clavicle
Subclavius muscle
Trapezius muscle
Thoracoacromial artery
Coracoid process
Cephalic vein
Pectoralis major muscle (cut)
Deltoid muscle
Intercostobrachial nerve
Long thoracic nerve and lateral thoracic artery
Pectoralis minor muscle
Digitations of serratus anterior muscle
Lateral cutaneous branches of intercostal nerves and arteries
External intercostal muscles
External intercostal membranes anterior to internal intercostal muscles
Internal abdominal oblique muscle
Rectus abdominis muscle and sheath (cut)
Internal jugular vein
Levator scapulae muscle
Anterior
Middle
Posterior
Scalene muscles
Phrenic nerve
Brachial plexus
Thoracic duct
Subclavian artery and vein
Axillary artery and vein
Superior thoracic artery
Internal thoracic artery and veins
External intercostal muscle
Internal intercostal muscle (cut)
Transversus thoracis muscle
Anterior intercostal branches of internal thoracic artery
Intercostal nerve
Musculophrenic artery and vein
Transversus abdominis muscle
Superior epigastric arteries and veins

# Thoracic Wall



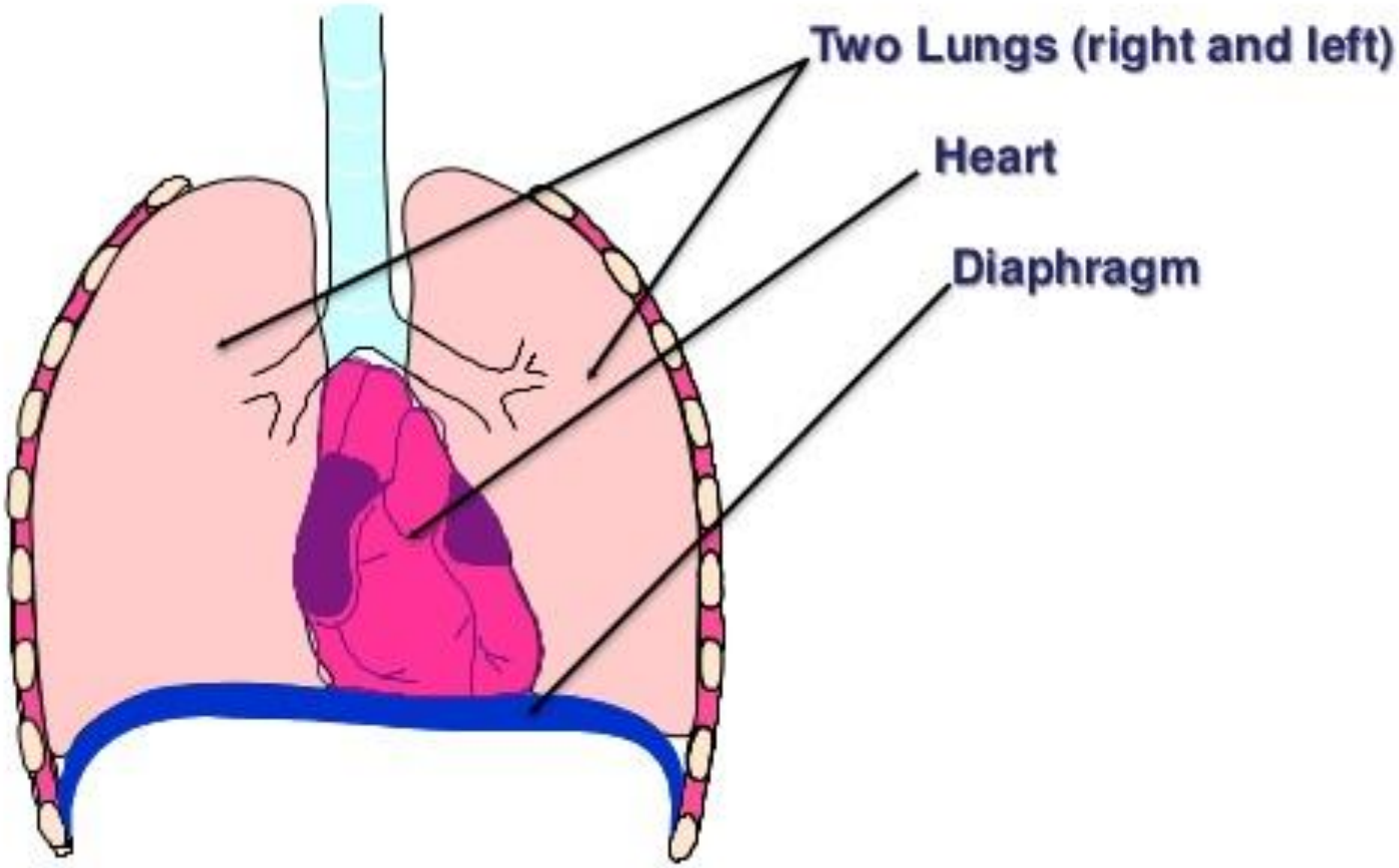
# Intercostal space


Technique for thoroacocentesis (in midaxillary line)



Intercostal nerve block

# Anatomy of the chest



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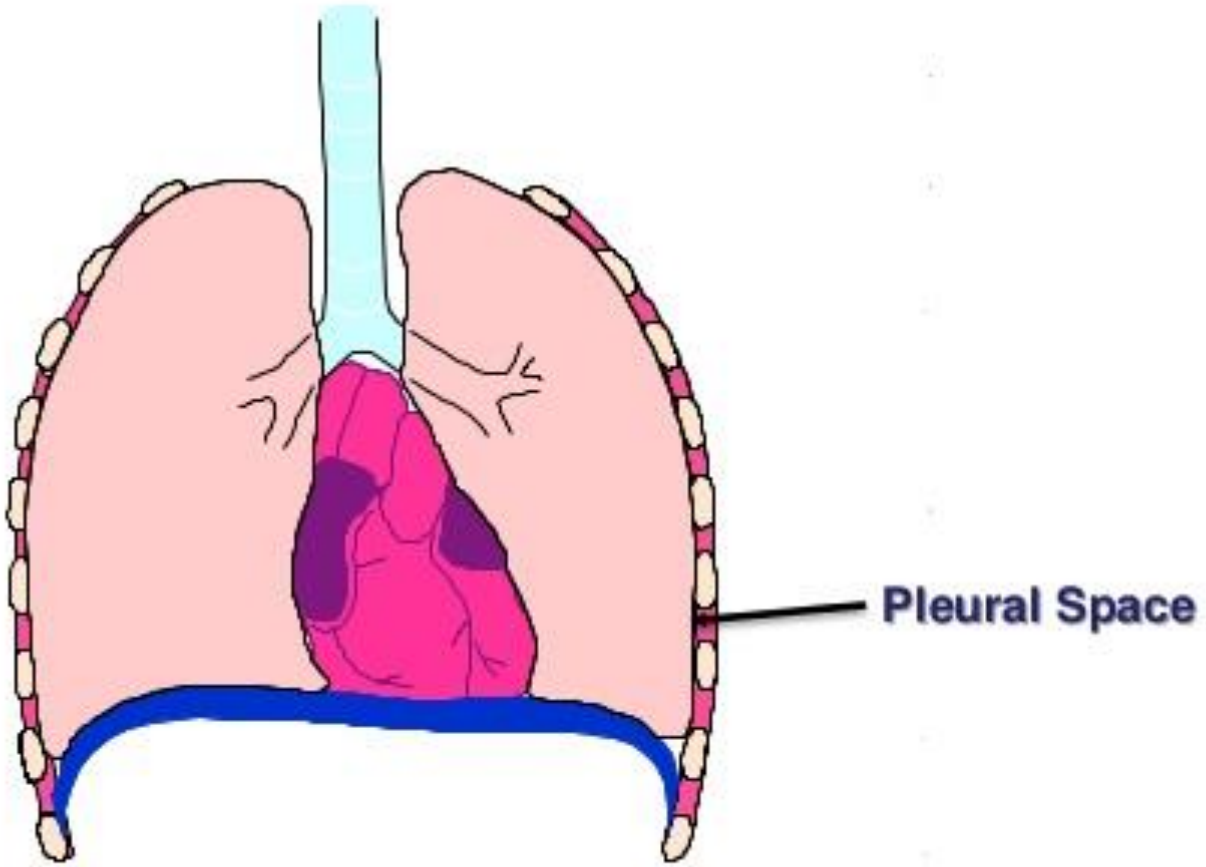

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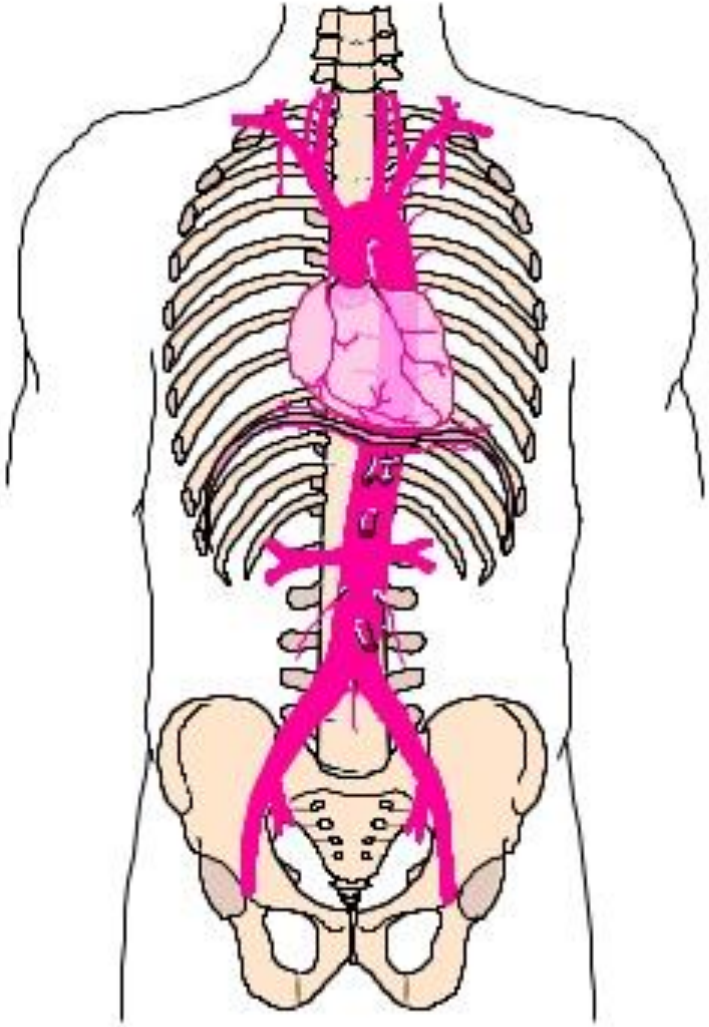


# ANATOMY OF THORAX

- Trachea
- Bronchi
- Lungs
- Heart
- Great Vessels.
- Oesophagus

# Chest Trauma

- Thoracic injury… 25% of all injuries.
- In another 25%, its contributor to other injuries.
- Major Cause of death…. Hemorrhage.

# Investigations

- CXR.... 1st choice.
- Ultrasound
- CT Scan..... Gold Standard.

  Rapid Diagnosis, 3- dimensional Images.

- Chest tube... may be theraputic and diagnostic.
- Angiography.

# General Management

**ATLS Principles of Resuscitation**

**Aim… To Restore Physiology, rather than anatomy**

**Early assessment and primary survey.**

**Simultaneous aggressive resuscitation.**

**Secondary survey with full examination.**

**Transfer to a definitive site of care.**

- **A. Airway**

  Assess for airway patency and air exchange - listen at nose & mouth

  Assess for intercostal and supraclavicular muscle retractions

  Assess oropharynx for foreign body obstruction

- **B. Breathing**

  Assess respiratory movements and quality of respirations - look, listen, feel.

  Shallow respirations are early indicator of distress - cyanosis is late.

- **C. Circulation**

Skin - look and feel for color, temperature, capillary refill- Look for cyanosis.

Assess pulses for quality, rate, regularity

Look at neck veins - flat vs. distended-fluid deficit or decreased supply to body from heart due to compression.

Assess the B.P.

- **D. Disability.**

  Immobilization of the spine.

**E. Exposure.**

# Main Causes of Chest Trauma

- ***Blunt Trauma***-

  Blunt force to chest.

- ***Penetrating Trauma***-

  Projectile that enters chest causing small or large hole.

- ***Compression Injury***-

  Chest is caught between two objects and chest is compressed.

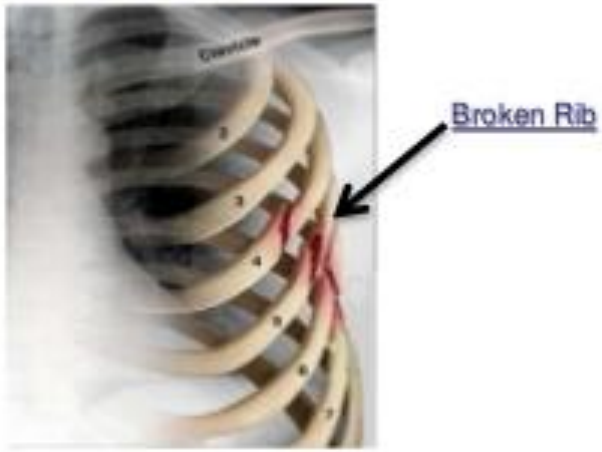
# Blunt Trauma to the Chest

# Chest wall injuries

- Buises
- Scratches
- Laceration
- Rib fractures
- Flail Chest
- Sternal fractures
- Thoracic spine injuries

# Rib Fracture

- Single or Multiple.
- Usually after blunt trauma.
- Fracture of First Rib is Associated with Injuries to great vessels, important nerves of the upper limb.
- If 8,10,11,12 Ribs involved, be suspicious for liver or spleen or kidney injuries.



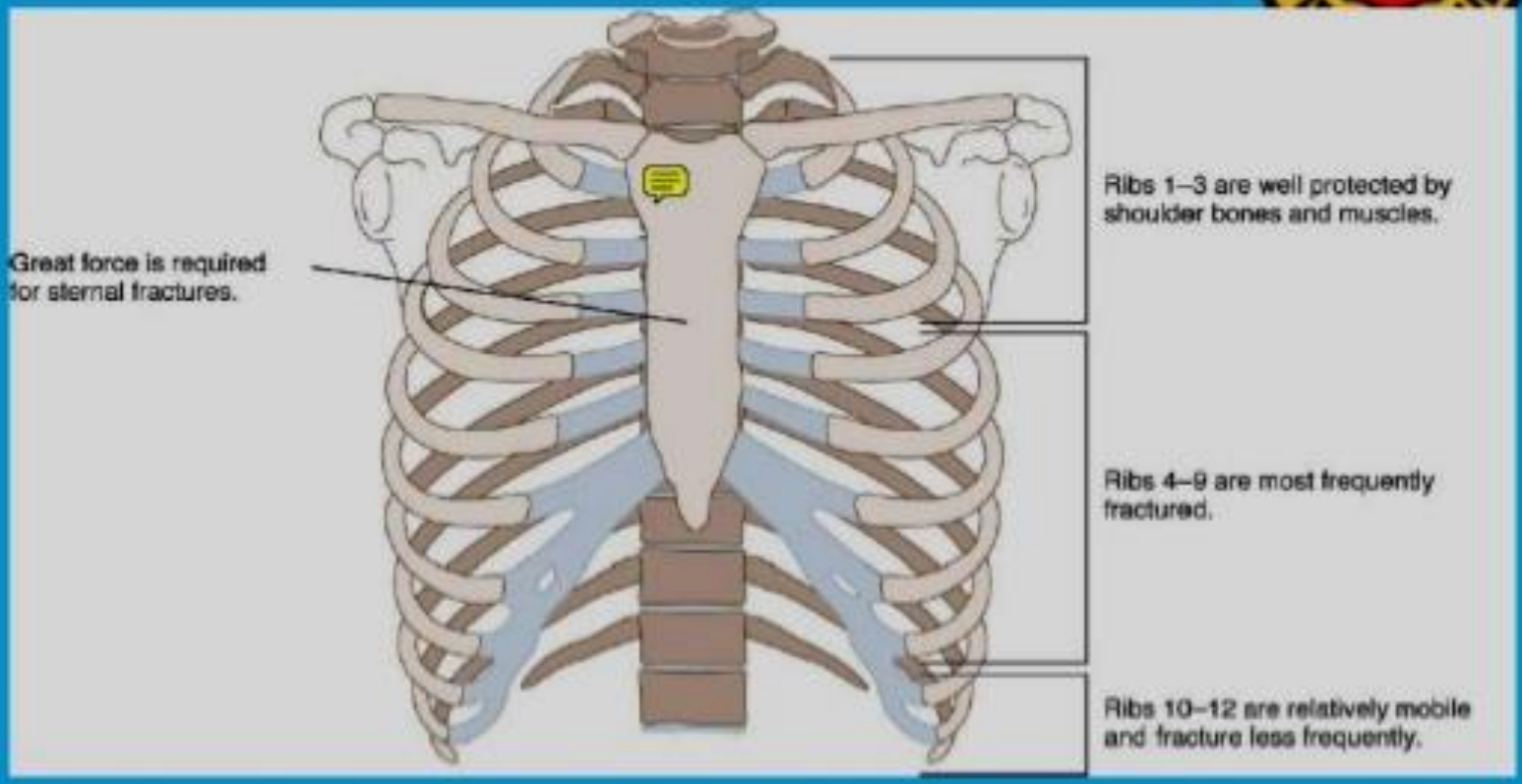

## Treatment:

- Strong analgesia
- Intercostal Nerve blocks With LA
- Pulmonary toilet -> Patient is asked to cough ,breathe deeply since the patient is usually unable to do so resulting in poor clearance of secretions. Reduces atelectasis and pneumonia.
- Severe injuries require Internal Fixation with plates and screws

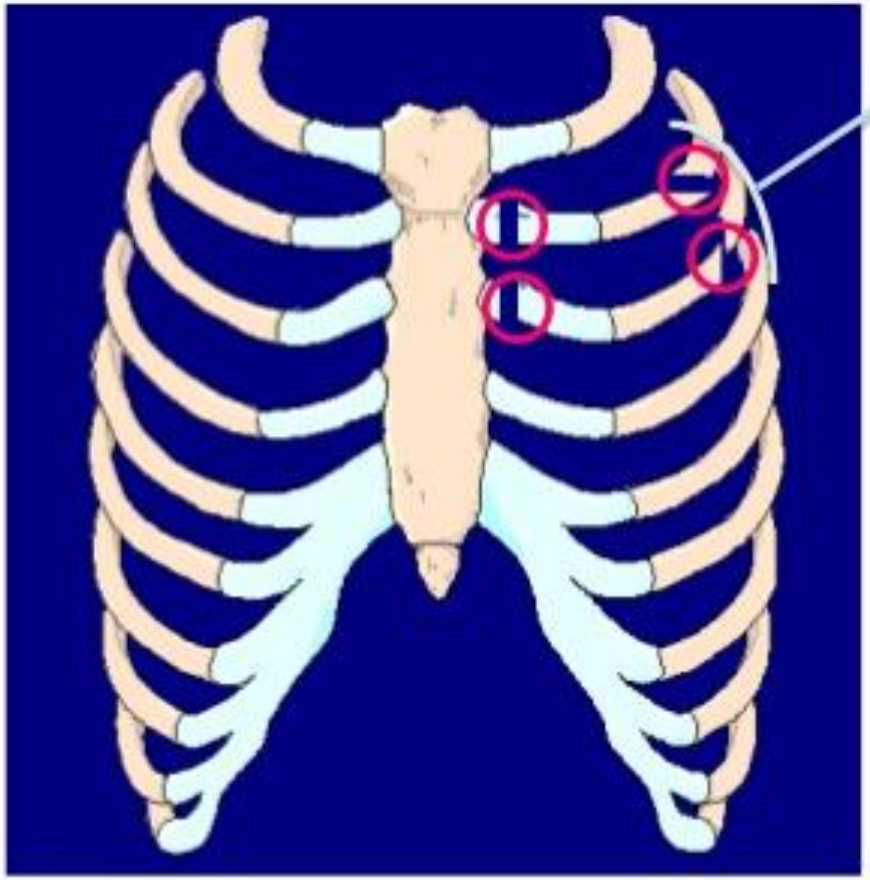
# S/S

- Pleuritic chest pain
- Rapid shallow breathing
- Splenting
- Atelectasis
- hypoxemia.

