



SOCIETY OF TRAUMA NURSES

# THE ELECTRONIC LIBRARY OF TRAUMA LECTURES



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# TRAUMA LECTURES

## Thoracic Trauma



SOCIETY OF TRAUMA NURSES



# Objectives

**At the conclusion of this presentation  
the participant will be able to:**

- Identify anatomy within the thorax
- List life-threatening injuries that should be identified during the primary survey
- Describe resuscitative interventions for patients with thoracic trauma
- Explain clinical manifestations associated with life-threatening injuries
- Identify general treatment for patients with thoracic trauma

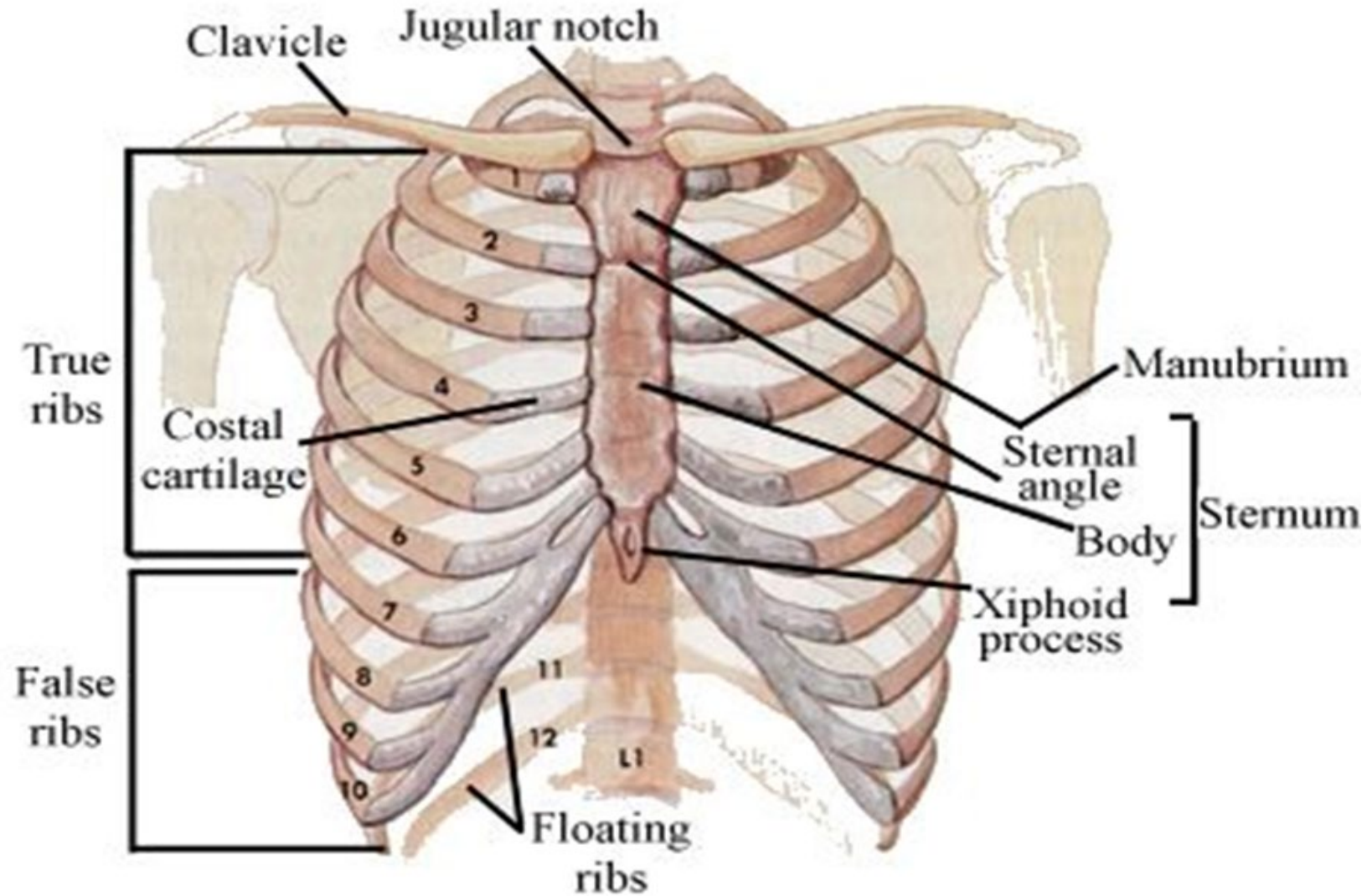


# Incidence

- Common in blunt and penetrating trauma
- Some of the most deadly and dramatic injuries
- Early recognition and treatment are crucial
- Basic interventions can save lives

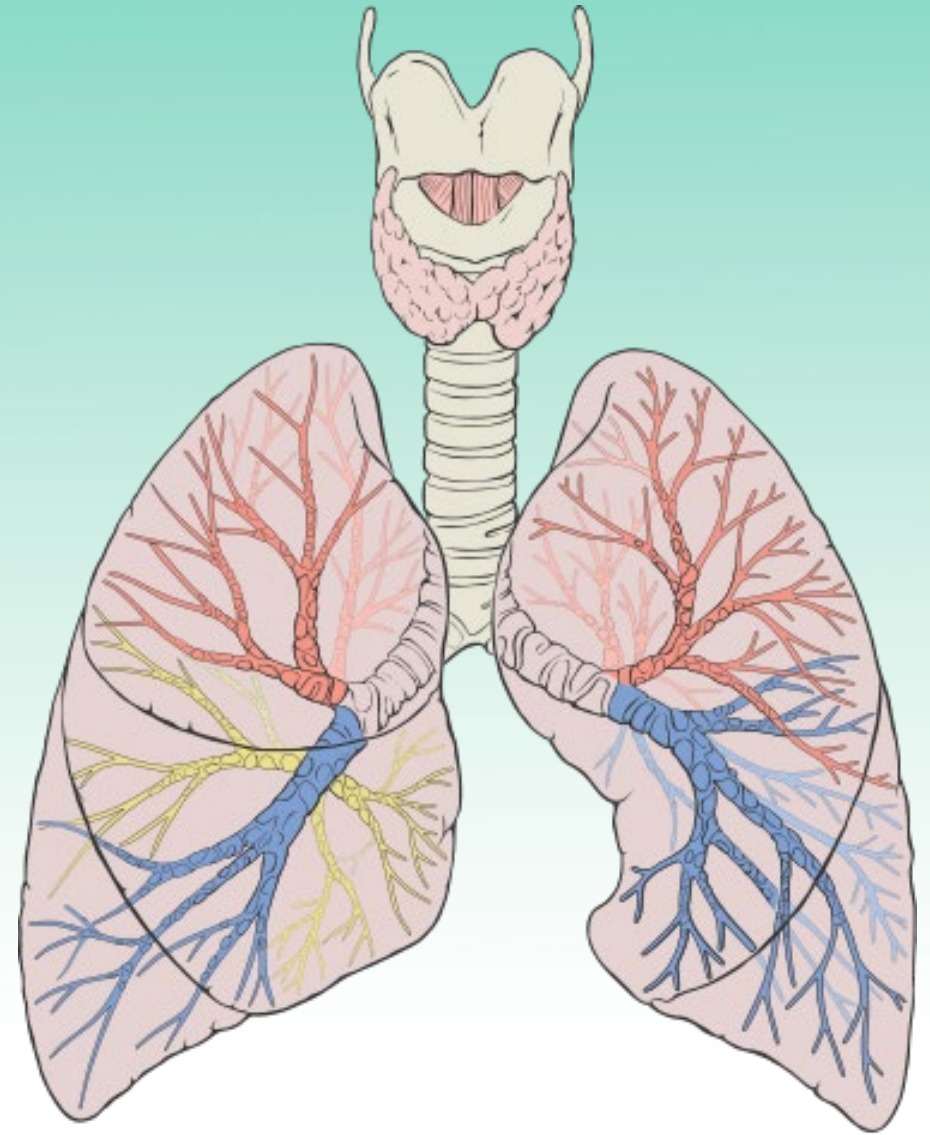


# Thoracic Anatomy



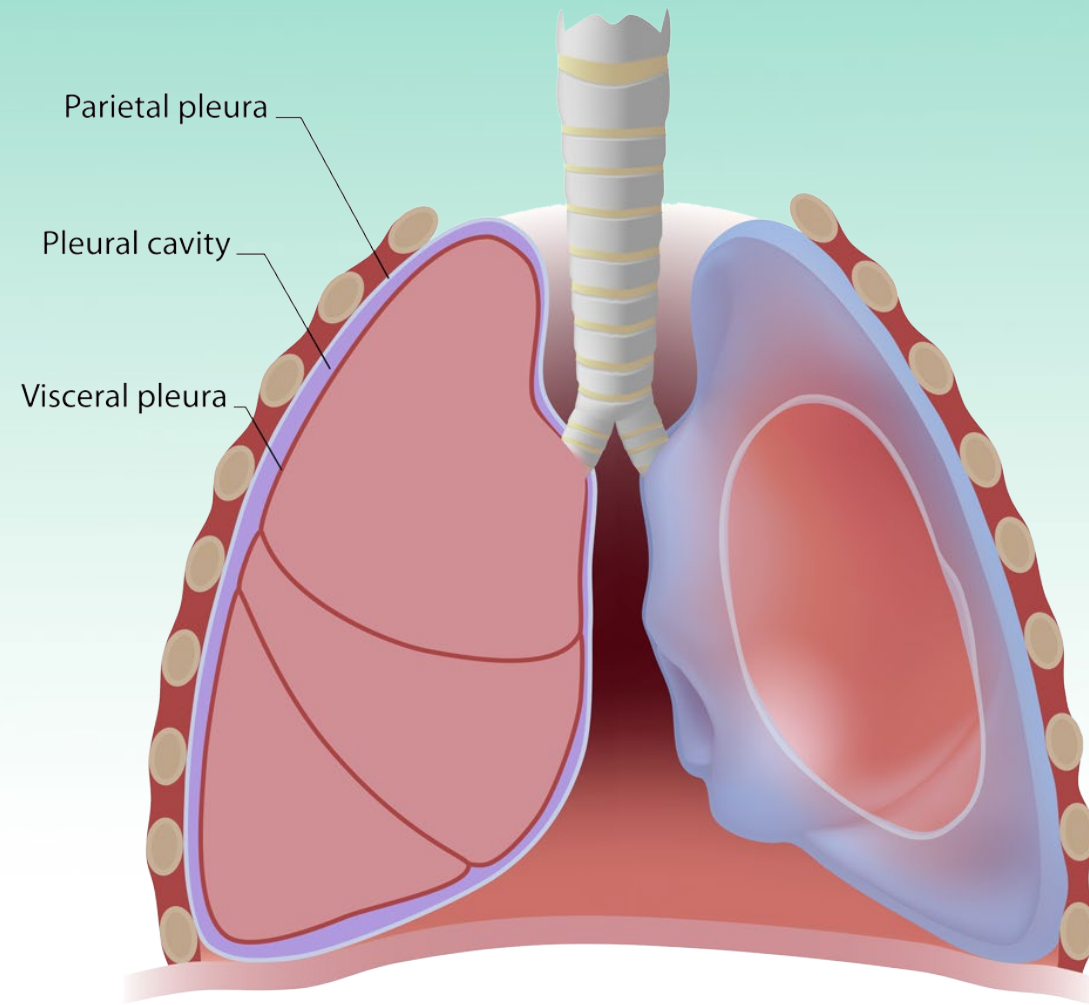
# Lungs

- Cone shaped organs
- Separated by heart and pulmonary vessels
- Hilum is entry point for bronchi and blood vessels