# Rib fractures

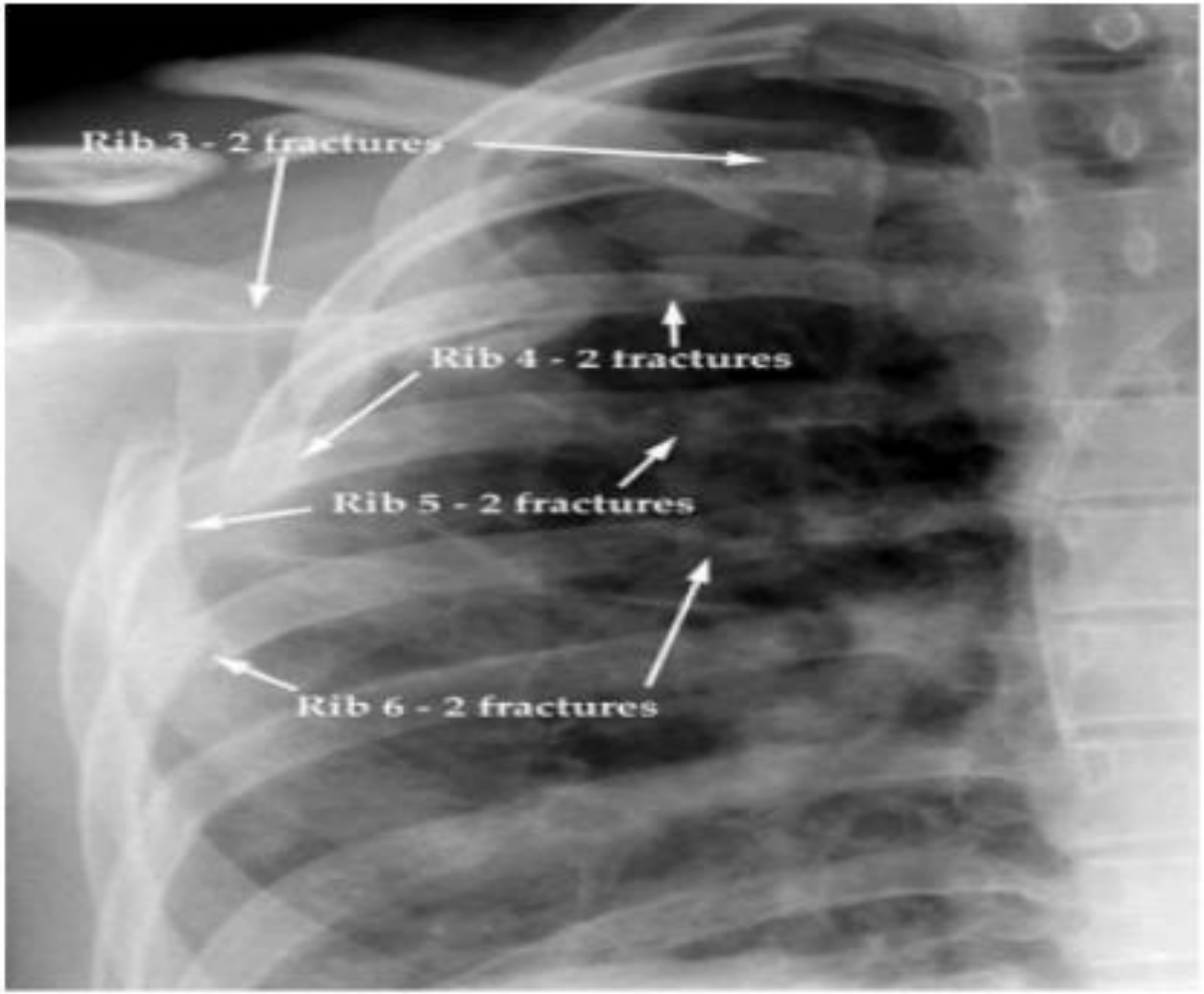


# Flail Chest

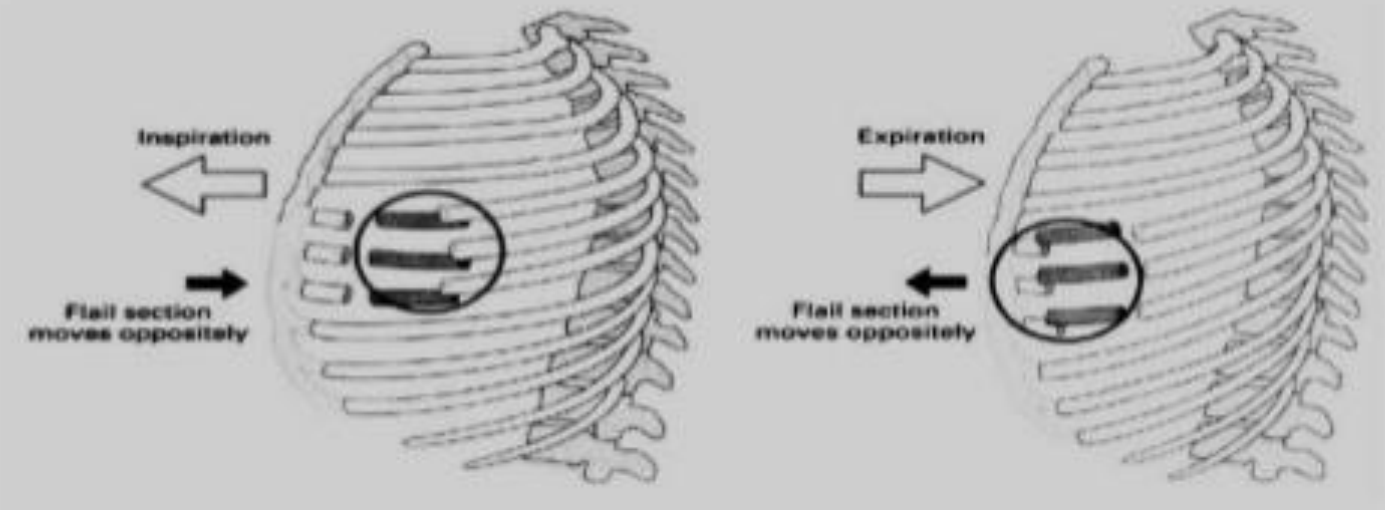


**The breaking of 2 or more ribs in 2 or more places**

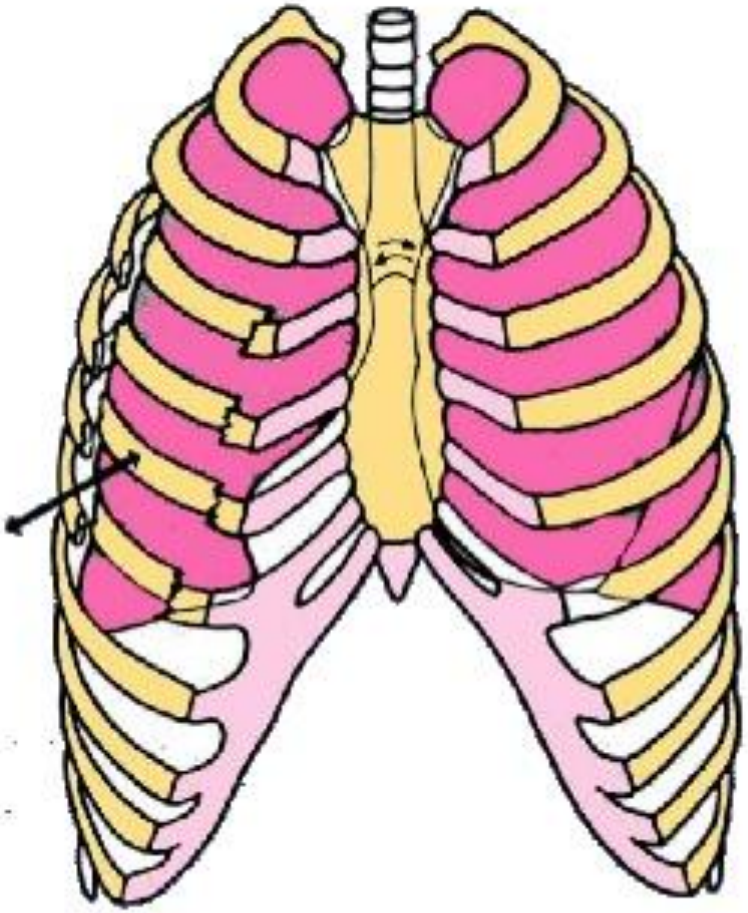
# Flail Chest

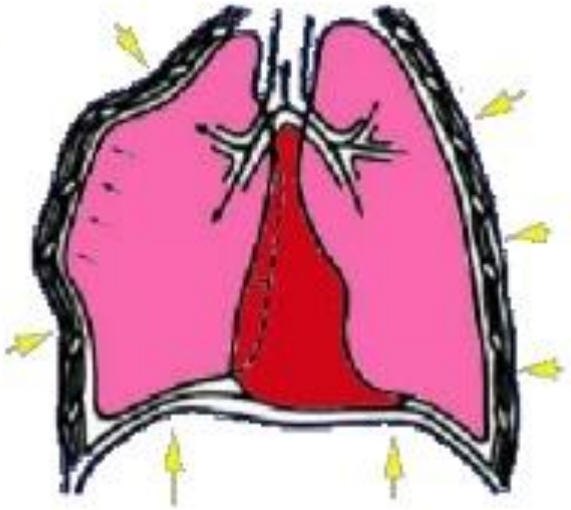

Rib 3 - 2 fractures
Rib 4 - 2 fractures
Rib 5 - 2 fractures
Rib 6 - 2 fractures

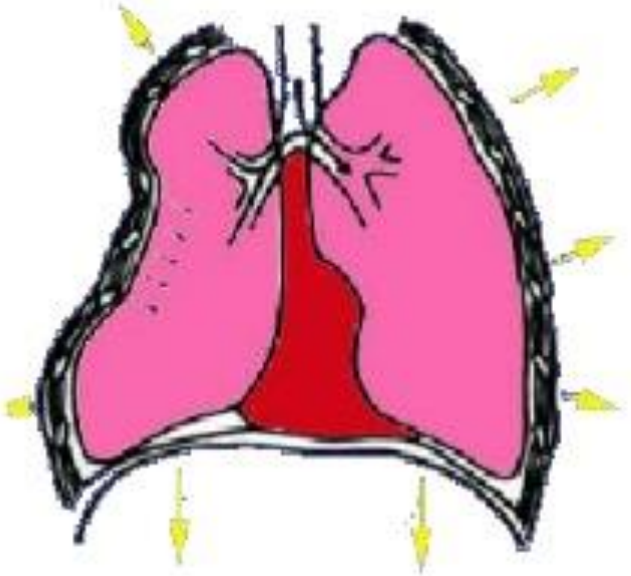
# Flail Chest


Inspiration
Flail section moves oppositely
Expiration
Flail section moves oppositely

# Flail Chest







# S/S of Flail Chest

- Painful Breathing.
- Paradoxical Chest Movements.
- Rapid, Shallow respiration, Dyspnea, Tachypnea, Tachycardia.
- Bruising/Swelling.
- Crepitus (Grinding of bone ends on palpation).
- Diagnosis is purely clinical.
- Chest X-Ray, ABG's can be done to confirm.

# Treatment of Flail Chest

- ABC's with c-spine control as indicated
- High Flow oxygen
- Adequate analgesia (Including opiates)
- Intra-plural local analgesia
- Observe the patient for development of Pneumothorax and even worse Tension Pneumothorax

If Tension Develops Needle Decompress affected side

- Surgery -> internal operative fixation.
- Rapid Transport! Remember a True Emergency

# Bulky Dressing for splint of Flail Chest

- Use Trauma bandage and Triangular Bandages to splint ribs.
- Can also place a bag of D5W on area and tape down. (The only good use of D5W I can find)

# Treatment for flail chest

# Deadly Dozen

**Immediately Life threatening**

- Airway obstruction
- Tension Pneumothorax
- Pericardial Temponade
- Open Pneumothorax
- Massive hemothorax
- Flail chest

**Potentially life Threatning**

- Aortic injuries
- Tracheobronchial injuries
- Myocardial contusion
- Rupture of diaphragm
- Esophageal injury
- Pulmonary conyusion

# PNEUMOTHORAX

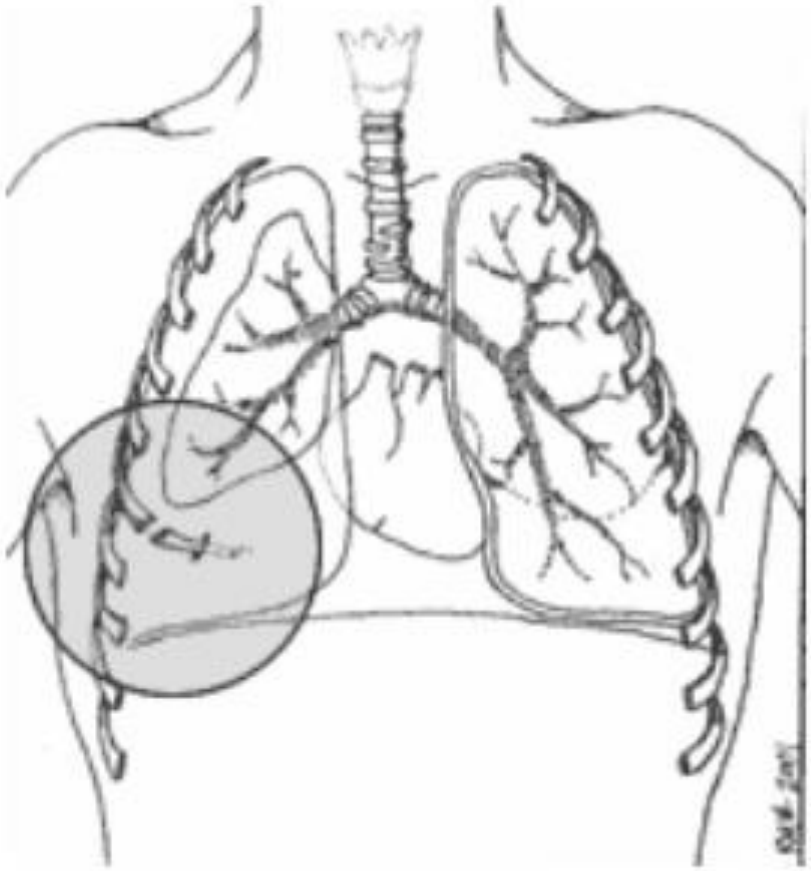
Pneumothorax is air in the pleural space resulting in partial or complete collapse of the lung space.

Types:

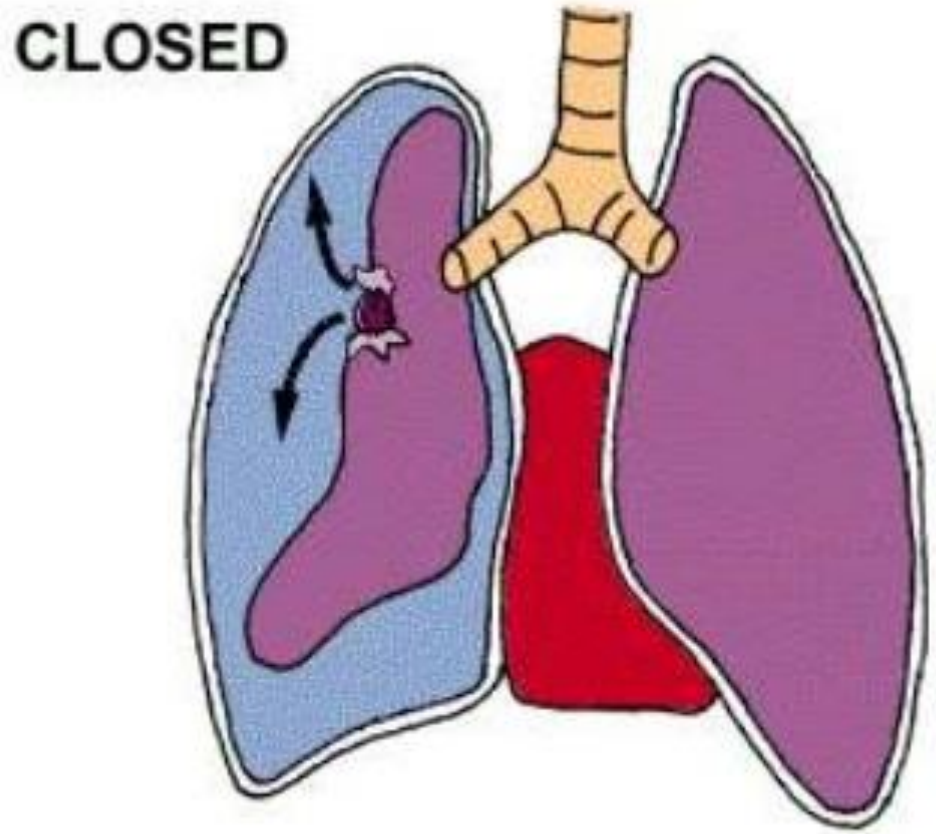
- Closed /Simple pneumothorax is one in which chest wall is intact and air enters the pleural space from lung surface
- Open pneumothorax is Sucking Chest Wound in which air enters the pleural space through opening in the chest wall.

# Simple/Closed Pneumothorax

- Opening in lung tissue that leaks air into chest cavity
- Blunt trauma is main cause
- Usually self correcting



# Closed Pneumothorax



# S/S of Simple/Closed Pneumothorax

- Chest Pain
- Dyspnea
- Tachypnea
- Decreased Breath Sounds on Affected Side

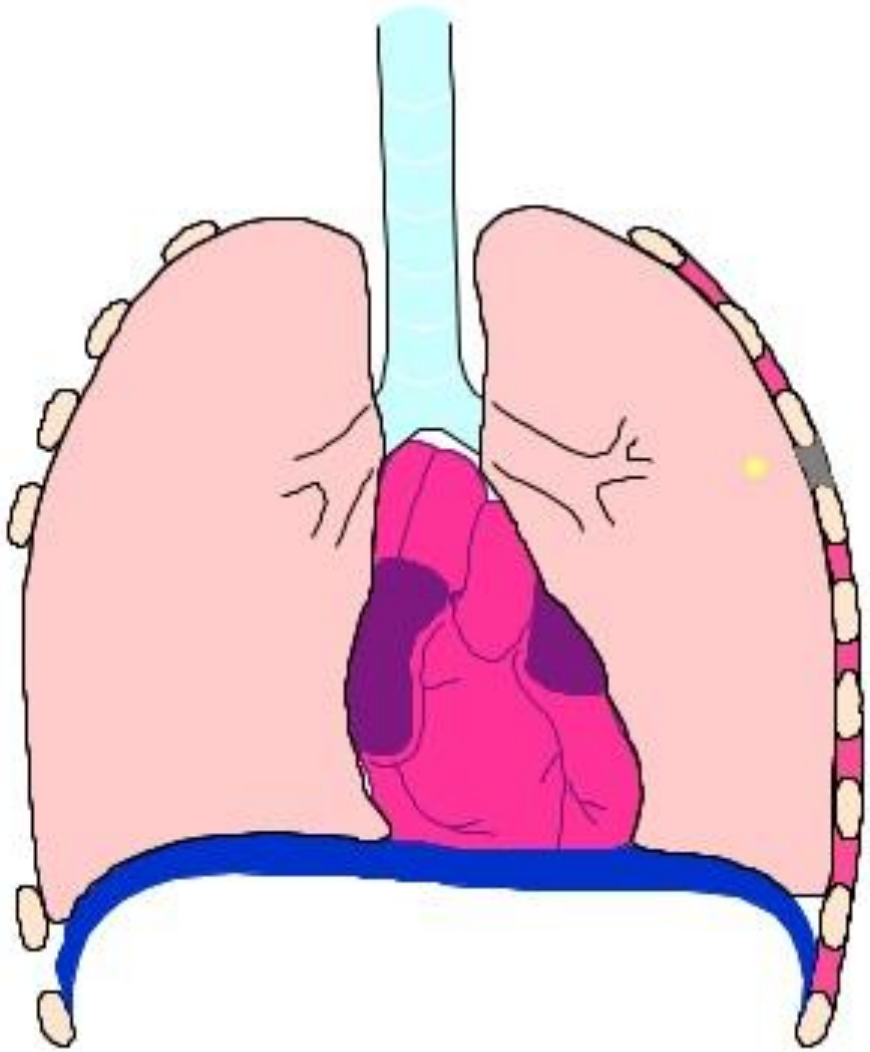
# Treatment for Simple/Closed Pneumothorax

- ABC's with C-spine control
- Airway Assistance as needed
- Provide supportive care
- Usually small and self limiting.
- Monitor for Development of Tension Pneumothorax

# Open Pneumothorax

- Opening in chest cavity that allows air to enter pleural cavity
- Causes the lung to collapse due to increased pressure in pleural cavity
- Can be life threatening and can deteriorate rapidly.

# Open Pneumothorax



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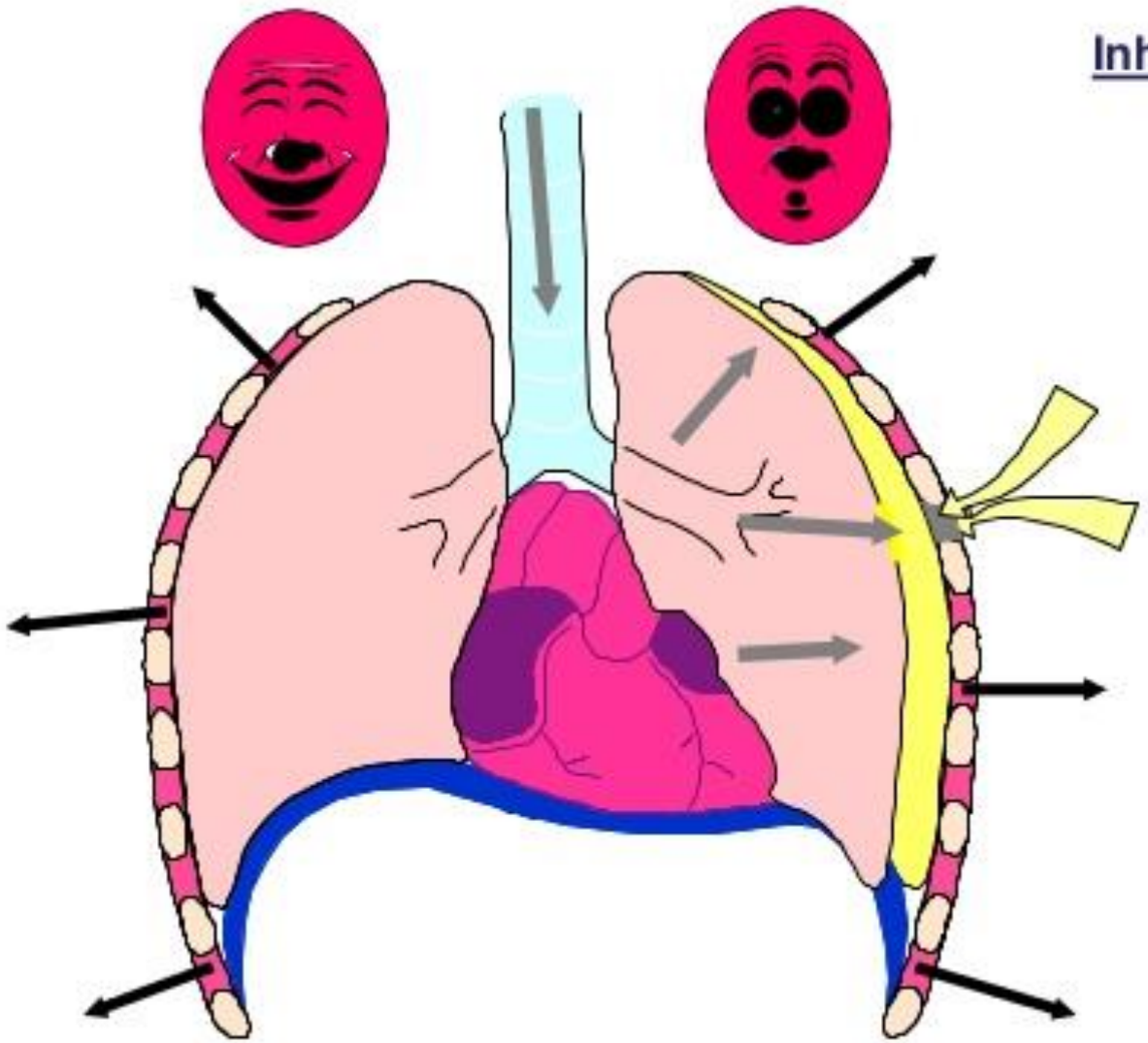