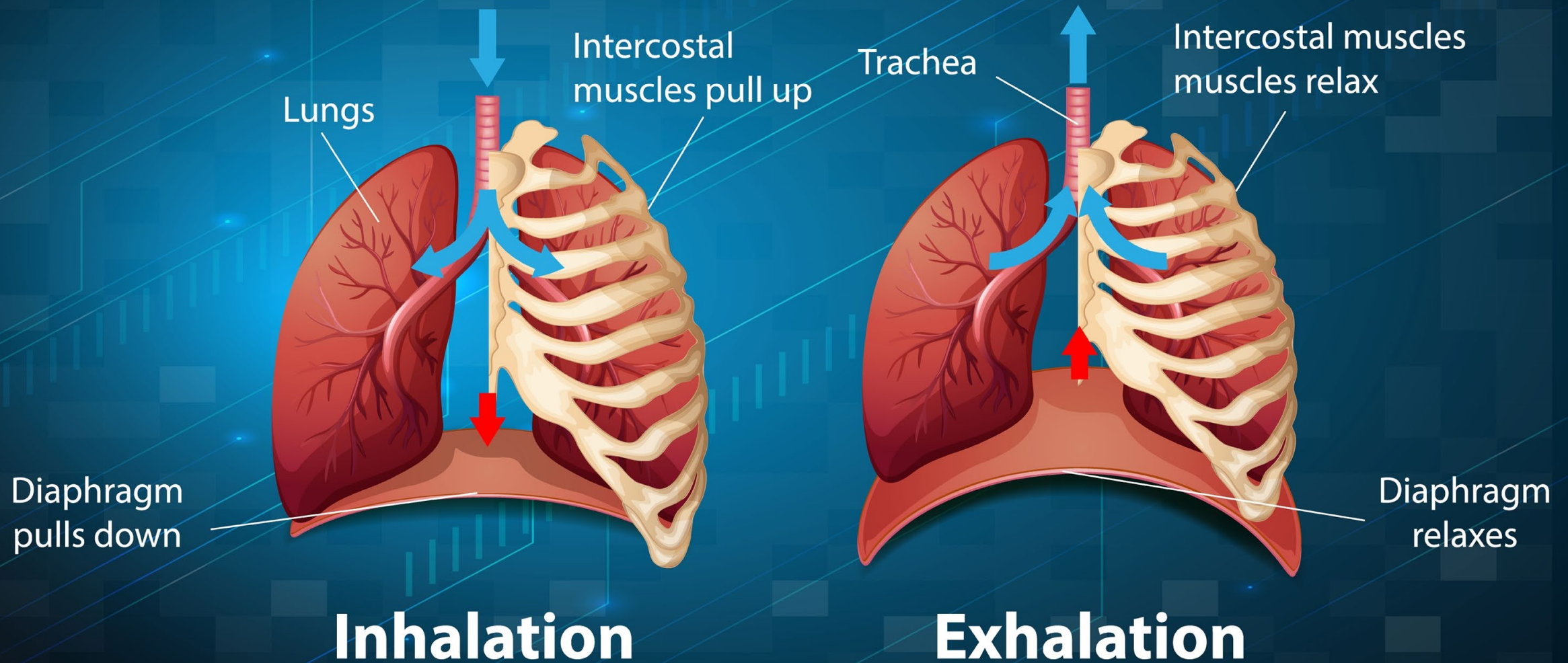
Patrick J. Lynch, medical illustrator, CC BY 2.5 <<https://creativecommons.org/licenses/by/2.5>>, via Wikimedia Commons

# Pleura





# THE DIAPHRAGM FUNCTIONS IN BREATHING



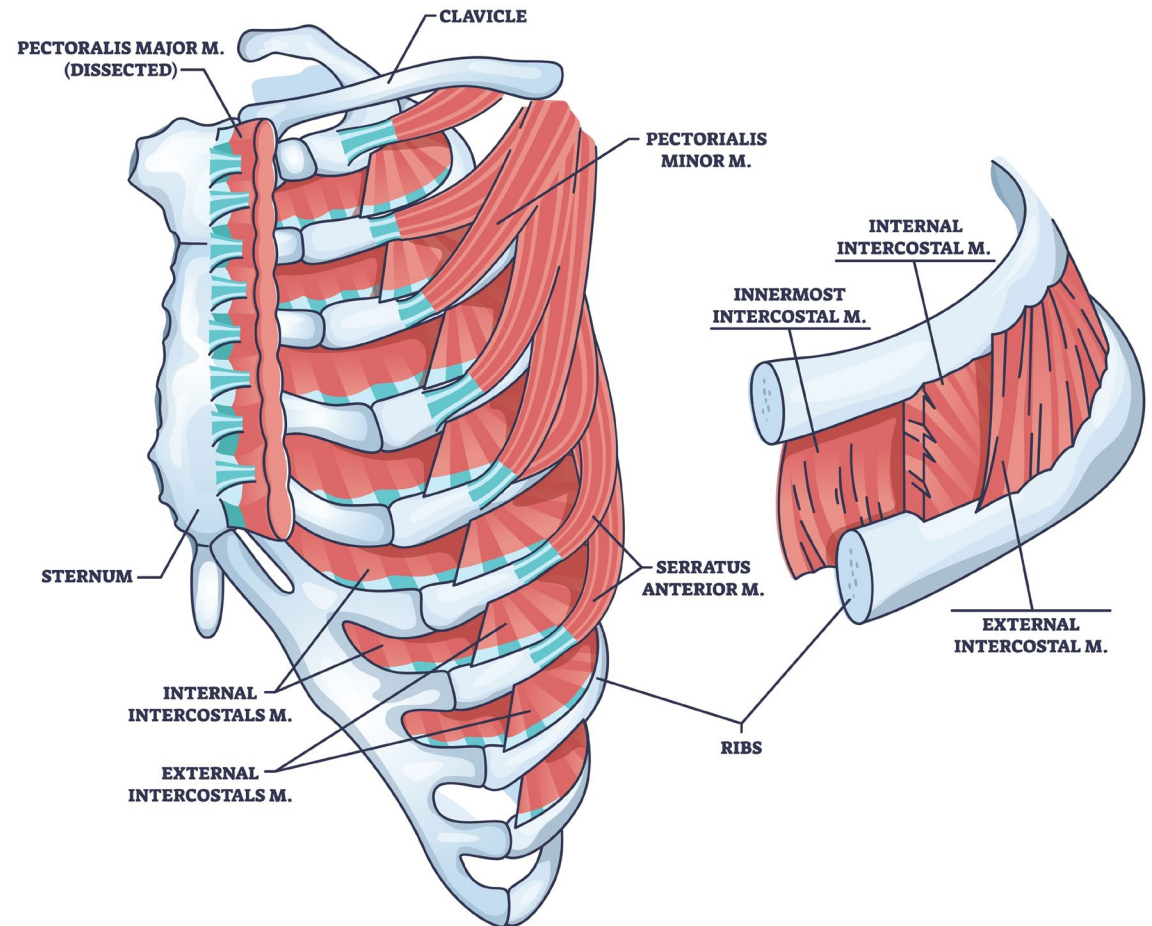
# Muscles of Ventilation

## Rib cage muscles

- **Intercostal muscles**
  - External & internal
  - Lift ribs to enlarge thorax
  - Innervated by intercostal nerves
- **Parasternal muscles**
- **Scalene and neck**

## Abdominal muscles

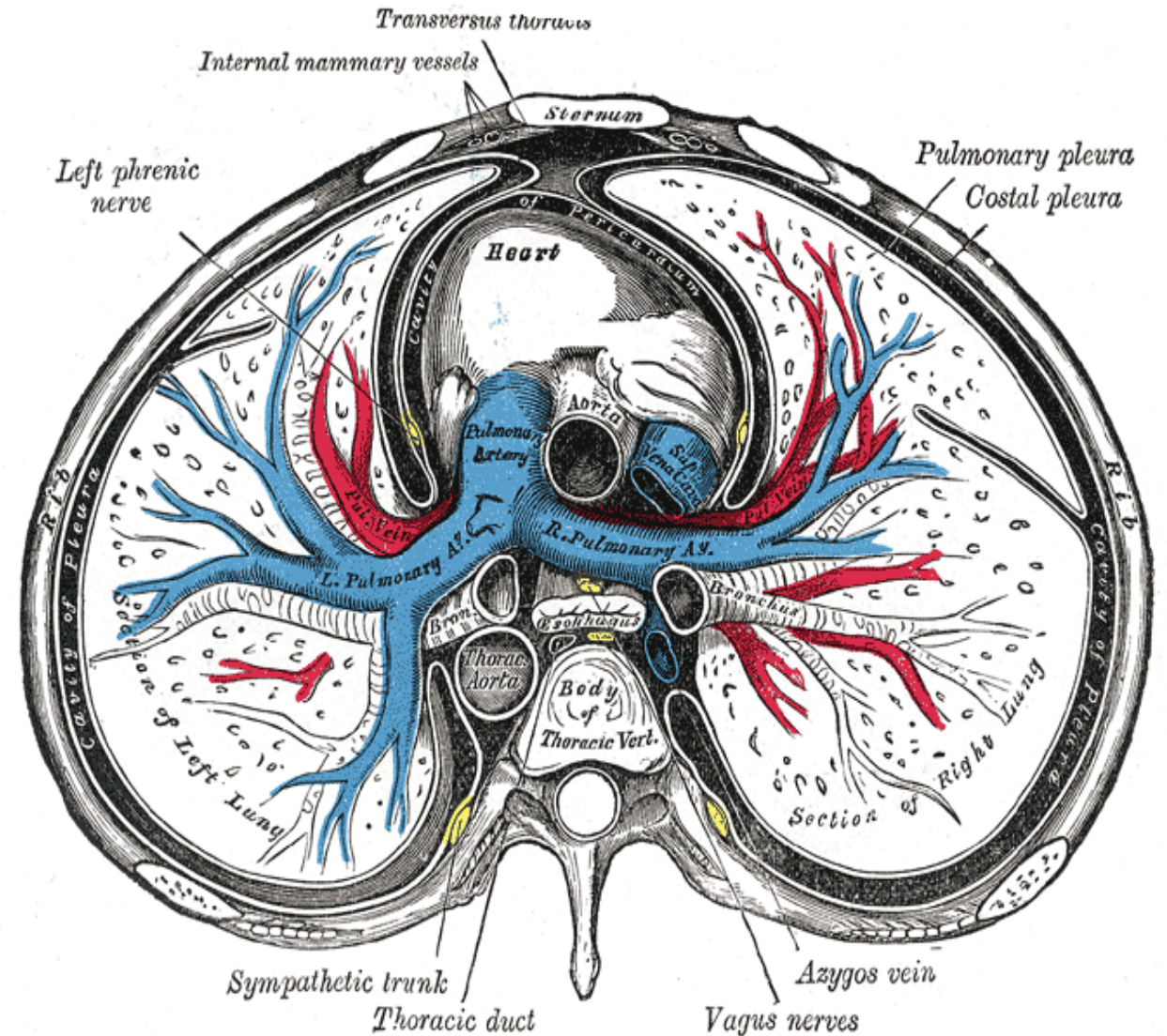
## INTERCOSTAL MUSCLES





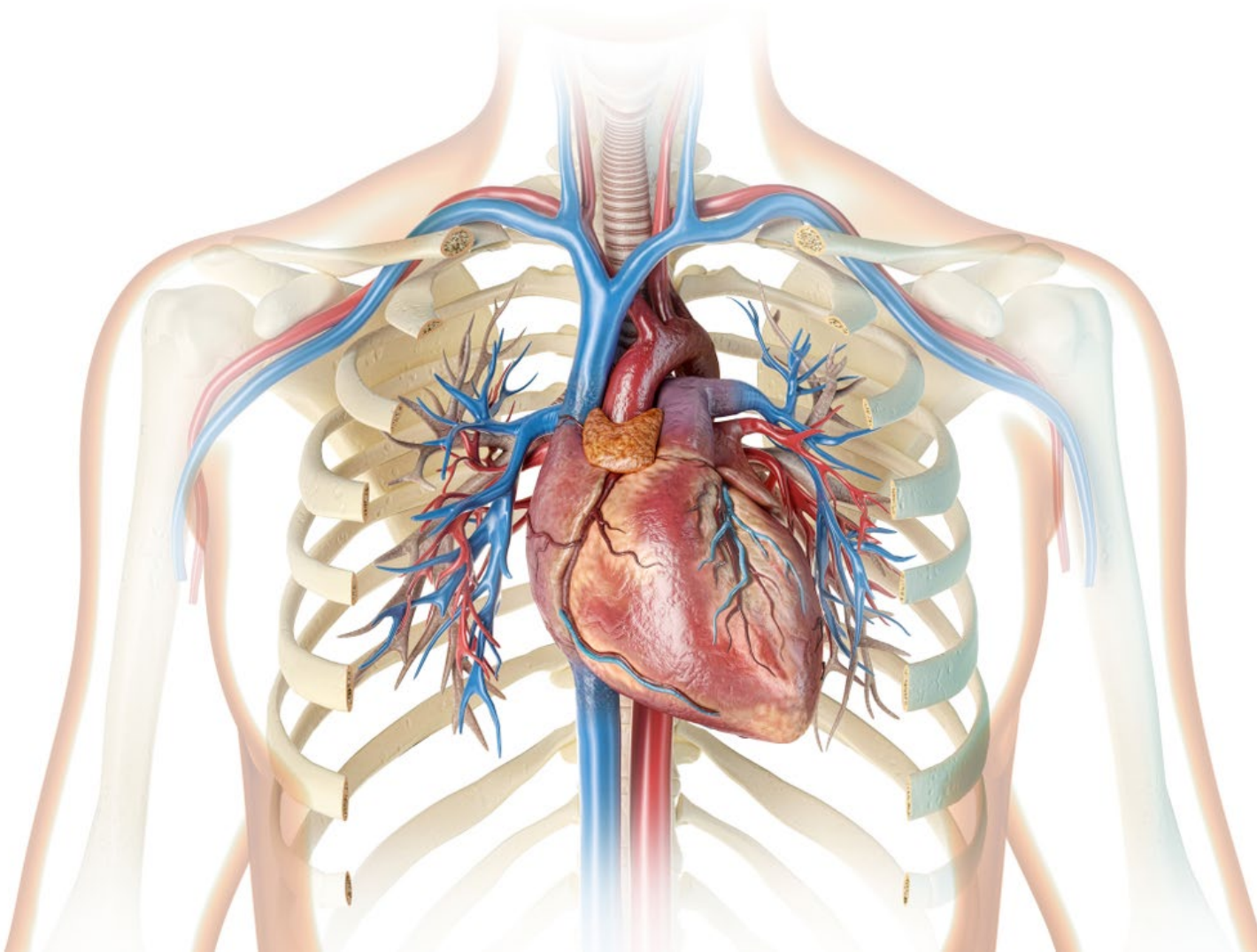
# Mediastinum

- Heart
- Thymus
- Great Vessels
- Trachea
- Thoracic duct
- Lymph nodes
- Vagus & phrenic nerves
- Sympathetic trunks