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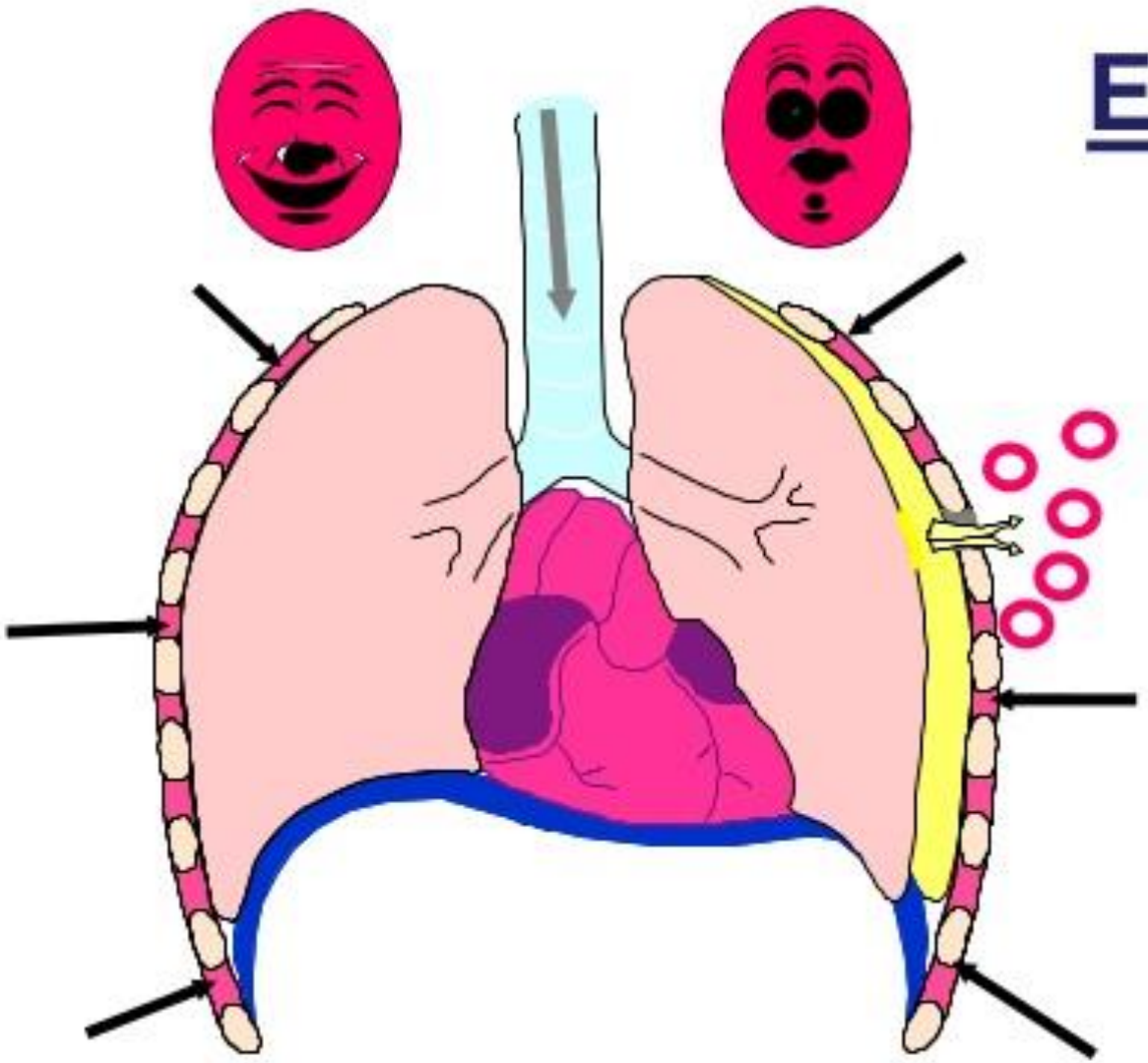
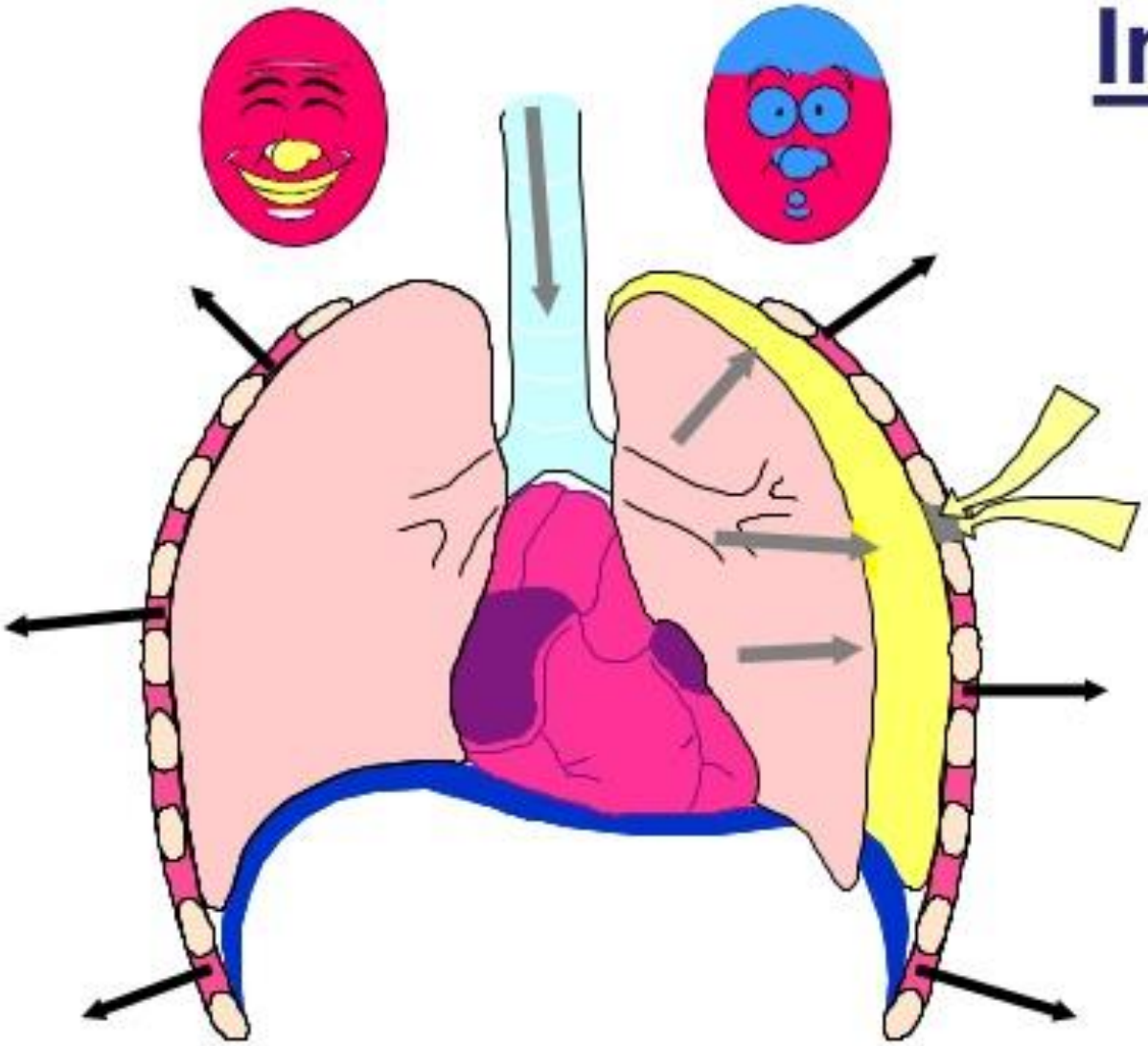


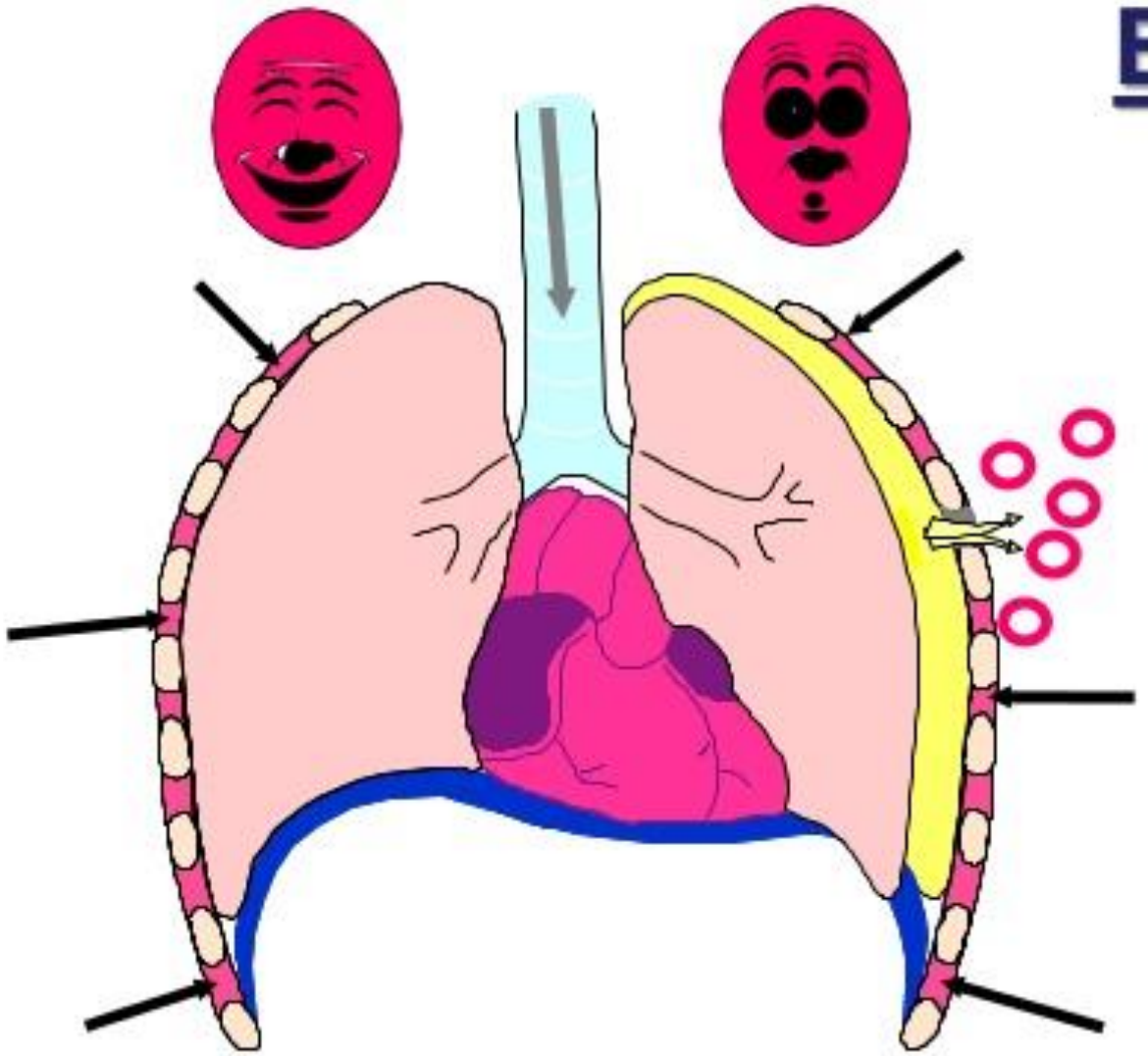
**Exhale**

# Open Pneumothorax



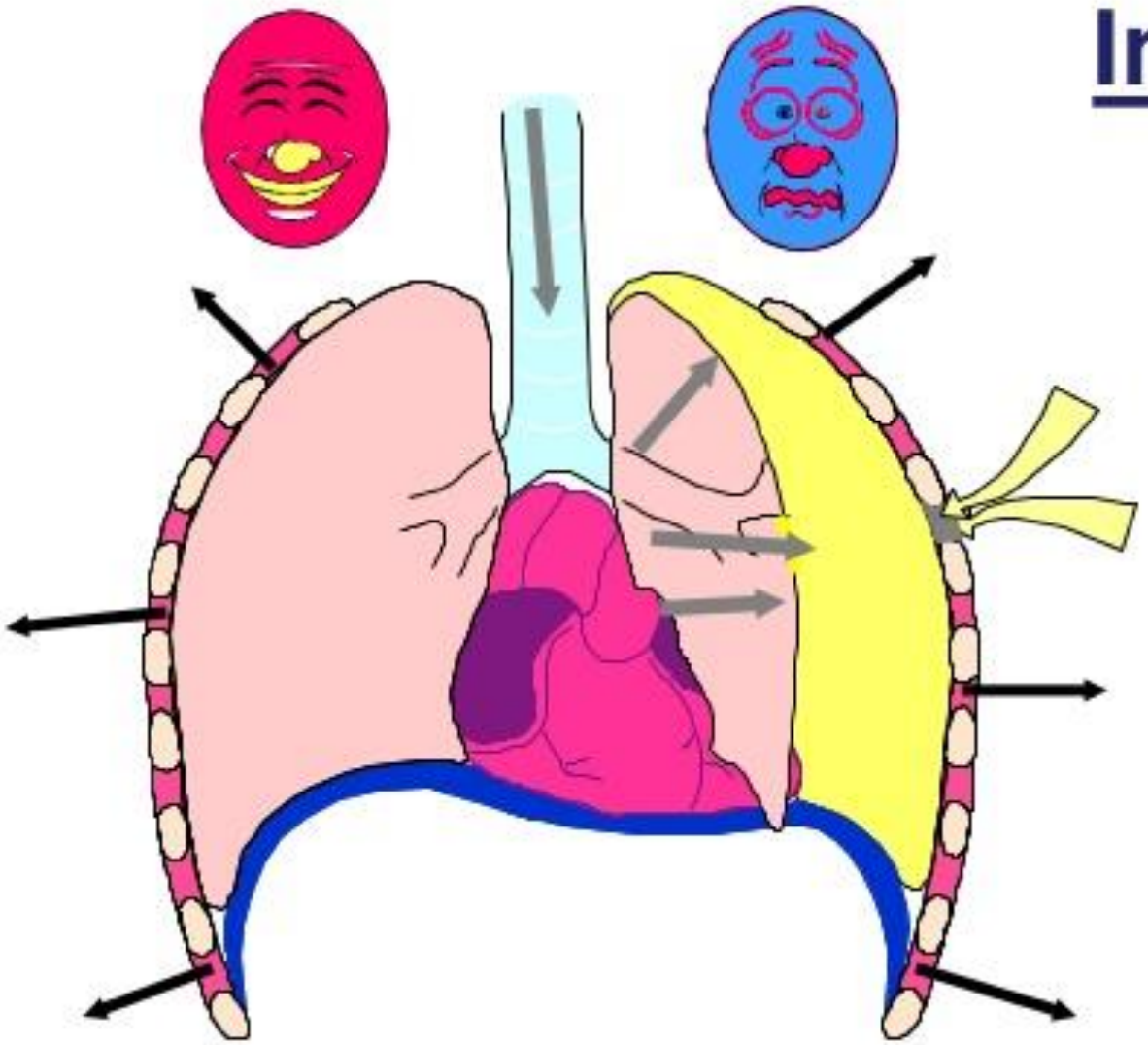
# Open Pneumothorax

**Exhale**

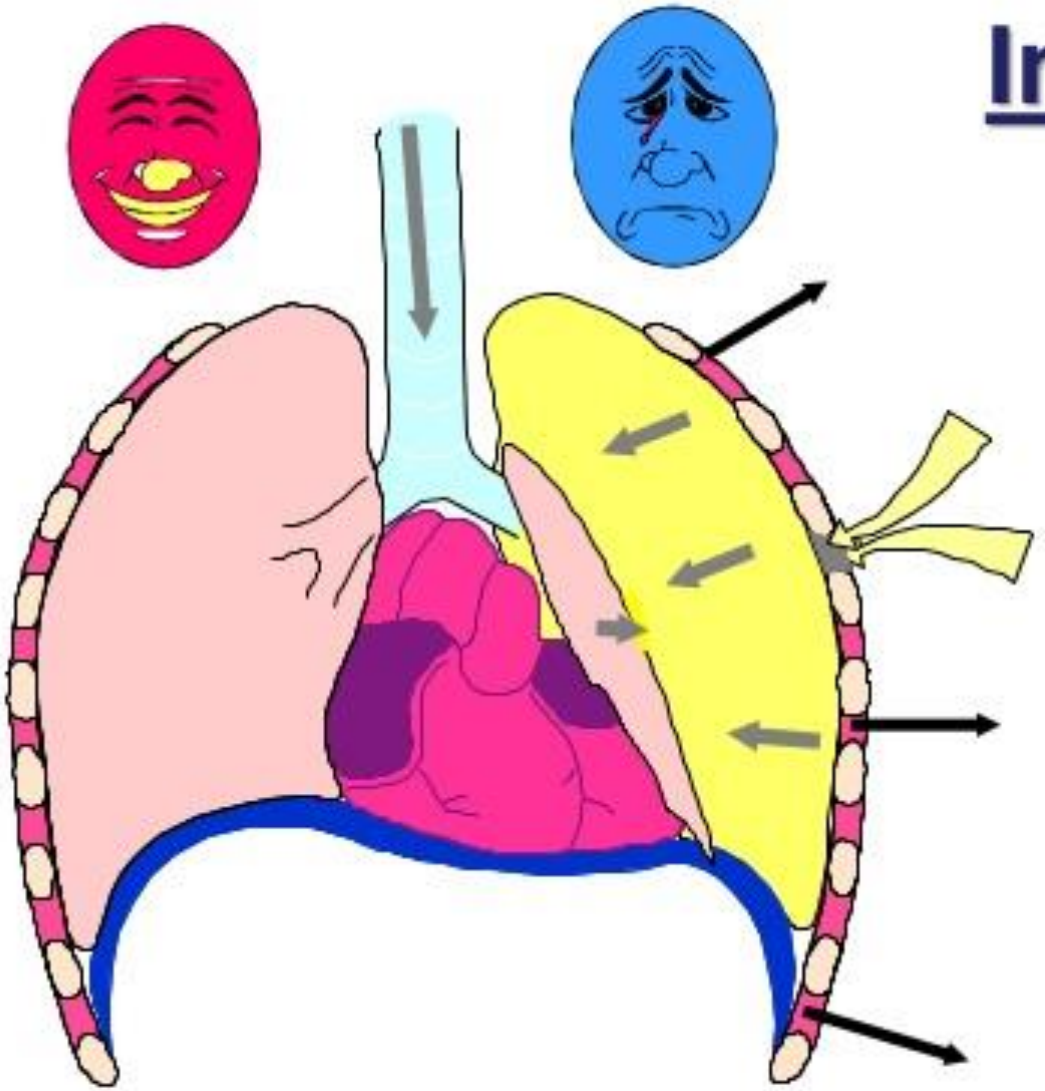


# Open Pneumothorax

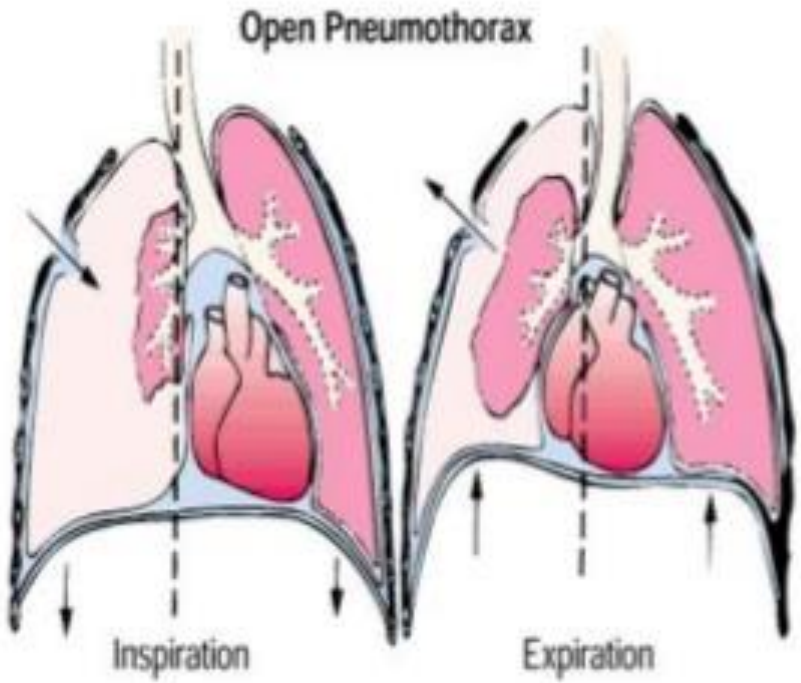
**Inhale**

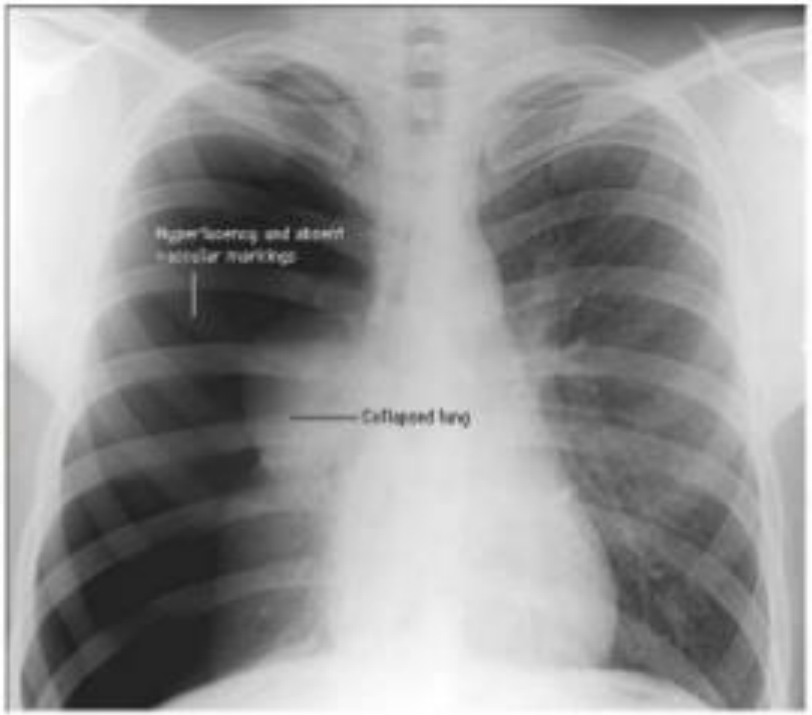


# Open Pnuemothorax



# OPEN PNEUMOTHORAX



# S/S of Open Pneumothorax

- Dyspnea
- Sudden sharp pain
- Subcutaneous Emphysema
- Decreased breath sounds on affected side
- Hyper-resonance
- Red Bubbles on Exhalation from wound (a.k.a. Sucking chest wound)

# Dx:

- CXR Standing.
- Smaller pneumothorax may need Expiration CXR or CT

# Mx:

- ❑ Observation…. Small pneumothorax, Asymtomatic.
- ❑ Aspiration.
- ❑ Chest Intubation…Gold standard,
- ❑ Pleurectomy
- ❑ Pleurodesis…. Sclerosig agents… Doxy, Bleomycin, talc.
- ❑ Surgery… needed in less than 20%… Thoracotomy.