# Heart and Great Vessels

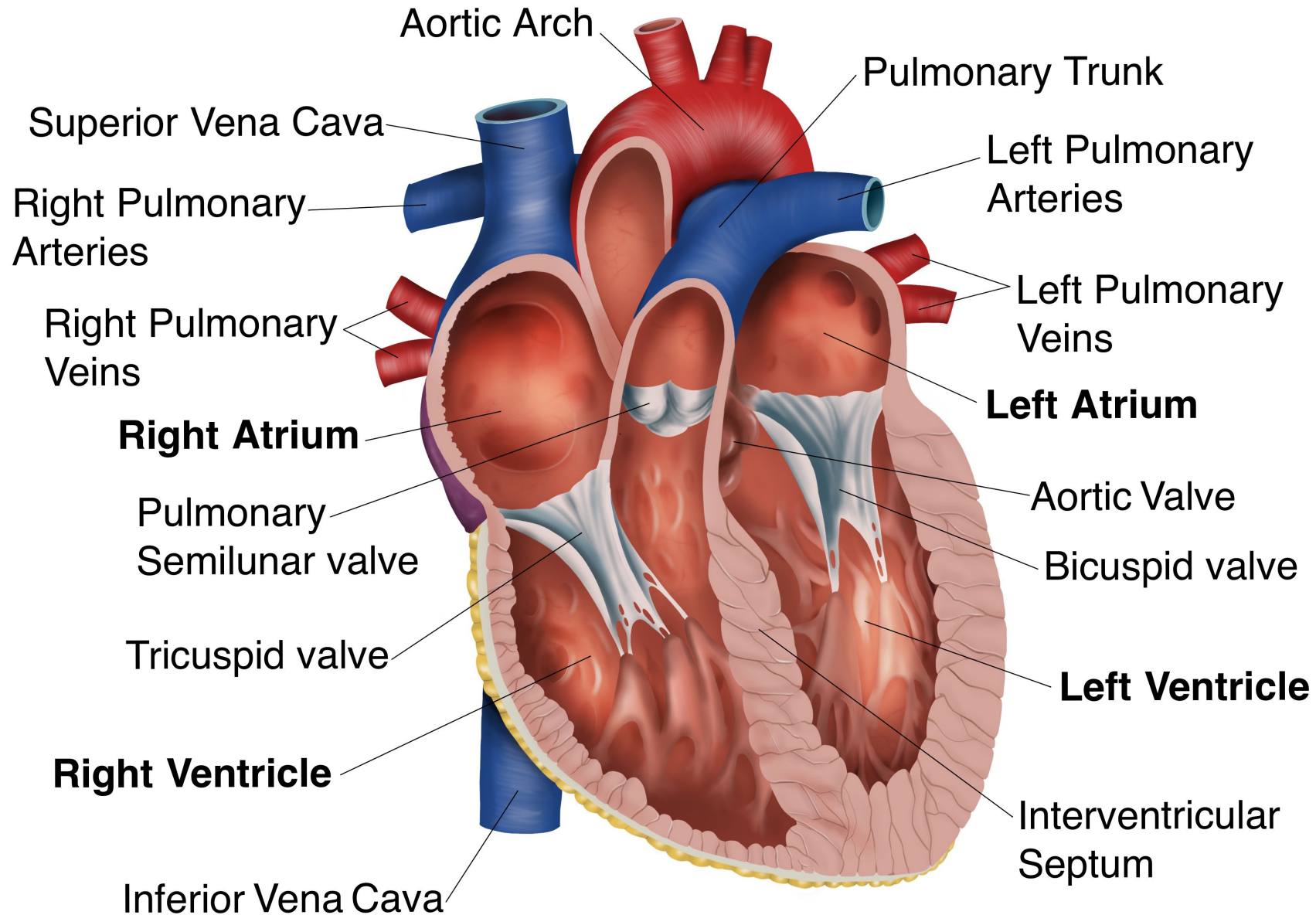


Heart

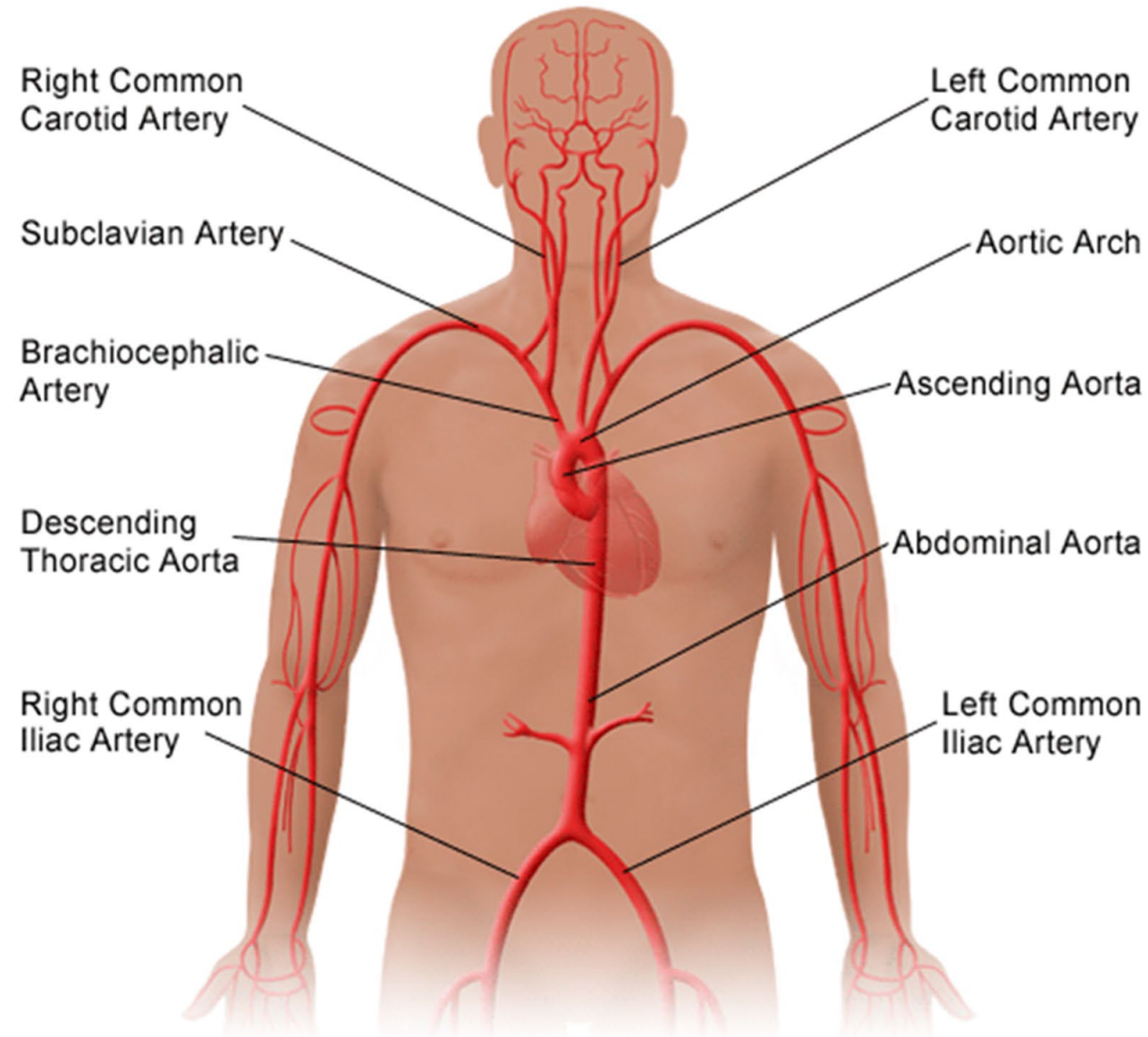
Aorta

Subclavian

Jugular

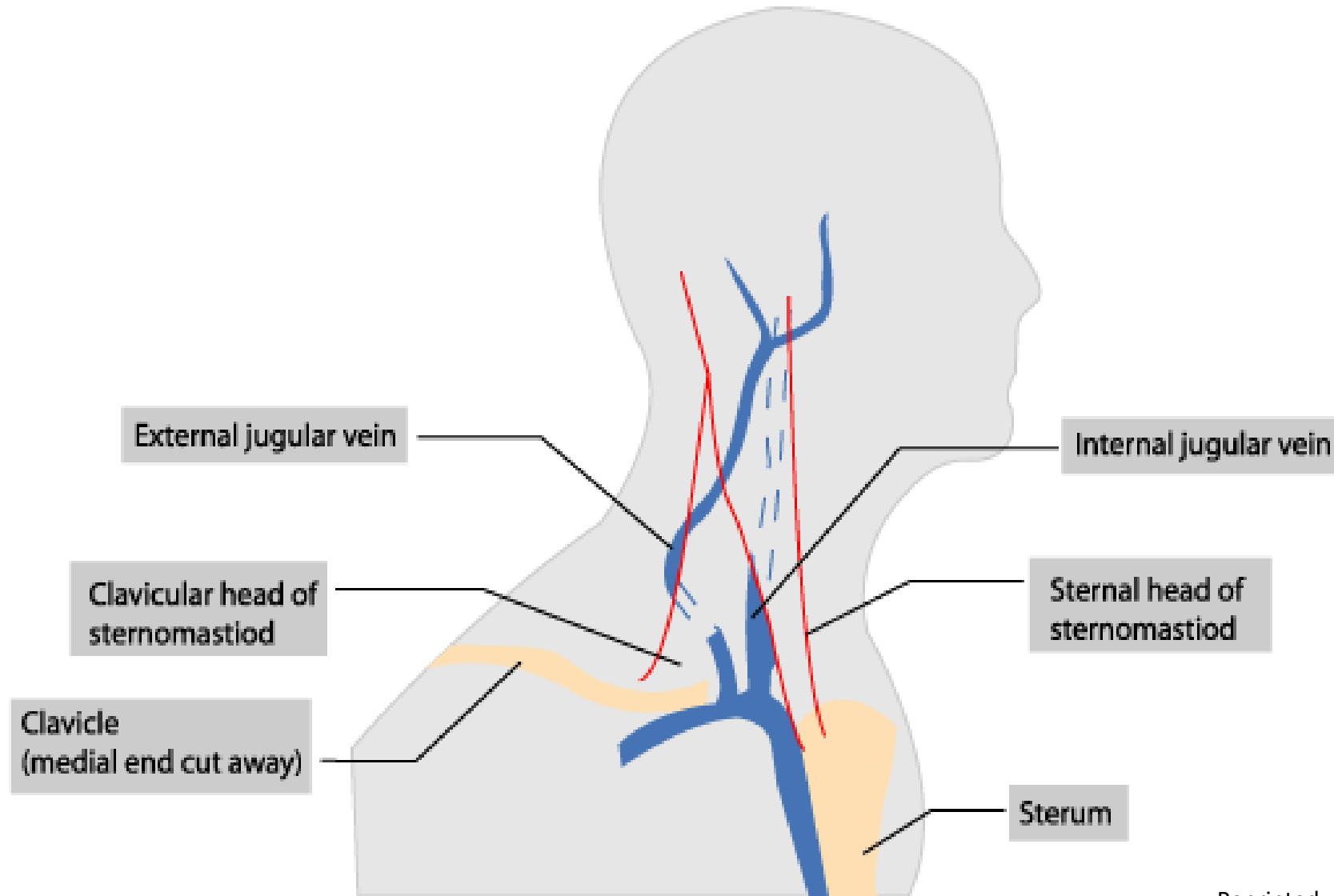