# Sucking chest wound

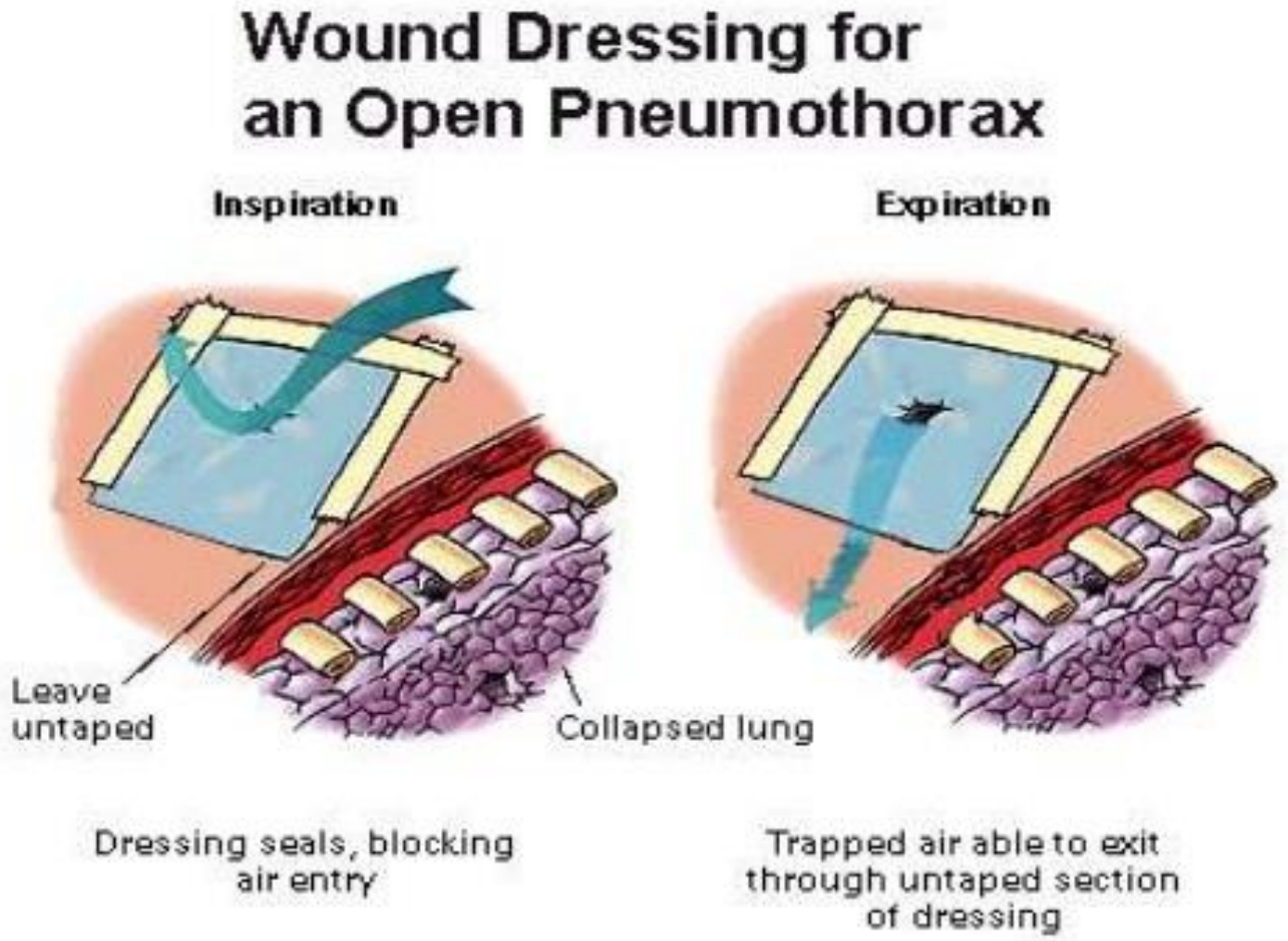
- Full thickness hole in the chest wall, more than 2/3$^{rd}$ of tracheal diameter.
- Inspiration… Flow of air into lungs… collapse.

## Tx:

- Occlusine dressing… taped on three sides act as one-way valve,,,, Followed by Chest intubation.

- Do not remove clothing stuck to the wound
- Do not clean the wound or remove objects stuck in the wound

# Occlusive Dressing



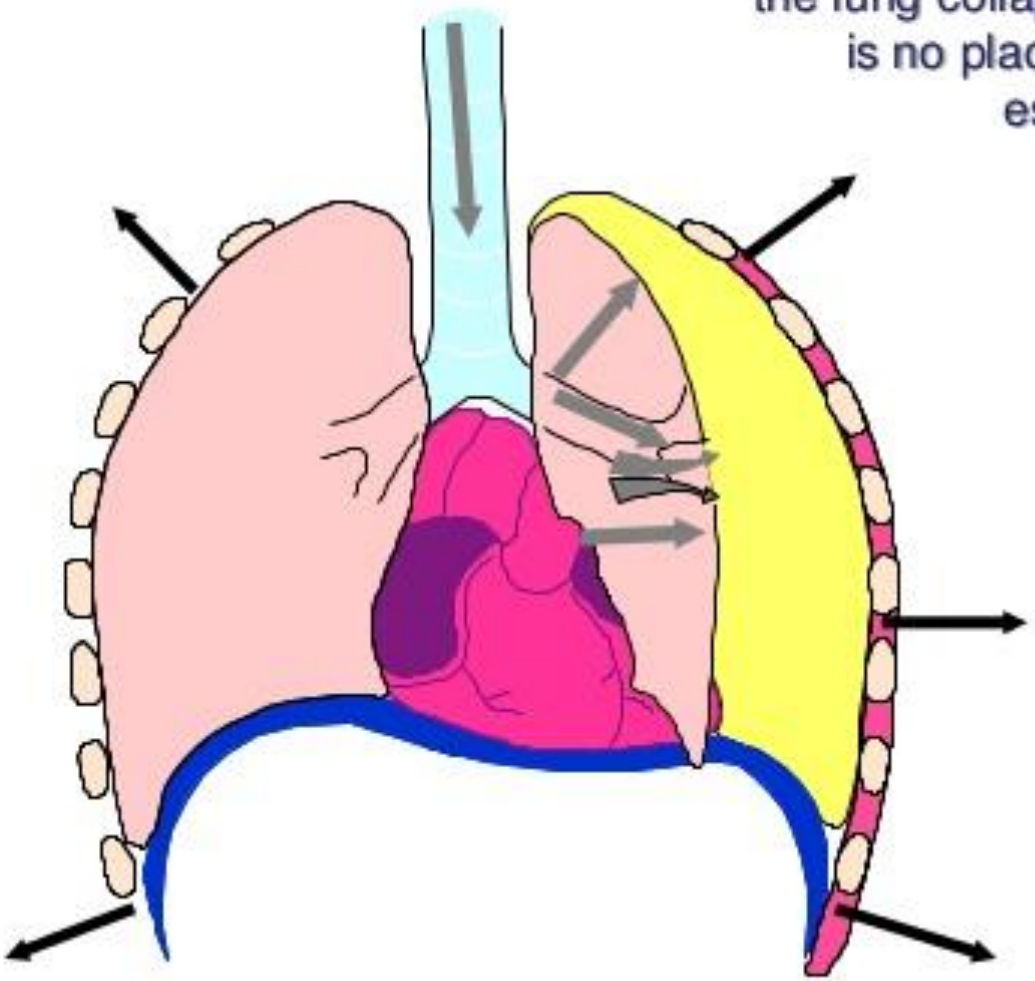
# Tension Pneumothorax

- Air builds in pleural space with no way for the air to escape
- Results in collapse of lung on affected side that results in pressure on mediastium, the other lung, and great vessels,…. Decreasing venous return => Shock
- **Causes:**

  Penetrating trauma, blunt trauma, Iatrogenic.

# Tension Pneumothorax

Each time we inhale, the lung collapses further. There is no place for the air to escape..



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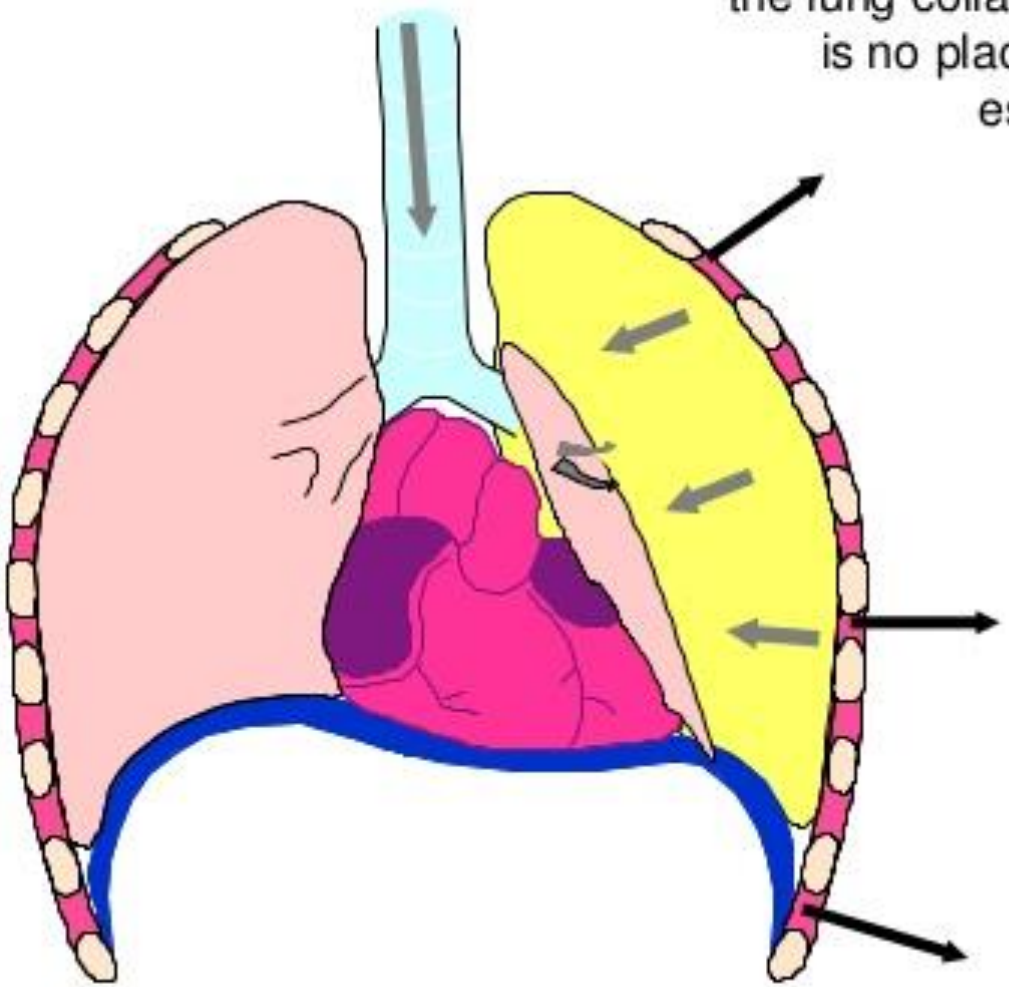

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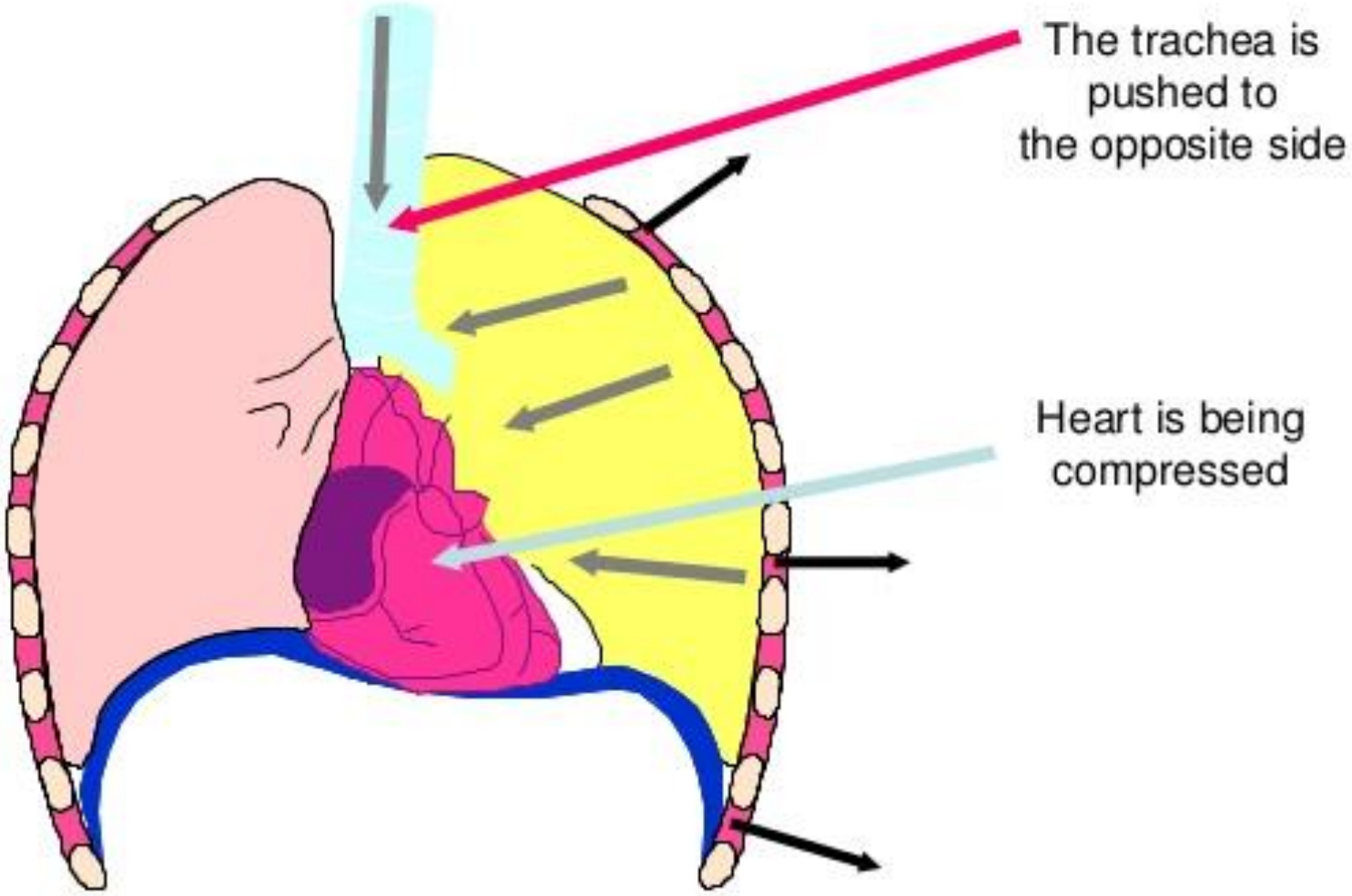
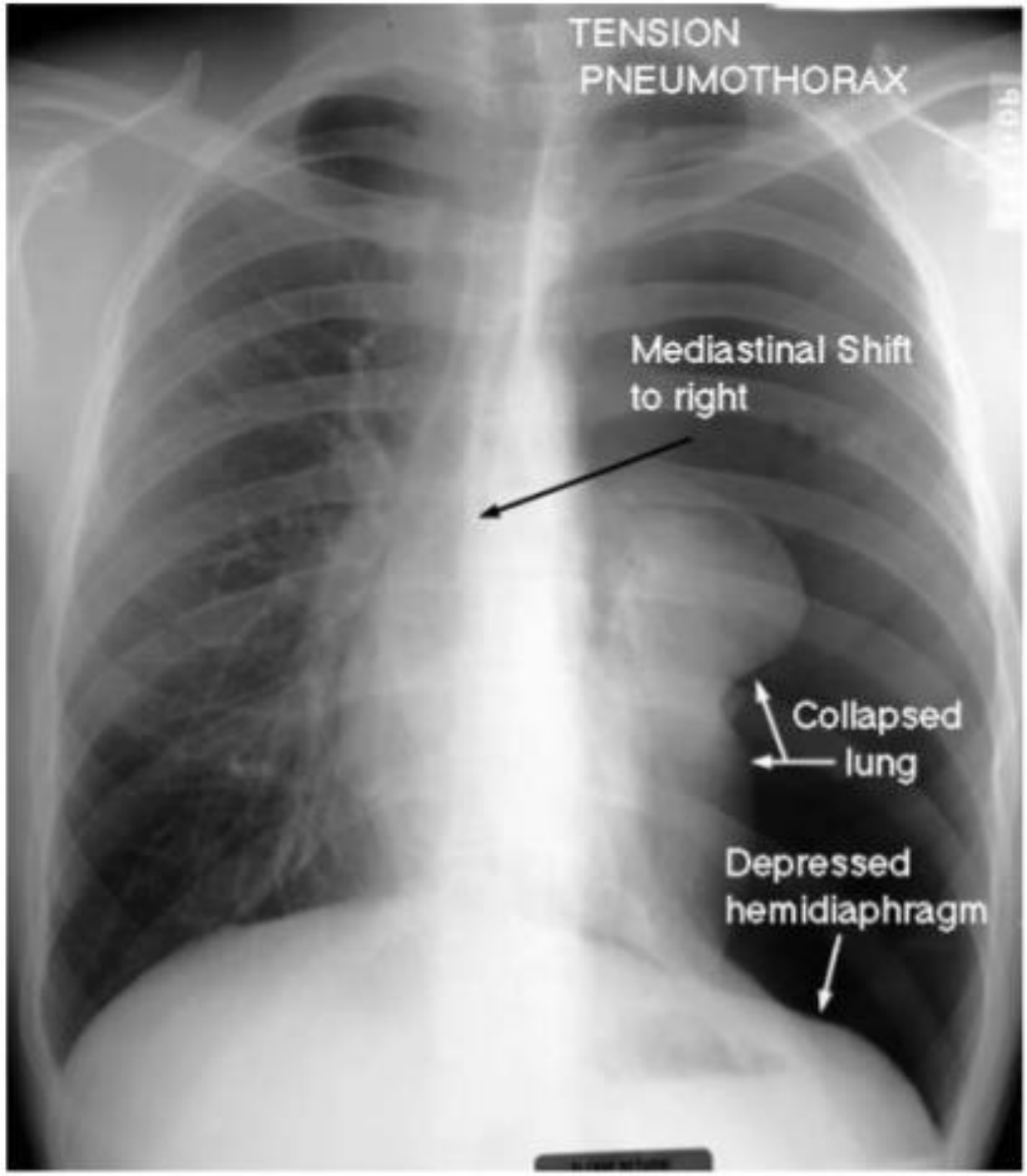



TENSION
PNEUMOTHORAX
Mediastinal Shift
to right
Collapsed
lung
Depressed
hemidiaphragm

# S/S of Tension Pneumothorax

***Dramatic Presentation.***

**It's a clinical diagnosis and treatment should not be delayed by waiting for X-ray**

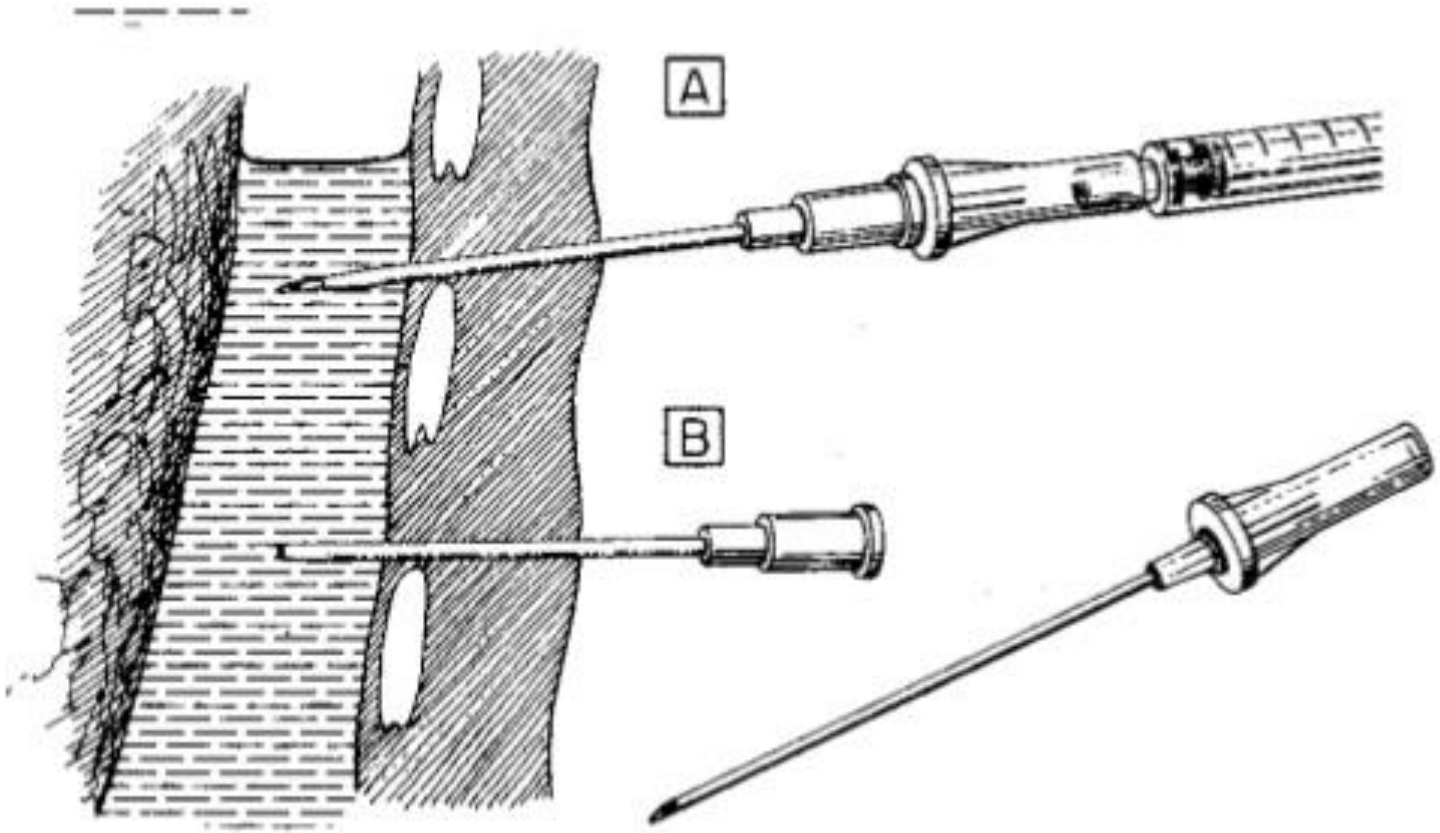
- Anxiety/Restlessness/Panicky
- Severe Dyspnea
- Absent Breath sounds on affected side
- Hyper-resonance
- Tachypnea
- Tachycardia
- Poor Color
- Accessory Muscle Use
- JVD
- Narrowing Pulse Pressures
- Hypotension
- Tracheal Deviation (late if seen at all)

# Treatment

**Needle Decompression**

- Insert a large bore needle (14G) in the second inter-costal space in mid-clavicular line.