# Anatomy of the Aorta

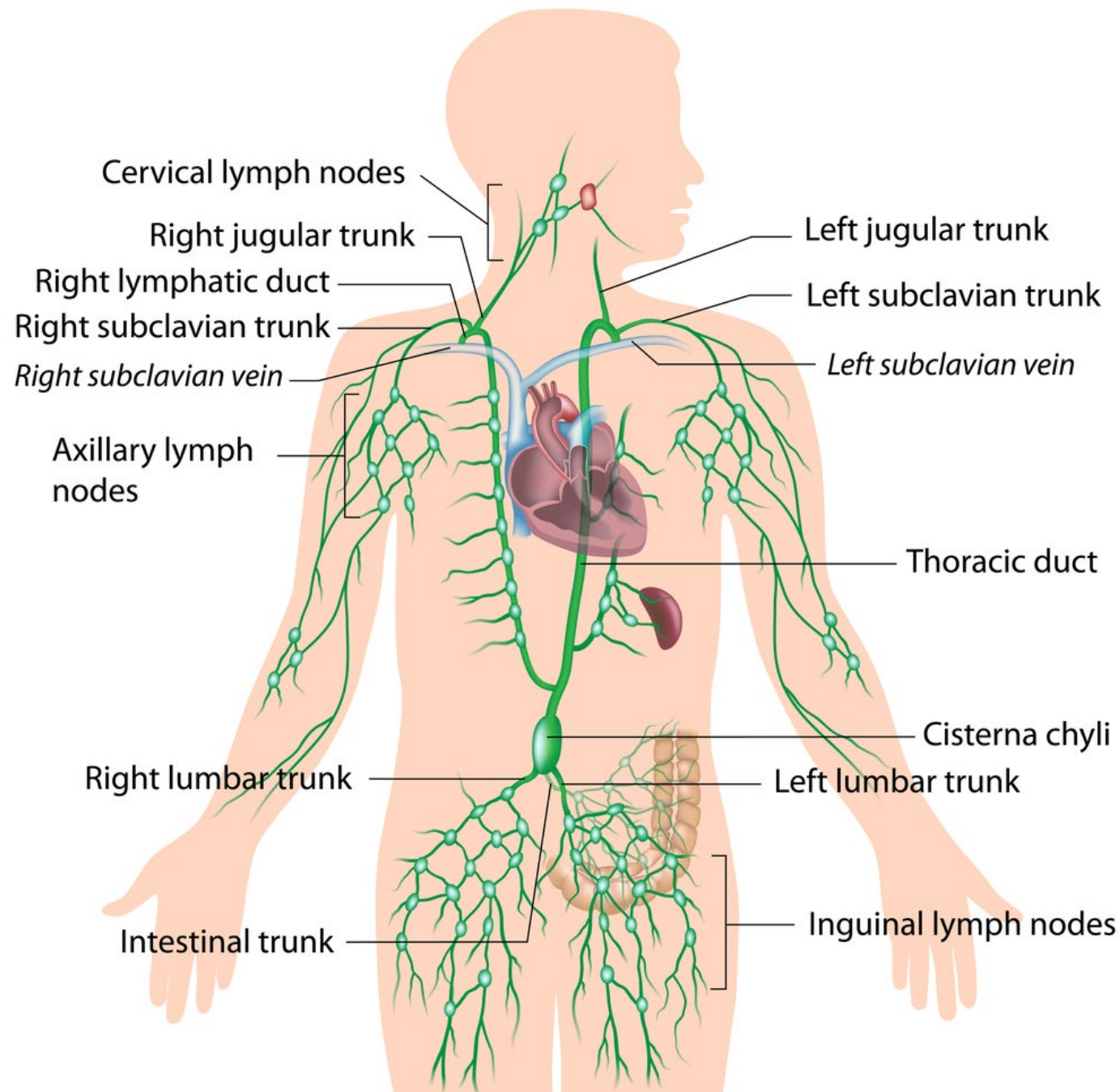




# Jugular Veins



# Thoracic Duct



- Lymphatic Duct
- Empties into venous system
- Protected by spine posteriorly
- Mediastinum anteriorly

# Thoracic Assessment

- Primary & Secondary Survey with ABC's
- Interventions for any life-threatening injuries