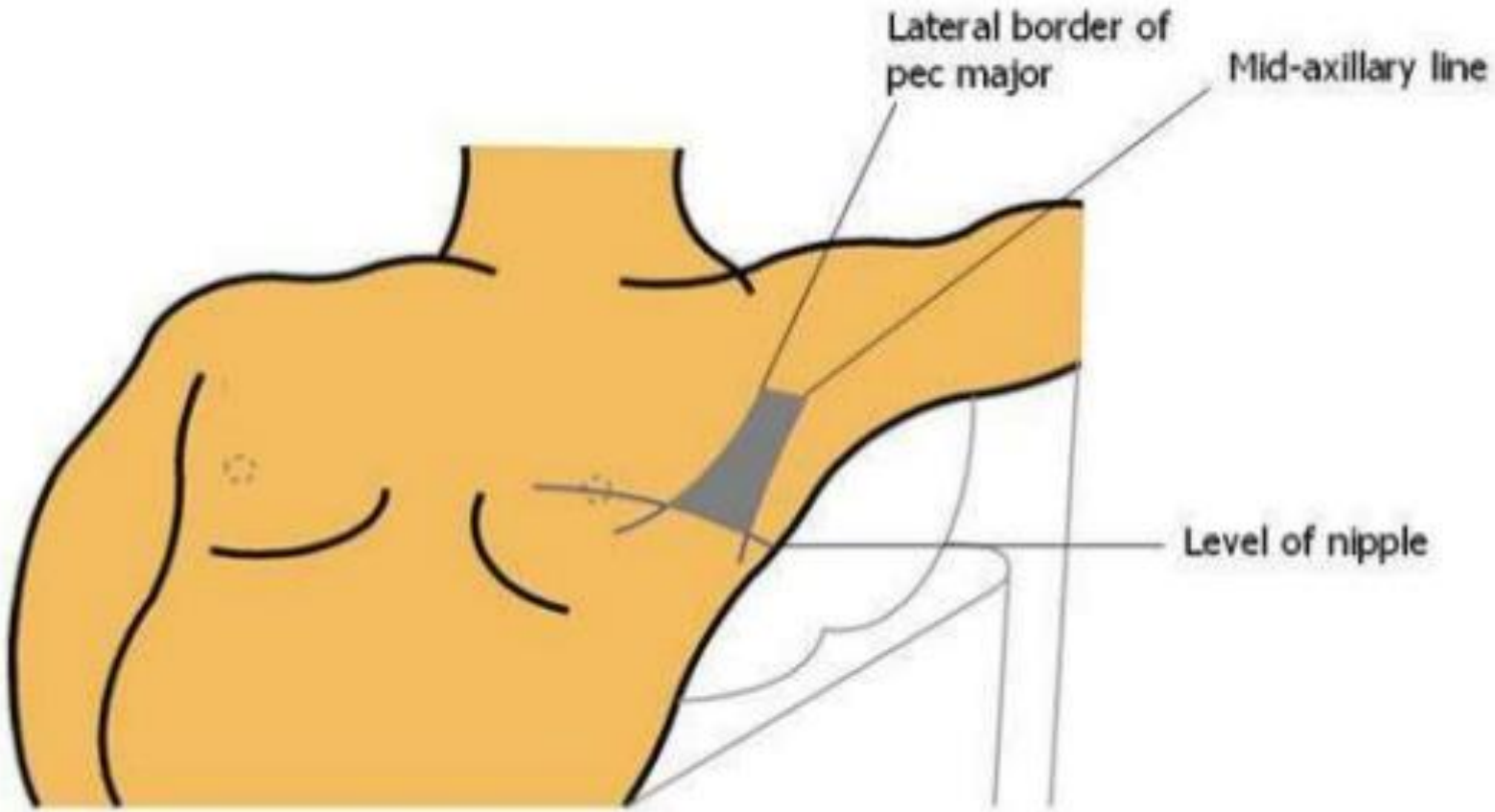
# Needle Chest Decompression



# Needle Decompression

# Chest intubation

# Triangle Of Safety



# Indications

- Pneumothorax
- Malignant pleural effusion
- Empyema and complicated parapneumonic pleural effusion
- Traumatic haemopneumothorax
- Postoperative—for example, thoracotomy, oesophagectomy, cardiac surgery.

# Contra- Indications

- Absolute…. Need for emrgency Thoracotomy
- Relatives are

  Bleeding Diathesis

  Anti-coagulation

  Adhesions

  Loculations

  Pulmonary bullae

# Complications of chest tube

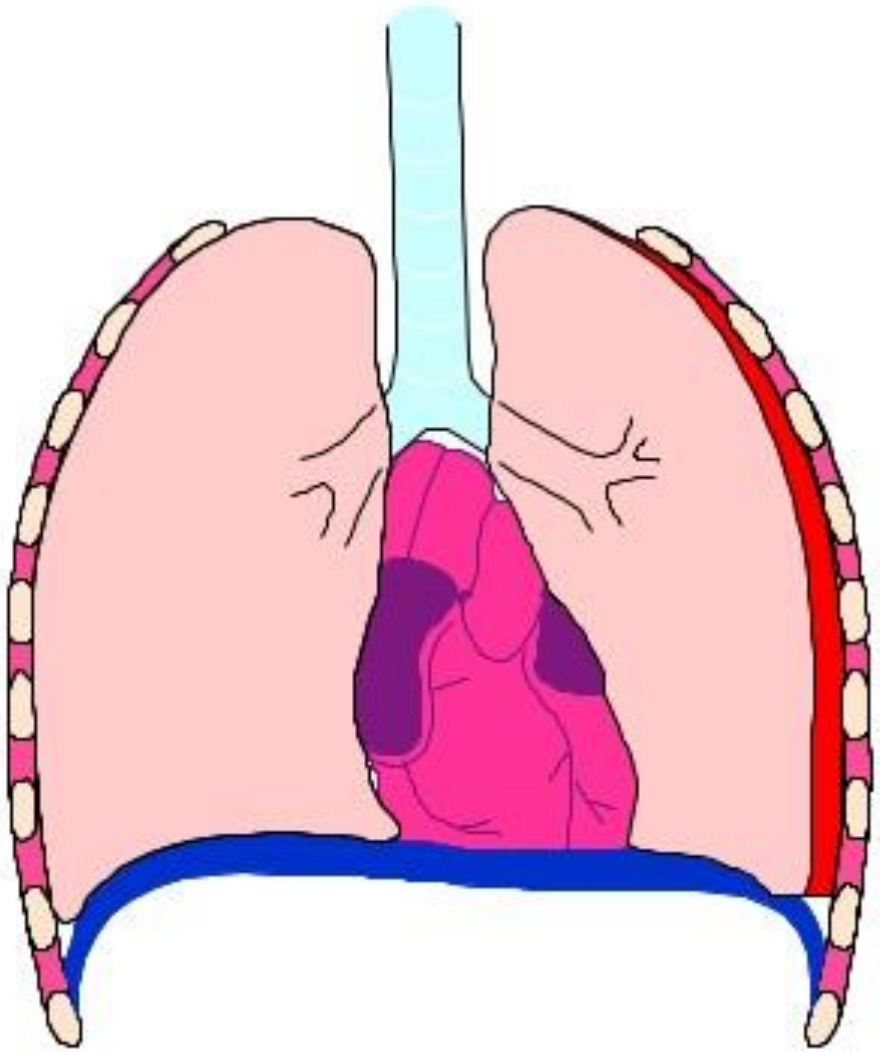
- Hemorrhage
- Infection
- Trauma to the Liver, spleen, Diaphragm, Aorta, Heart.
- Minor complications like,

  Subcut hematoma, Cough, dyspnea,
- Improper placement

# Hemothorax

- Follows Blunt injury
- Occurs when pleural space fills with blood
- Usually occurs due to lacerated blood vessel in thorax mainly Intercostal and internal mammary vessels.
- As blood increases, it puts pressure on heart and other vessels in chest cavity
- Each Lung can hold 1.5 liters of blood

# Hemothorax



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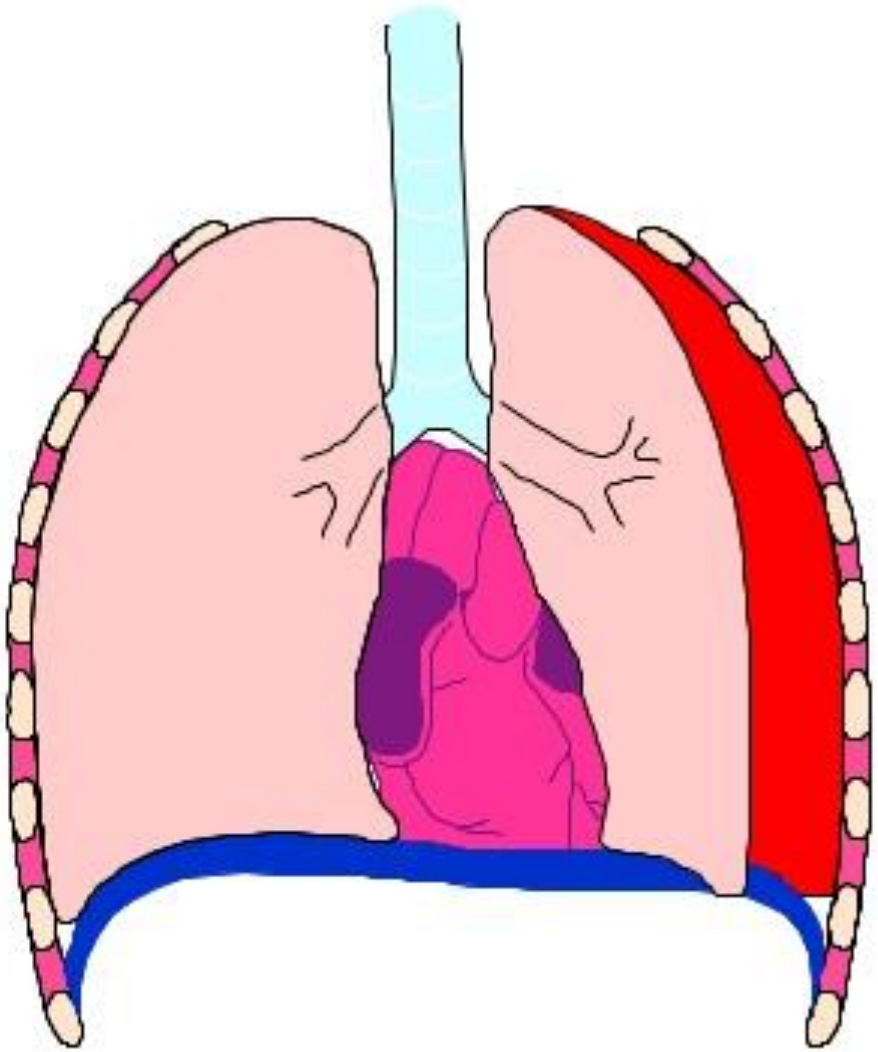
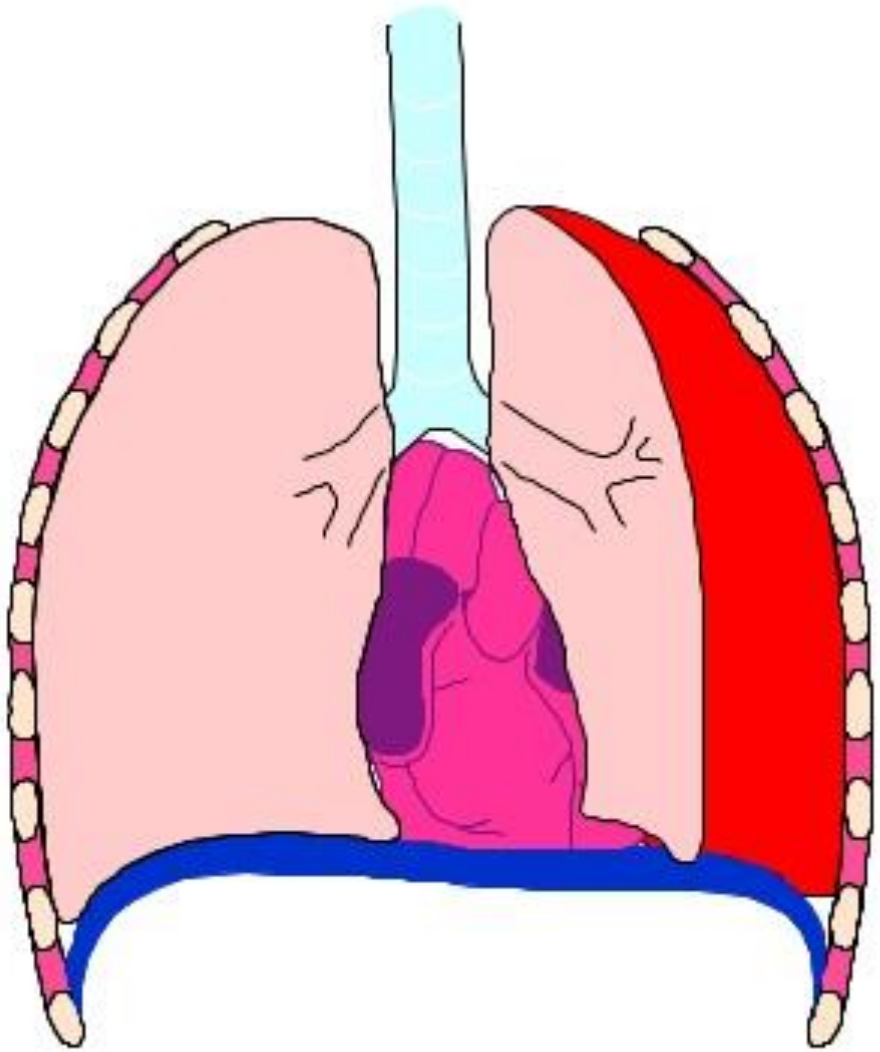


# Hemothorax



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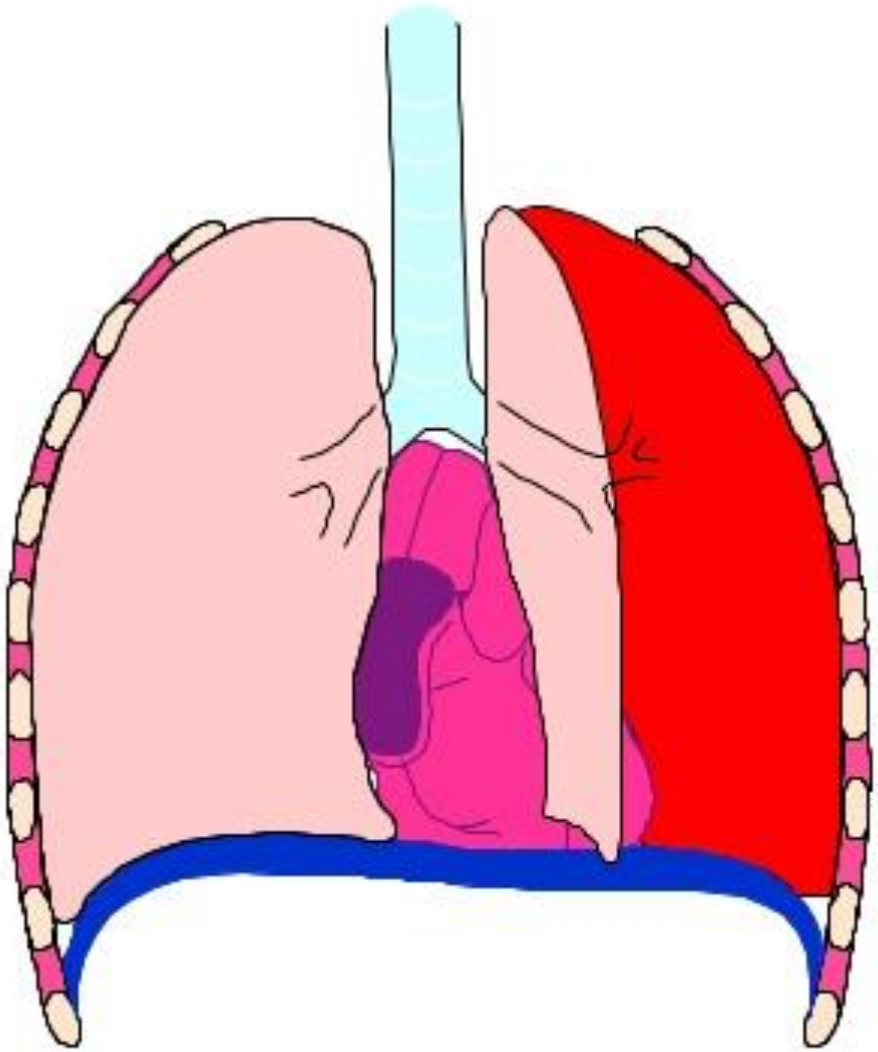
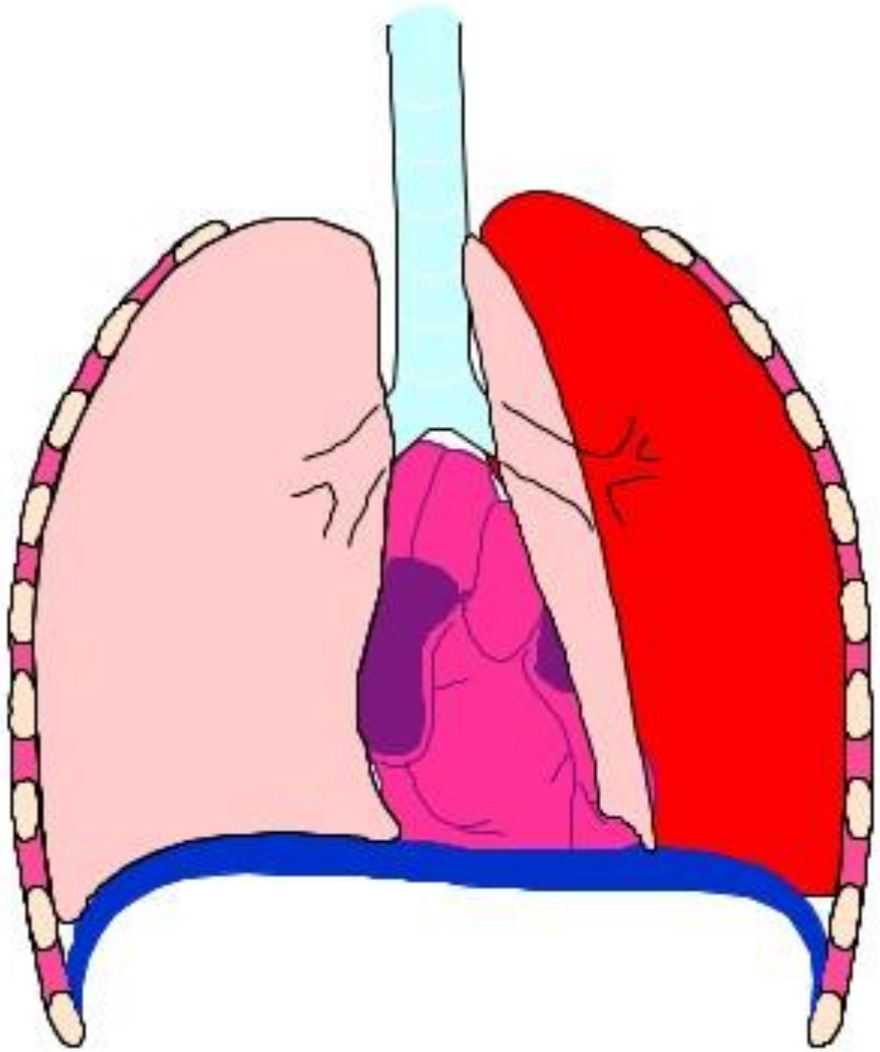


# Hemothorax



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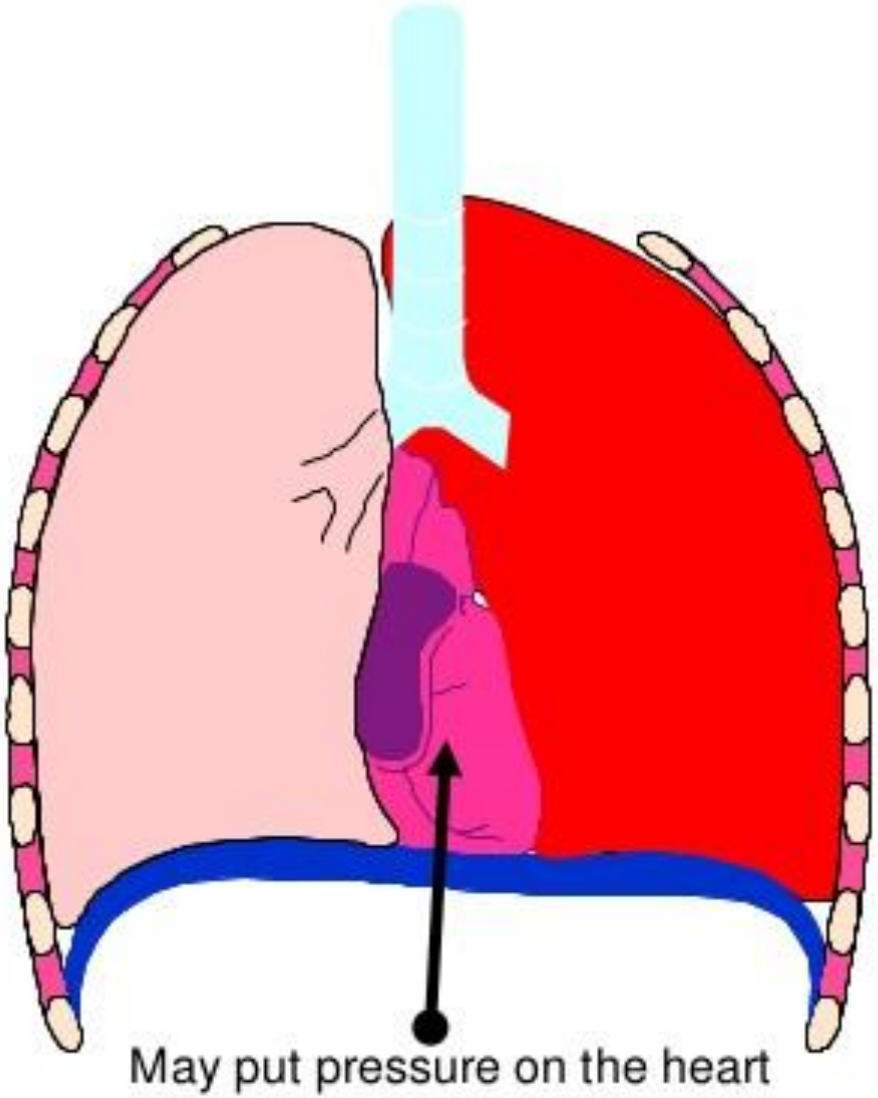
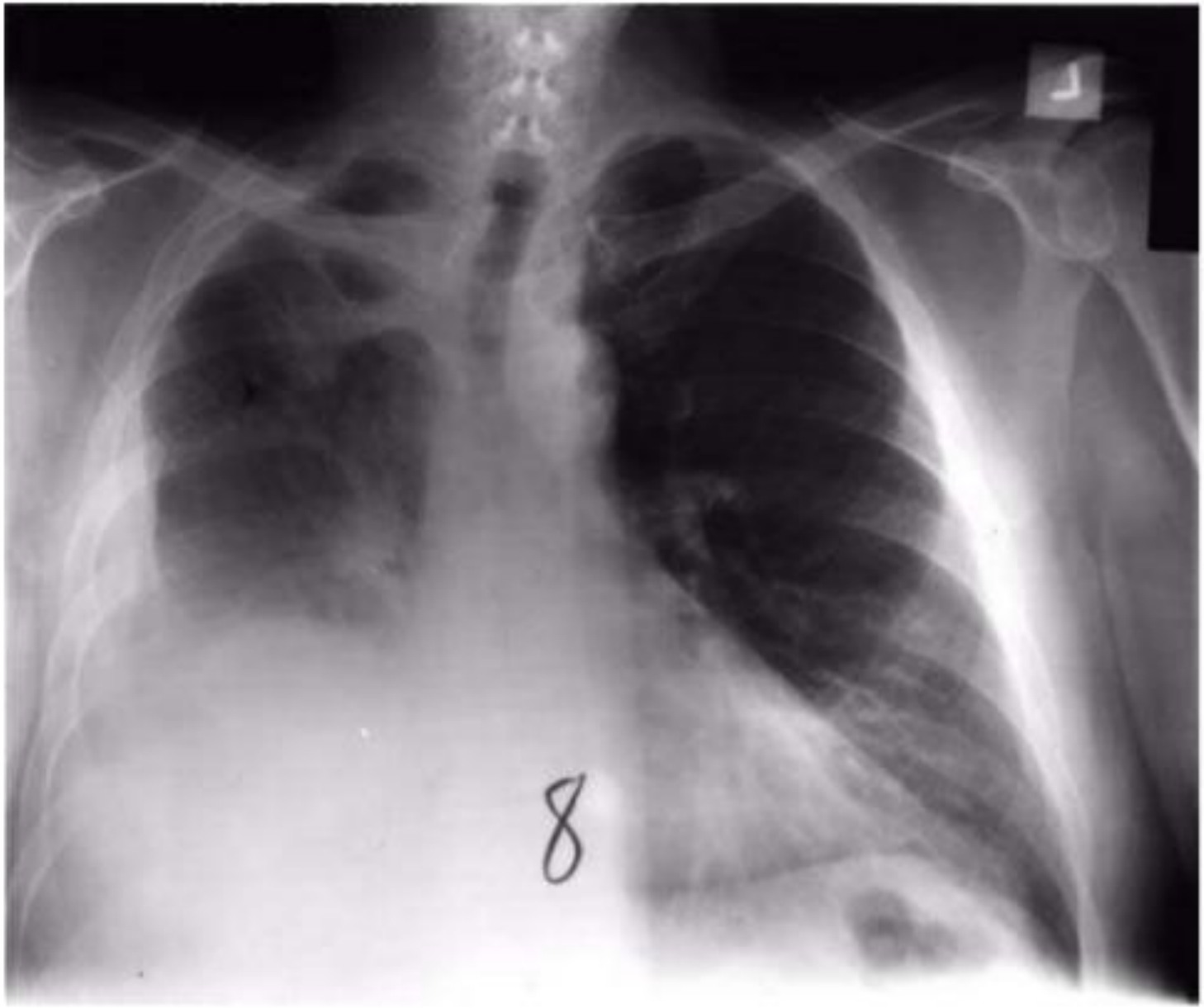
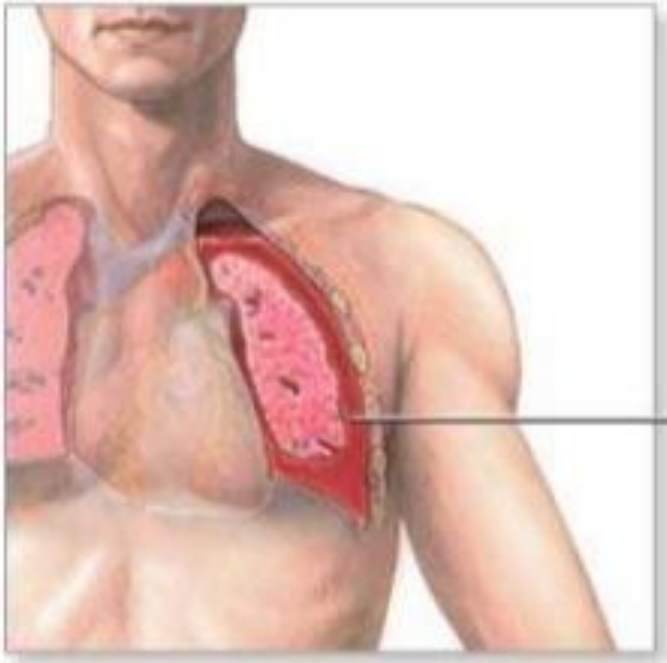


# Hemothorax



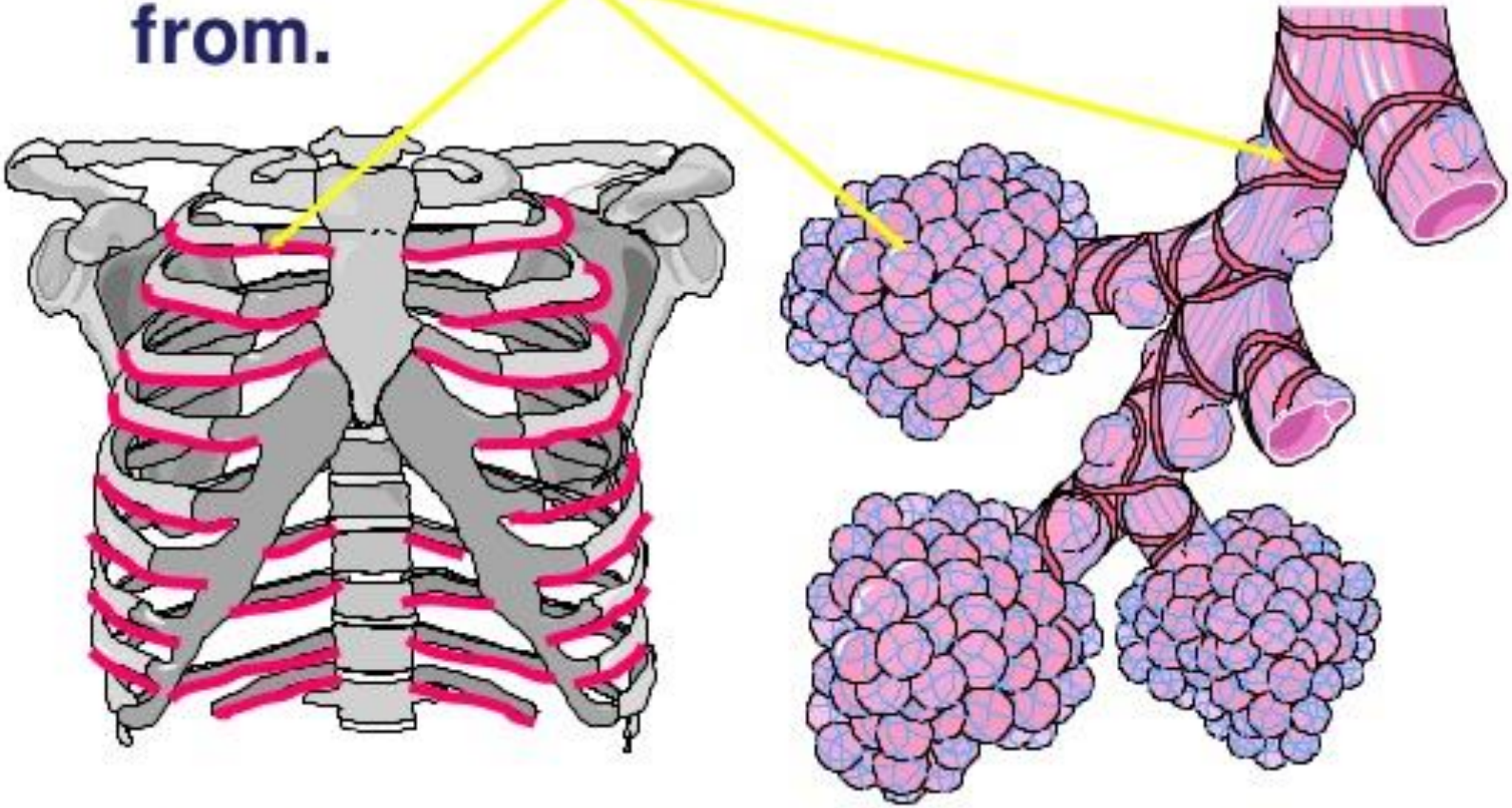
# HEMOTHORAX




ADAM.

# Hemothorax

**Where does the blood come from.**



**Lots of blood vessels**

# S/S of Hemothorax

- Anxiety/Restlessness
- Tachypnea
- Signs of Shock
- Frothy, Bloody Sputum
- Diminished Breath Sounds on Affected Side
- Dull percussion note… maybe resonant in supine position.
- Tachycardia
- Flat Neck Veins

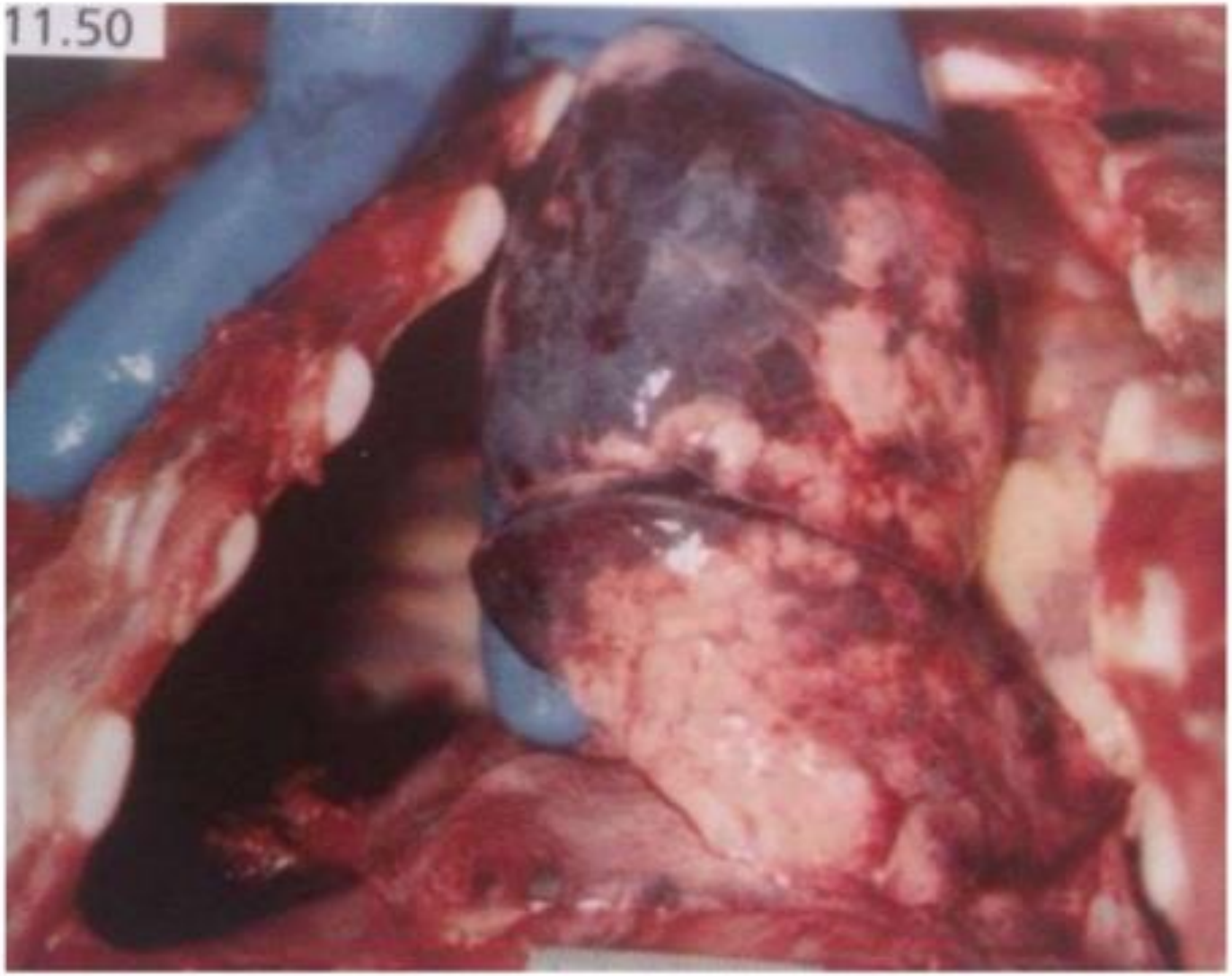
# Treatment for Hemothorax

- ABC's with c-spine control as indicated
- General Shock Care due to Blood loss
- Chest intubation
- Thoracotomy… If more than 1500 ml blood drains initially, or ongoing hemorrhage of more than 200 ml/ hr over 3-4 hrs.

# Pulmonary Contusion

- Crushing and bruising of the lung parenchyma.
- Sudden blow or blunt injury to the chest => compression of thoracic cavity and lung followed by an equally sudden decompression. Concussive and compressive force is most important cause.
- The natural progression of pulmonary contusion is worsening hypoxemia for the first 24 to 48 hours.
- X-ray findings not significant initially.
- CT with contrast is confirmatory.

# Contusion of left upper & lower lobe with aspirated blood around



# S/S of Pul. Contusion

- Hemoptysis
- Dyspnea
- Cough
- Chest wall abrasion
- Echymosis.

# Tx. Of Pul. contusion

- Oxygen administration
- Pul. Toilet
- Mechanical ventilation => in severe case

# Subcutaneous Emphysema

- Air collects in subcutaneous tissues from pressure of air in pleural cavity
- Feels like rice crispies
- Can be seen from neck to groin area
- usually occurs on the chest, neck and face, where it is able to travel from the chest cavity along the fascia.

# S/S of SCE

- swelling of the neck
- Chest pain
- Neck pain
- Dysphagia
- Wheezing and difficulty breathing.

## Causes of SCE

- Both blunt and penetrating trauma

## Diagnosis

- Mainly clinical
- CXR

# Treatment

- Usually benign, no treatment needed.
- If massive then small cuts in the skin.
- Catheters in subcutaneous tissues.
- Treat the underlying cause.

# Tracheo-bronchial Injuries

- Blunt and penetrating trauma
- Presented as hoarseness, SCE.
- Dyspnea , Pneumothorax , hemoptysis , Mediastinal crunch {Hamman's Sign}, Intercostal retractions, Respiratory distress , Stridor.
- Chest drain will reveal a large air leak and the collapsed lung may fail to re-expand.
- **Diagnosis** => Bronchoscopy

# Managment

- Priority is to stabilize AIRWAY.
- Intubation of the unaffected bronchus and operative repair.

# Traumatic Asphyxia

- Results from sudden compression injury to chest cavity
- Can cause massive rupture of Vessels and organs of chest cavity
- Ultimately Death

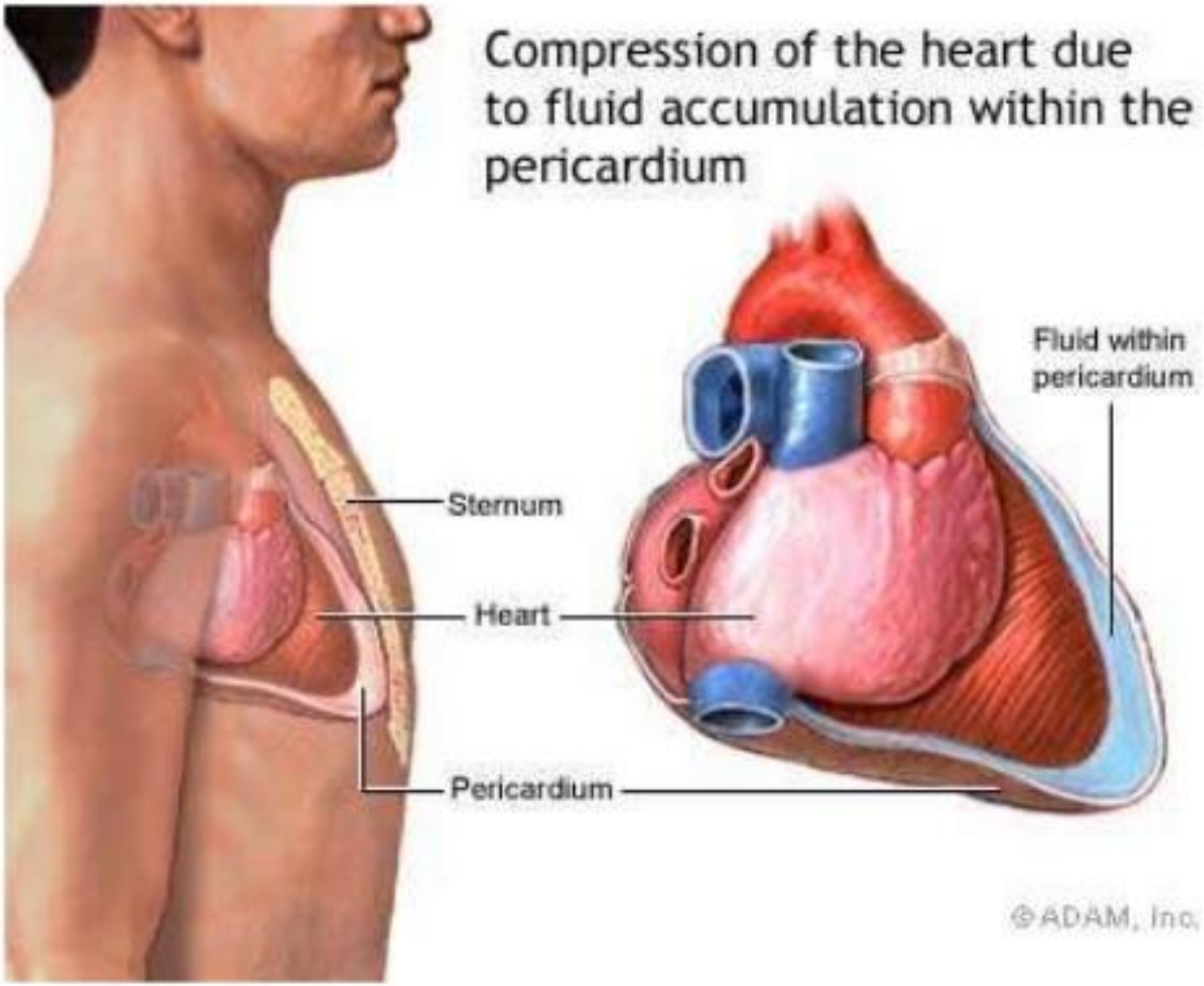
# S/S of Traumatic Asphyxia

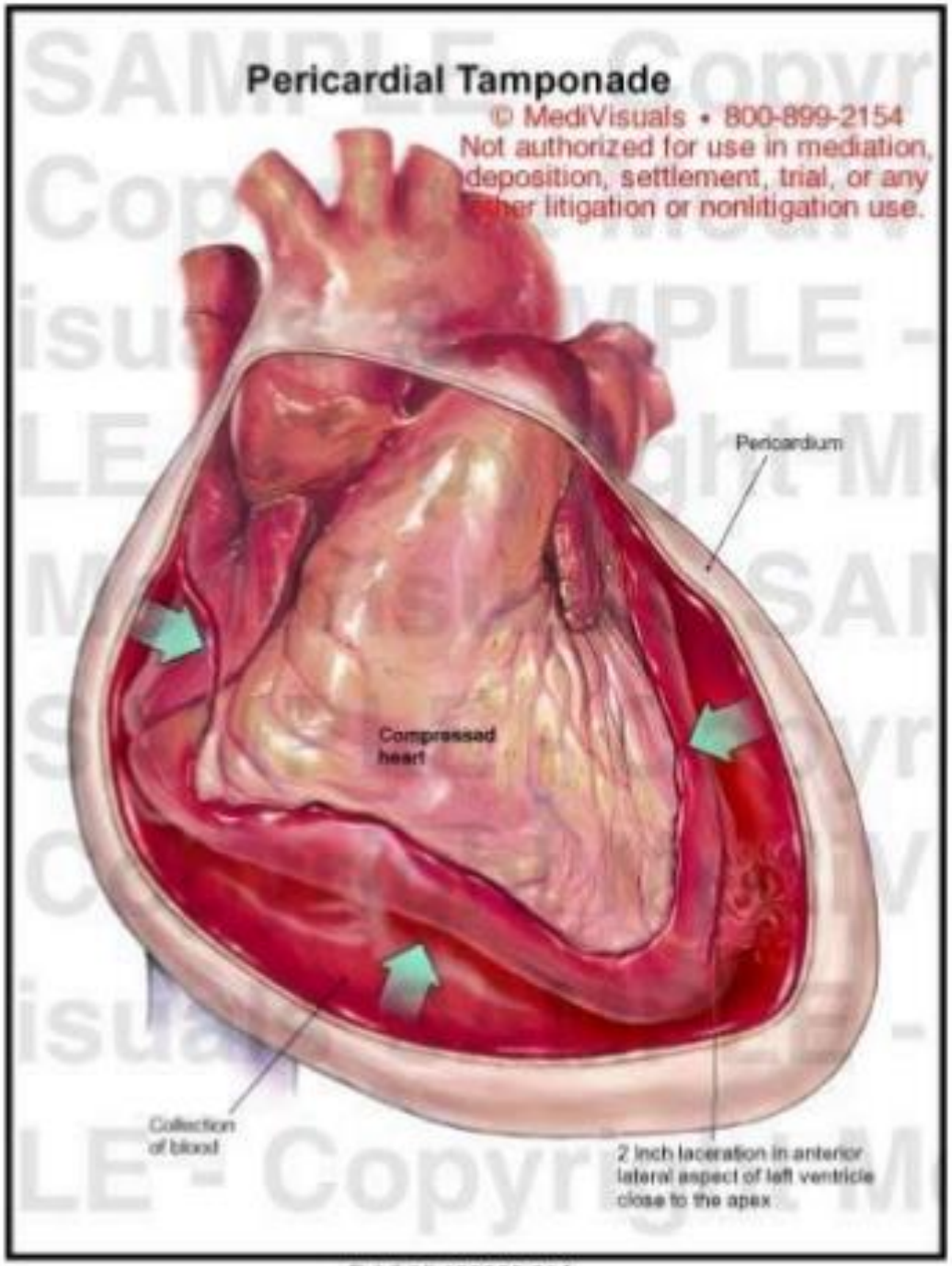
- Severe Dyspnea
- Distended Neck Veins
- Bulging, Blood shot eyes
- Swollen Tounge with cyanotic lips
- Reddish-purple discoloration of face and neck
- Petechiae

# Treatment for Traumatic Asphyxia

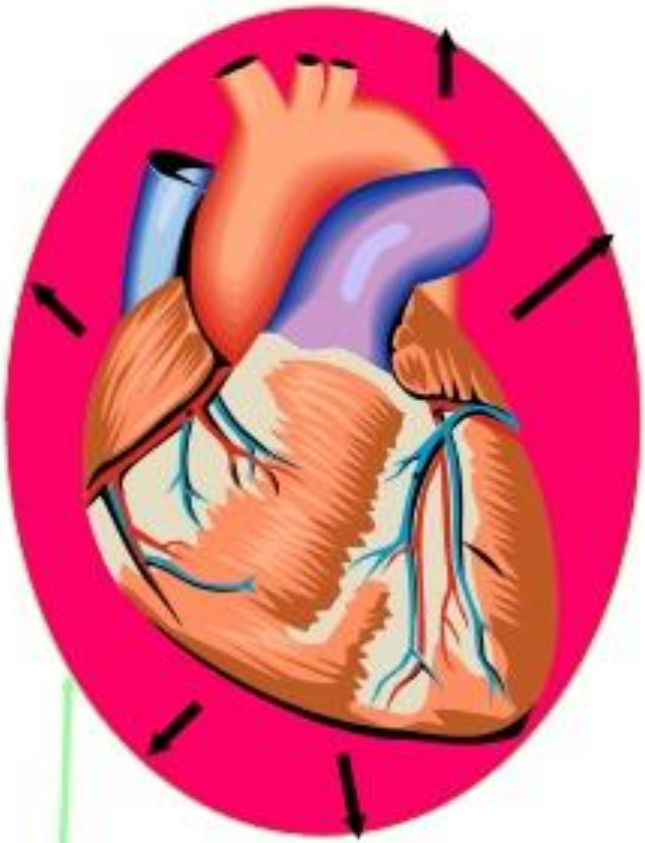
- ABC's with c-spine control as indicated
- High Flow oxygen
- Treat for shock
- Care for associated injuries

# Pericardial Temponade




Pericardial Tamponade
© MediVisuals • 800-899-2154
Not authorized for use in mediation, deposition, settlement, trial, or any other litigation or nonlitigation use.
Pericardium
Compressed heart
Collection of blood
2 inch laceration in anterior lateral aspect of left ventricle close to the apex
Exhibit# 403020-01A

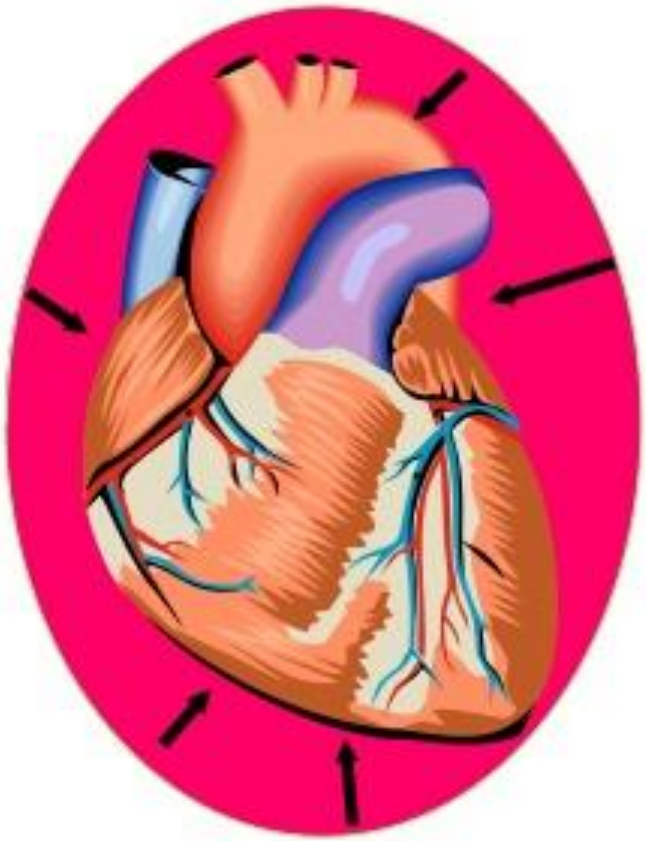
# Pericardial Tamponade



**pericardial sac**

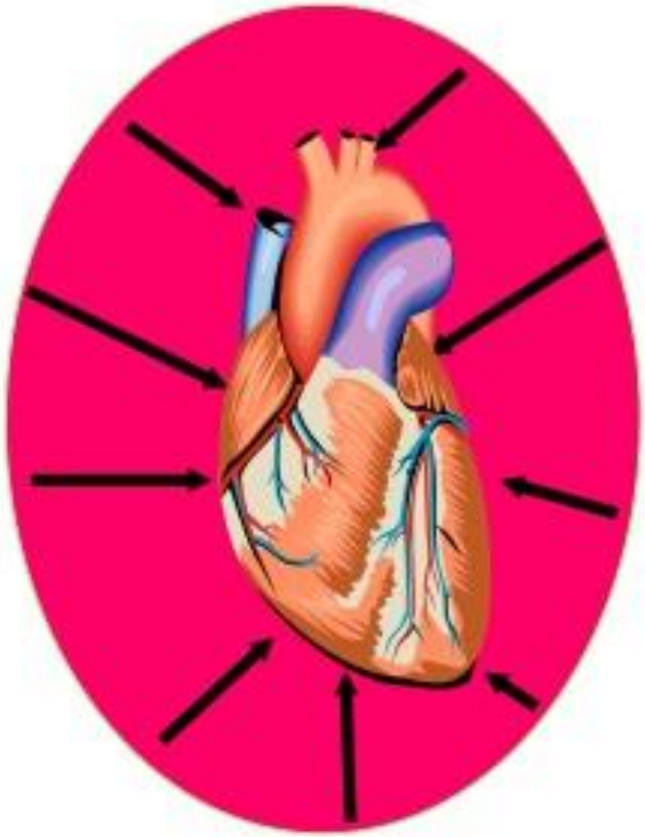
- Penetrating Trauma
- Blood and fluids leak into the pericardial sac which surrounds the heart.
- As the pericardial sac fills, it causes the sac to expand until it cannot expand anymore

# Pericardial Tamponade



- Once the pericardial sac can't expand anymore, the fluid starts putting pressure on the heart
- Now the heart can't fully expand and can't pump effectively.

# Pericardial Tamponade



- With poor pumping the blood pressure starts to drop.
- The heart rate starts to increase to compensate but is unable
- The patient's level of conscious drops, and eventually the patient goes in cardiac arrest

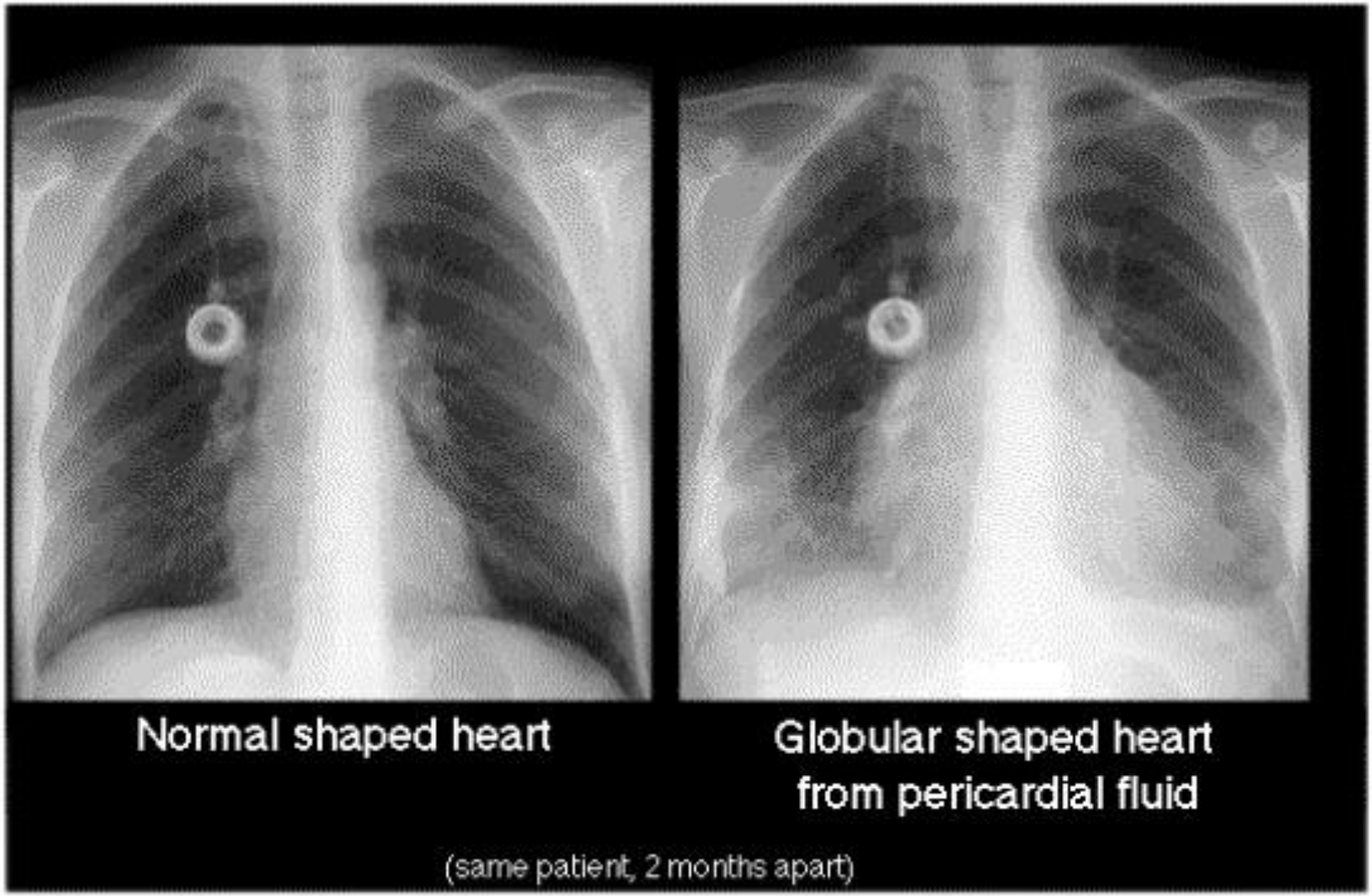
# S/S of Pericardial Tamponade

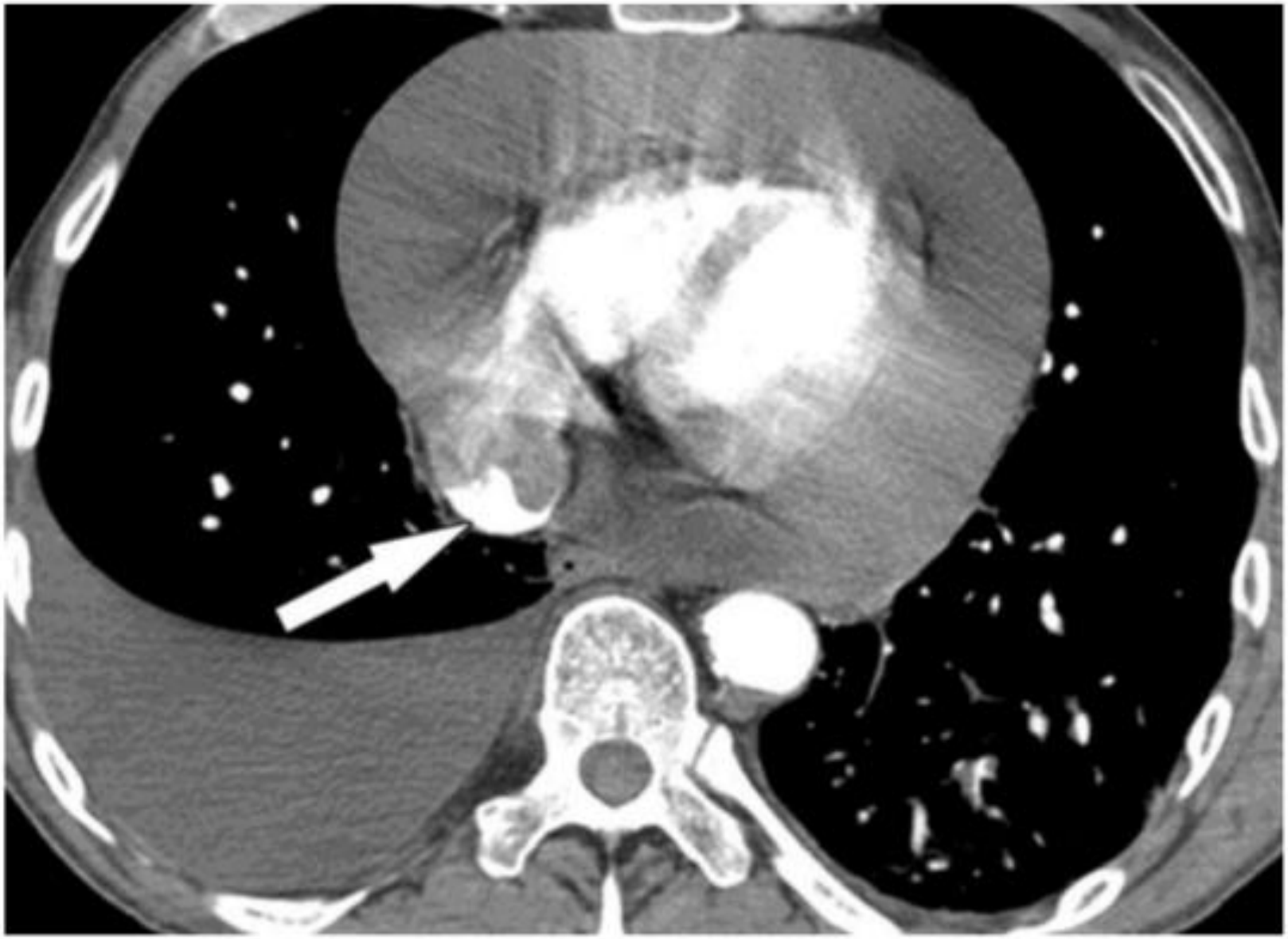
- Distended Neck Veins
- Increased Heart Rate
- Muffled heart sound
- Respiratory Rate increases
- Poor skin color
- Hypotension
- Death
- Beck's Triad… Low BP, Raise venous pressure, Muffled Heart sounds.

- All the pts with penetrating injury anywhere near the heart + Shock => Always suspect cardiac injury.
- Must be differentiated from Tension pneumothorax.
- In case of major bleeding from other site, neck veins may be flat.

# Dx:

- Clinical suspicion.
- CXR… enlarged Globular heart shadow.
- Echo…. Fluid in pericardial sac.
- Central venous pressure… high
- CT scan


Normal shaped heart
Globular shaped heart
from pericardial fluid
(same patient, 2 months apart)



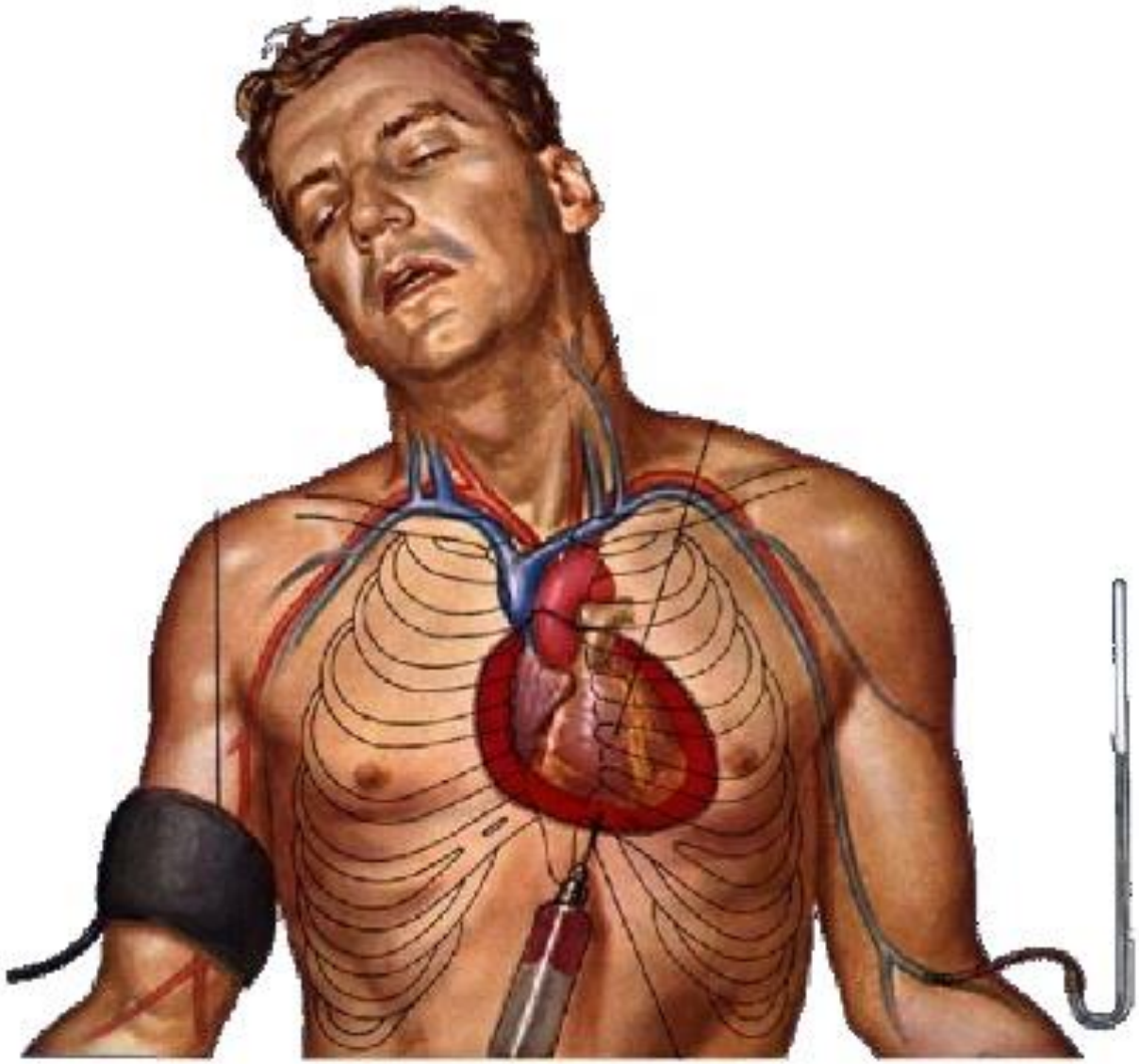
# Treatment of Pericardial Tamponade

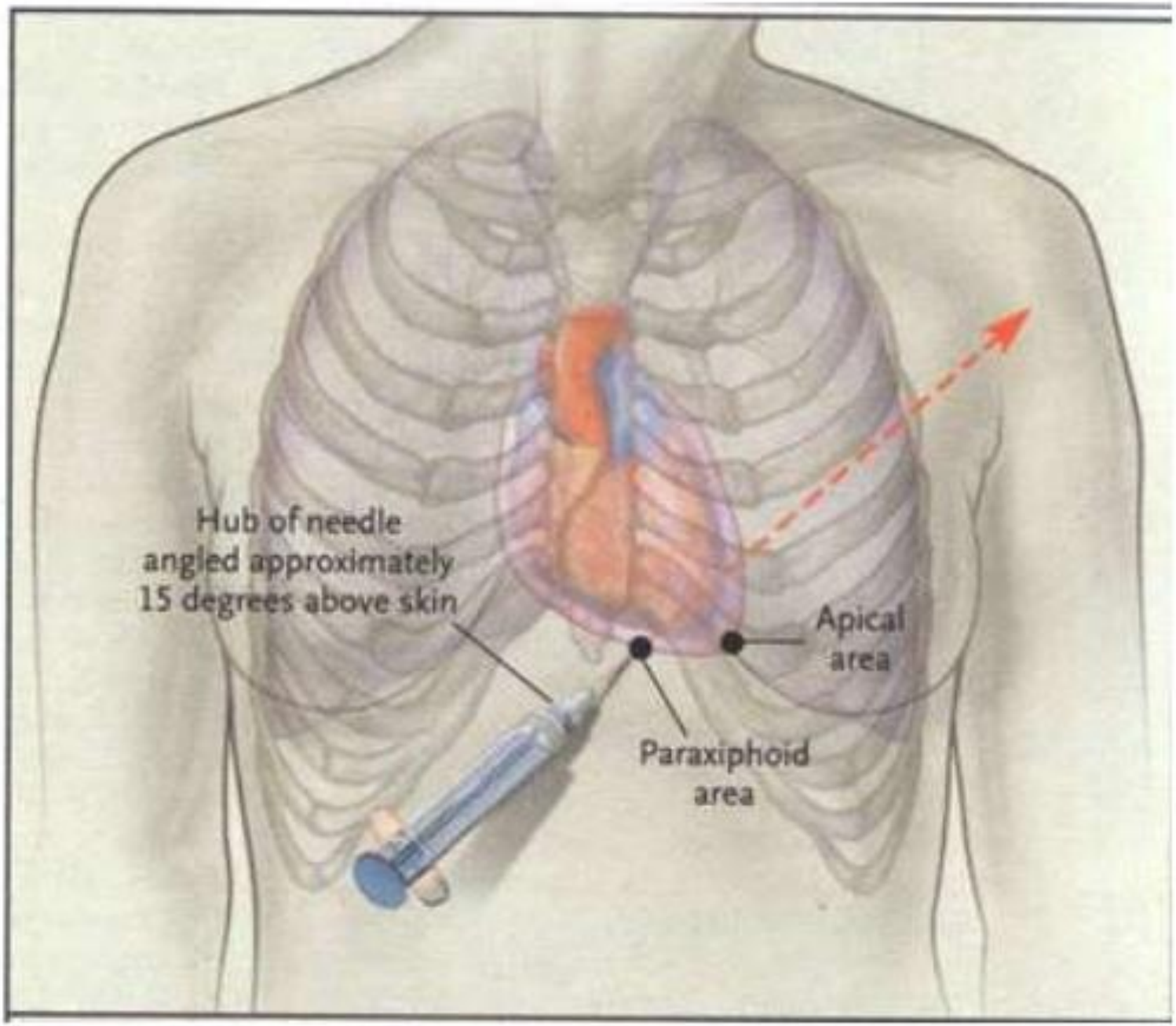
- ABC's with c-spine control as indicated
- High Flow oxygen.
- Treat S/S of shock
- ***Rapid Transport***
- What patient needs is ***Pericardiocentesis***

# Pericardiocentesis

- Using aseptic technique, Insert at least 3" needle at the angle of the Xiphoid Cartilage at the 7$^{th}$ rib
- Advance needle at 45 degree towards the clavicle while aspirating syringe till blood return is seen
- Continue to Aspirate till syringe is full then discard blood and attempt again till signs of no more blood
- Closely monitor patient due to small amout of blood aspirated can cause a rapid change in blood pressure

# Pericardiocentesis.




Hub of needle
angled approximately
15 degrees above skin
Apical
area
Paraxiphoid
area

# Definitive treatment

- Sternotomy
- Left Thoracotomy

# Pericardial Tamponade

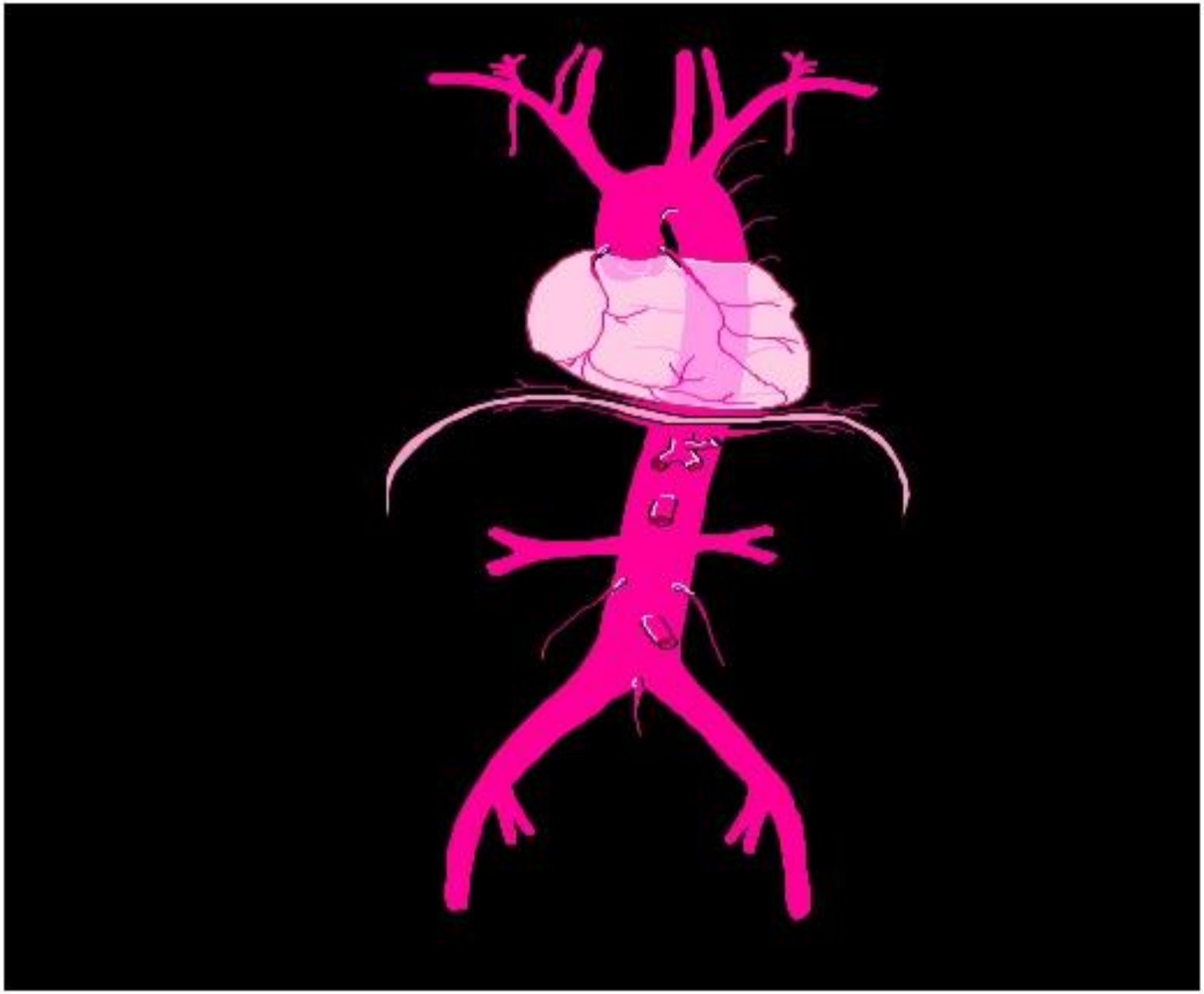
- *Is A Dire Emergency*

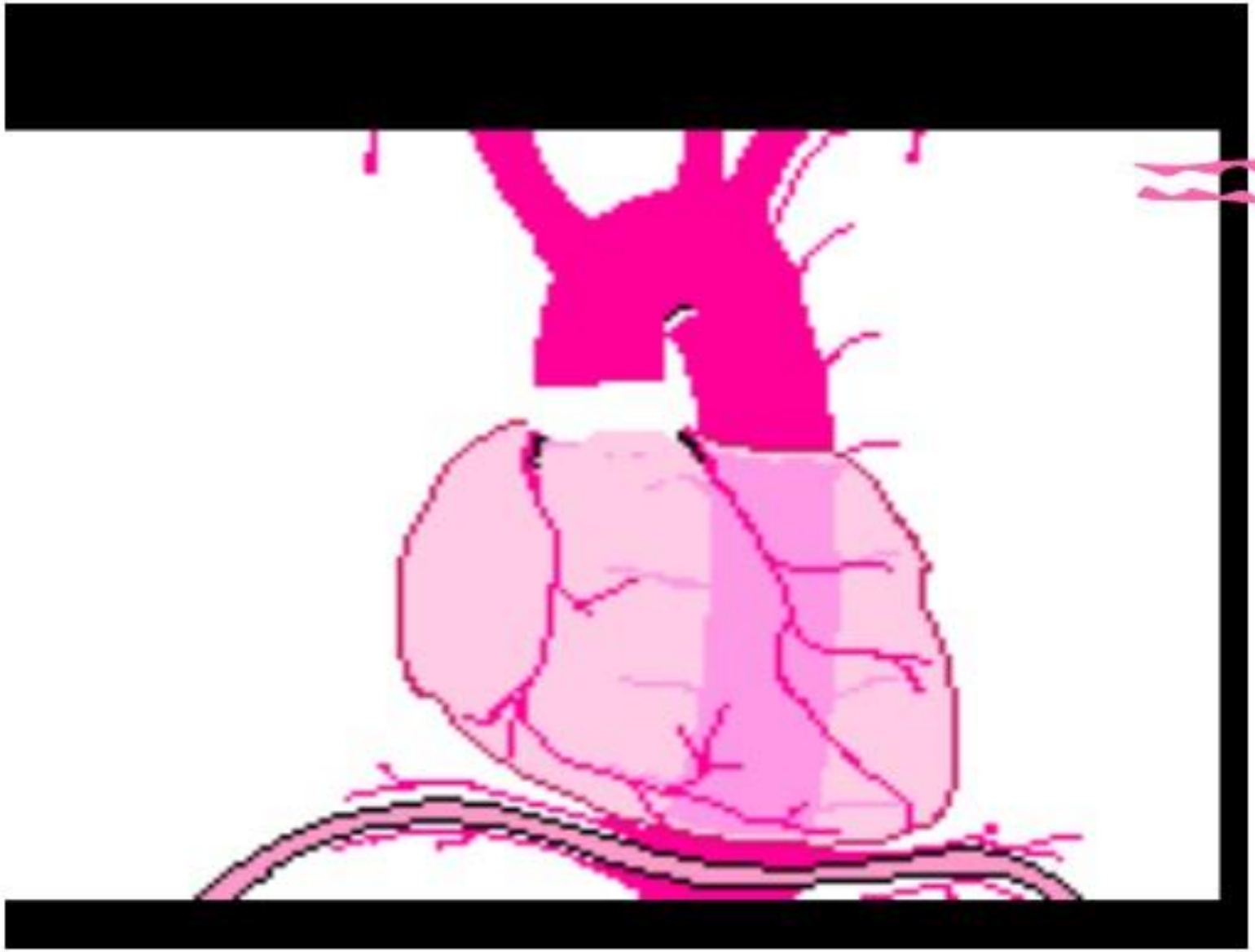
# Blunt Myocardial Injury

- Rarely Causes hemodynamic Instability.
- Dx on ECG.. Echo, Trans esophageal Echo, Cardiac enzymes… Little role.
- Complication… Arrythmias in 1st 24 hrs.

# Traumatic Aortic Disruption

- Most common cause of sudden death after MVA or fall from height
- Relatively fixed distal to the origin of Lt subclavian artery.
- The heart, more or less, just hangs from the aortic arch much like a big pendulum.
- Deceleration Injury
- If Intima and media are disrupted, but Adventitia is intact……. Pt may be Stable.





# S/S Of Traumatic Aortic Rupture

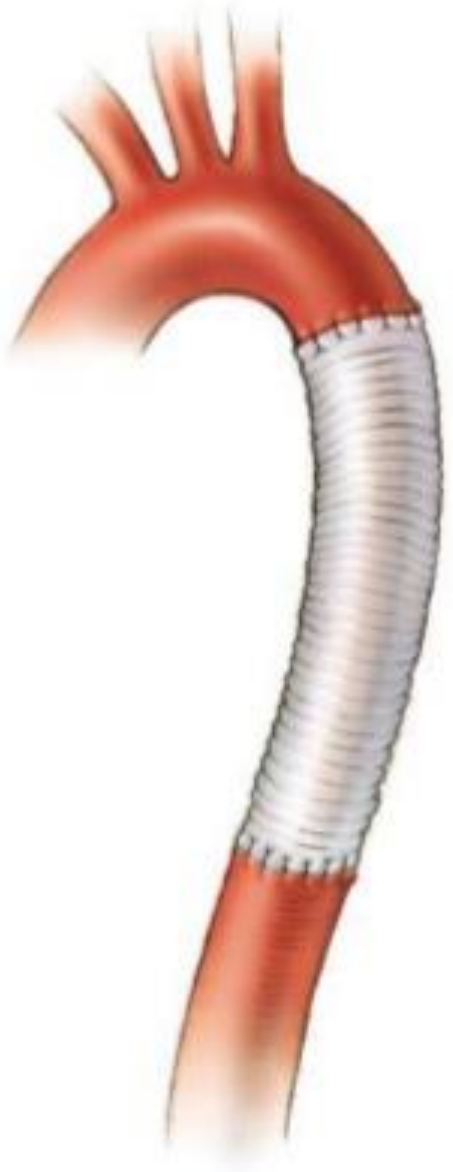
- Burning or Tearing Sensation in chest or shoulder blades
- Rapidly dropping Blood Pressure
- Pulse Rapidly Increasing
- Asymmetry of both upper limbs, or upper and lower limbs Blood Pressure.
- Widened Pulse Pressure.
- Chest wall contusions
- Rapid Loss of Consciousness.

# Dx

- CXR Erect…. Widened Mediastinum
- Aortogram.
- CT with Contrast.
- Trans-esophageal echo.

# Treatment of Traumatic Aortic Rupture

- ABC's with c-spine control as indicated
- High Flow oxygen.
- Treatment for Shock
- Control of systolic B.P to less than 100mmHg.
- Stenting.
- Direct repair
- Excision and grafting using a Dacron graft.



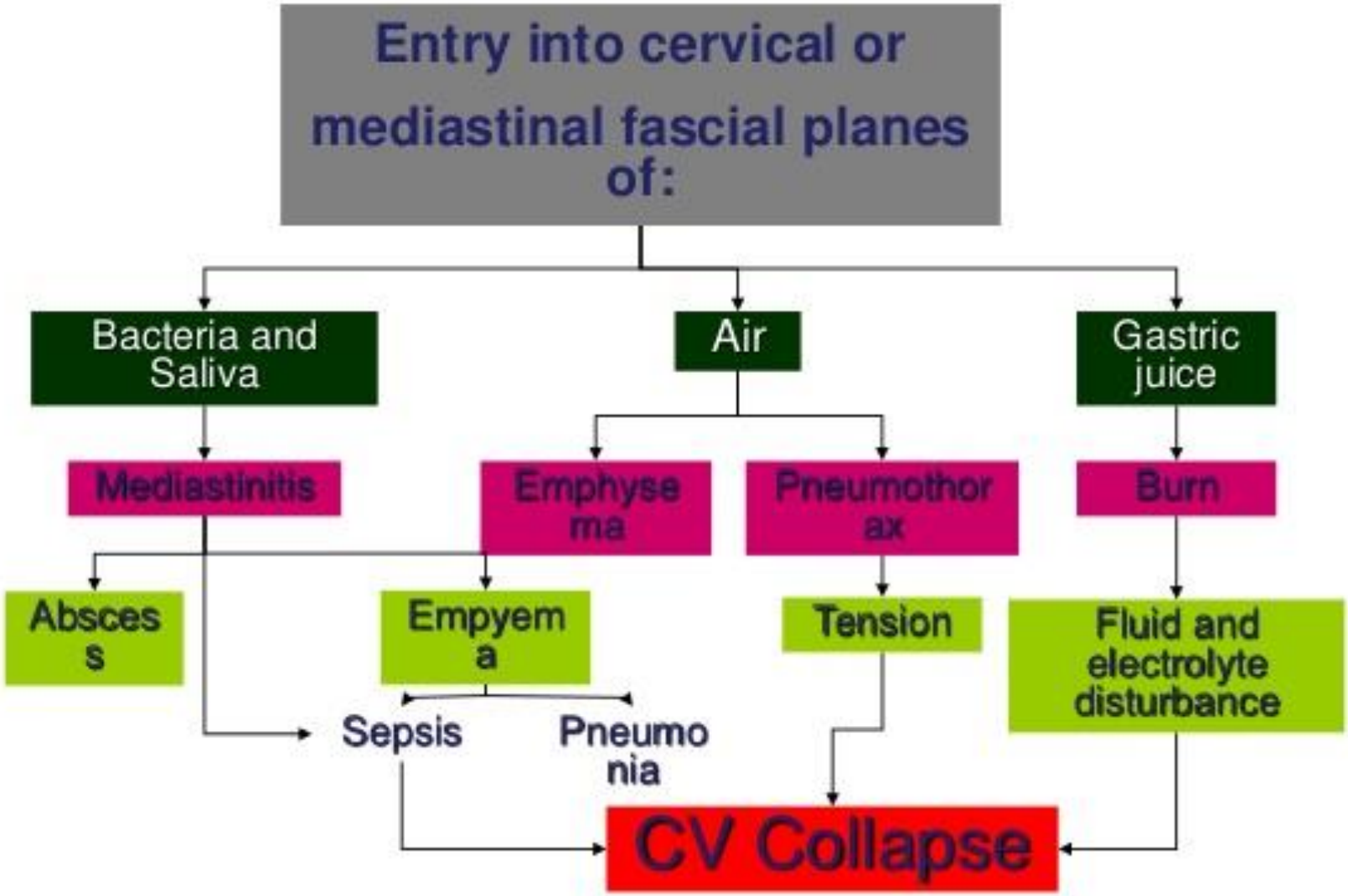
With Open Surgery

With Stent

# OESOPHAGEAL INJURY

- Results from penetrating trauma; blunt injury is rare
- Patient can present with odynophagia, subcutaneous or mediastinal emphysema, pleural effusion, air in the retro-oesophageal space and unexplained fever within 24 hours of injury
- Combination of oesophagogram and oesophagoscopy confirm diagnosis
- CT can be done
- Treatment is operative repair and drainage
- Mid-oesophageal injury => Right thoracotomy.
- Distal oesophageal injury => Left thoracotomy.

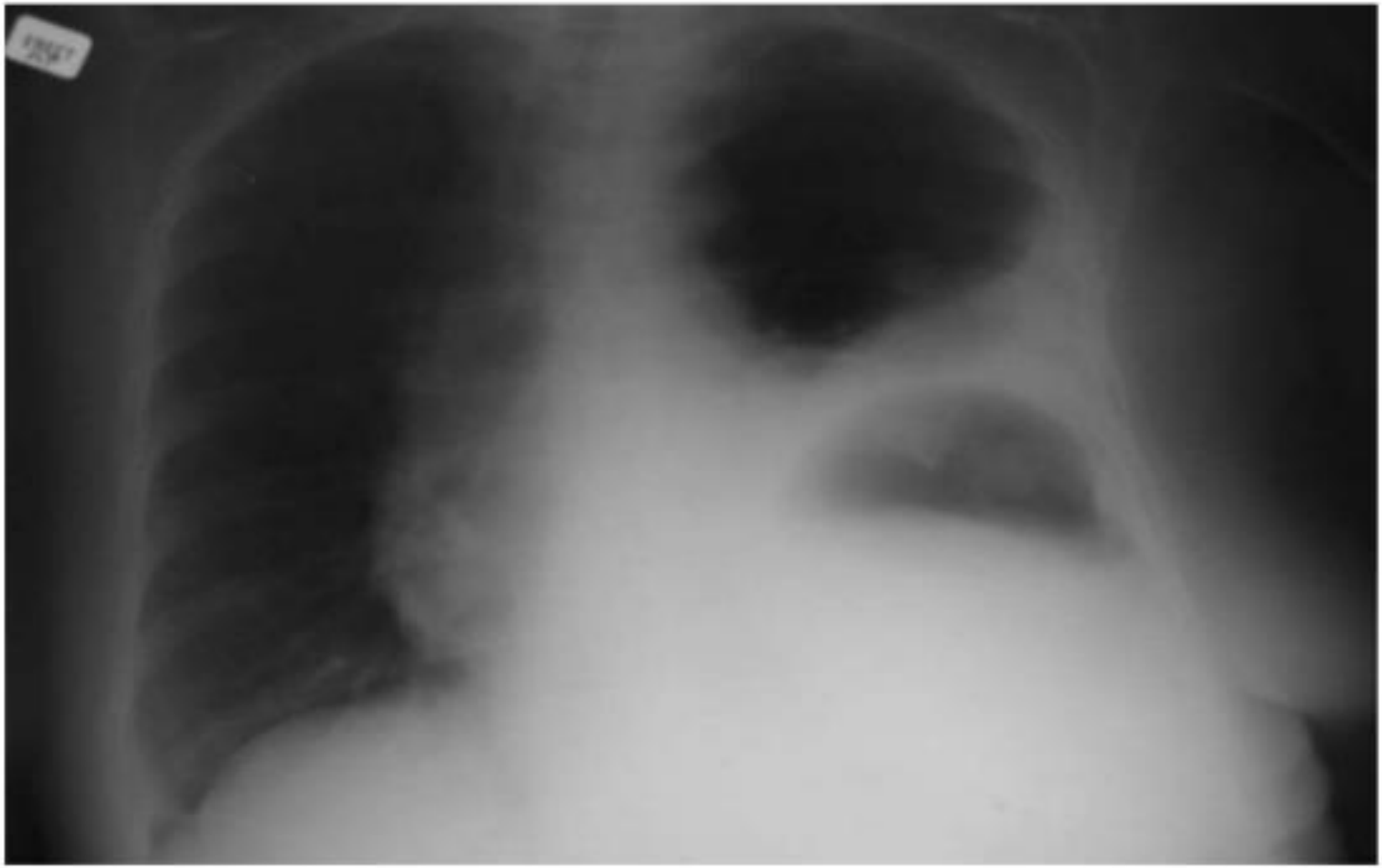
# Pathology of oesophagal injury.



# Diaphragmatic Rupture

- A tear in the Diaphragm that allows the abdominal organs enter the chest cavity
- Any penetrating injury to or below 5th intercostal space can cause diaphragmatic penetration & abdominal injury
- Blunt injury to the diaphragm is usually caused by a compressive force applied to the pelvis & abdomen.
- More common on Left side due to liver helps protect the right side of diaphragm
- Associated with multiple injury patients
- usually large, with herniation of the abdominal contents into the chest.

# Diaphragm Rupture



# S/S of Diaphragmatic Rupture

- Abdominal Pain
- Shortness of Air
- Decreased Breath Sounds on side of rupture
- Bowel Sounds heard in chest cavity

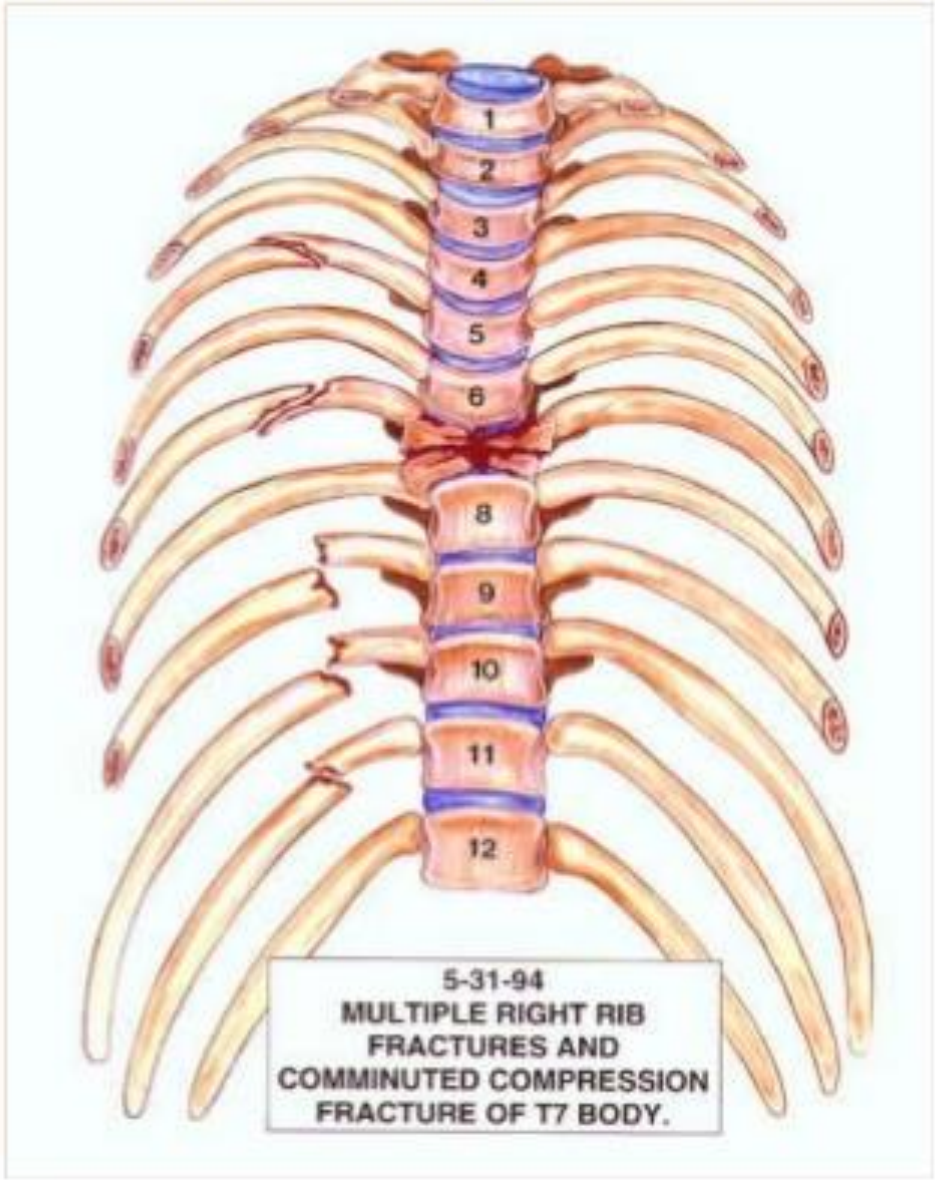
# Dx

- - Chest radiography after placement of a nasogastric tube, Contrast studies of the upper or lower gastrointestinal tract, CT scan & diagnostic peritoneal lavage.
- Most accurate evaluation is by video-assisted thoracoscopy (VATS) or laparoscopy.

# Treatment of Diaphragmatic Rupture

- .Operative Repair.
- Penetrating diaphragmatic injury must be repaired via the abdomen and not the chest, to rule out penetrating hollow viscus injury.
- Laproscopy can be done.

# Thoracic Spine Trauma



# INDICATIONS FOR THORACOTOMY

- Post-traumatic cardiovascular collapse
- Pericardial tamponade
- Vascular injury to the thoracic outlet
- Control of Hge from lung injury
- Massive Air leak
- Proved tracheobronchial injury
- Internal cardiac massage

# Types

- Emergency / Resuscitative Thoracotomy.

  For bleeding control.

- Planned Thoracotomy.

  For repair of specific injury

# Approaches

- Median Sternotomy.
- Anterolateral Approach.

# Median Sternotomy

- Anterior aspect of the heart
- Anterior mediastinum
- Ascending and arch of aorta
- Pul. Arteries
- Trachea.. Carina

# Lt A/L Thoracotomy

- Lt lung and hilum
- Thoracic Aorta
- Origin of Lt Sub clavian artery
- Lt side of the heart
- Lower esophagus

# Summary

- Chest Injuries are common and often life threatening in trauma patients. So, Rapid identification and treatment of these patients is paramount to patient survival. Airway management is very important and aggressive management is sometimes needed for proper management of most chest injuries.

# When Minutes Matter


# The END