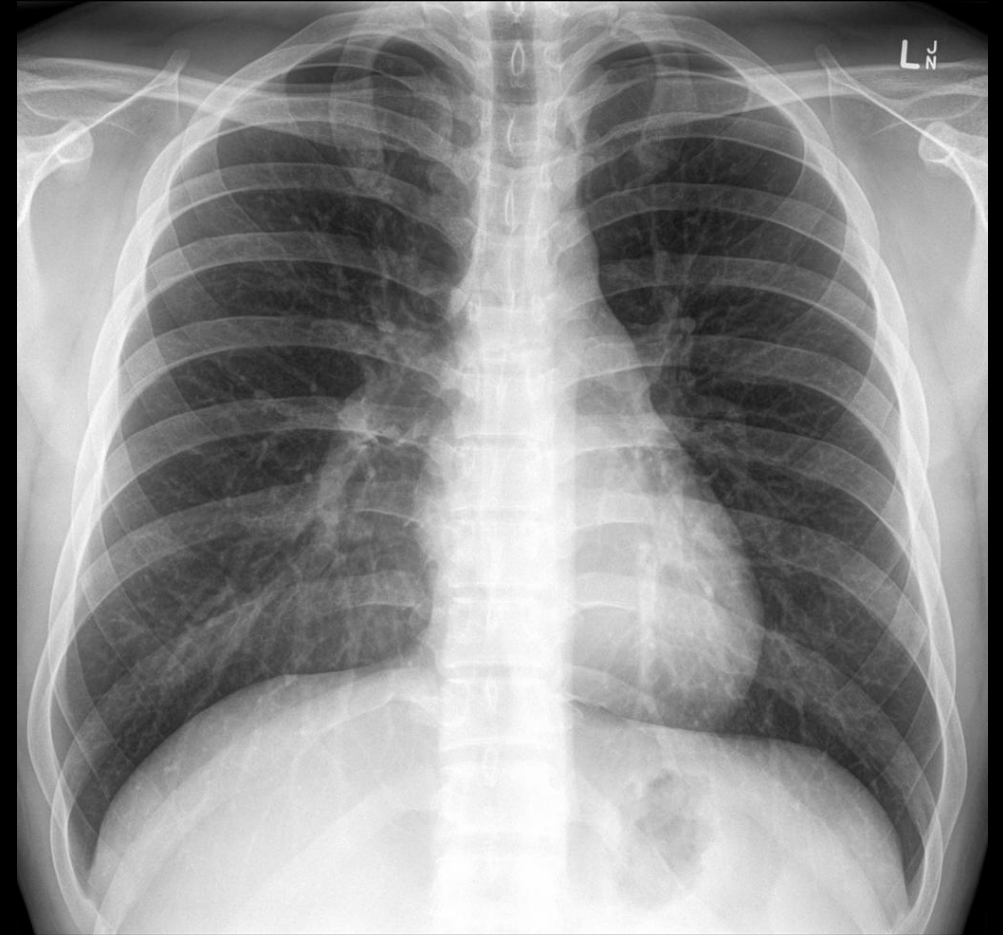






# Diagnostics

- Chest X-Ray
- Focused Assessment with Sonography for Trauma (FAST)
- Computed Tomography
- Arteriography and other diagnostics











# Immediately Life Threatening

- Airway obstruction
- Tracheobronchial tree Injury
- Tension pneumothorax
- Open pneumothorax
- Massive hemothorax
- Cardiac tamponade
- Traumatic circulatory arrest



# Airway Obstruction

High index of suspicion if:

- Secretions/blood/vomitus in airway
- Direct laryngeal/neck trauma
- Expanding neck hematoma

# Symptoms

- Tachypnea
- Hypoxia
- Agitation
- Hoarseness and dysphonia
- Stridor
- Subcutaneous emphysema
- Palpable fracture crepitus
- Low oxygen saturation (late sign)





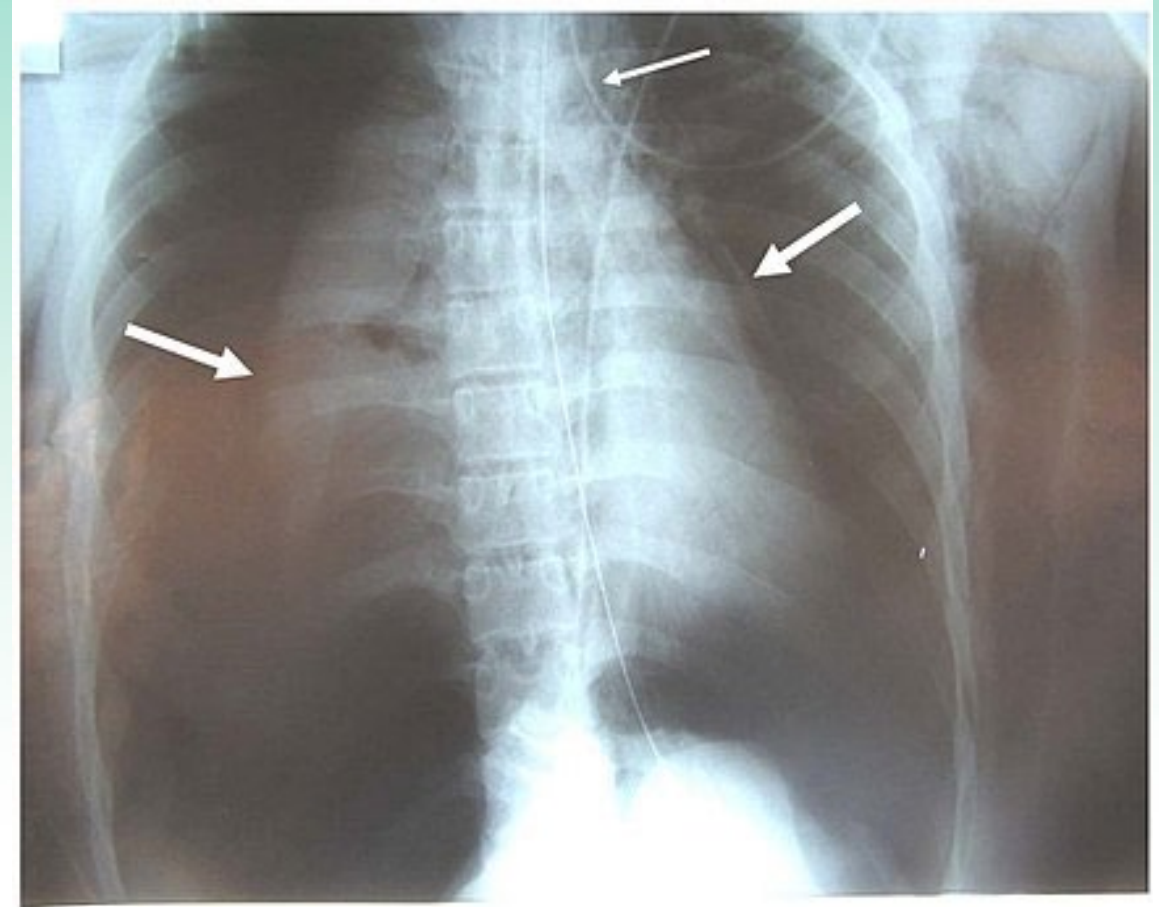


# Treatment

- Control airway in primary survey
- Utilize adjuncts
- Intubate cautiously or perform a tracheostomy

# Tracheobronchial Tree Injury

- Dyspnea and respiratory distress
- Hemoptysis
- Cervical subcutaneous emphysema
- Tension pneumothorax
- Cyanosis
- Dysphonia
- Hoarseness



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# Tracheobronchial Tree Injury

## Treatment

- Chest tube placement
- Bronchoscopy
- Immediate surgical intervention



# Tension Pneumothorax

Increase in intrapleural pressure



Collapsed lung on affected side

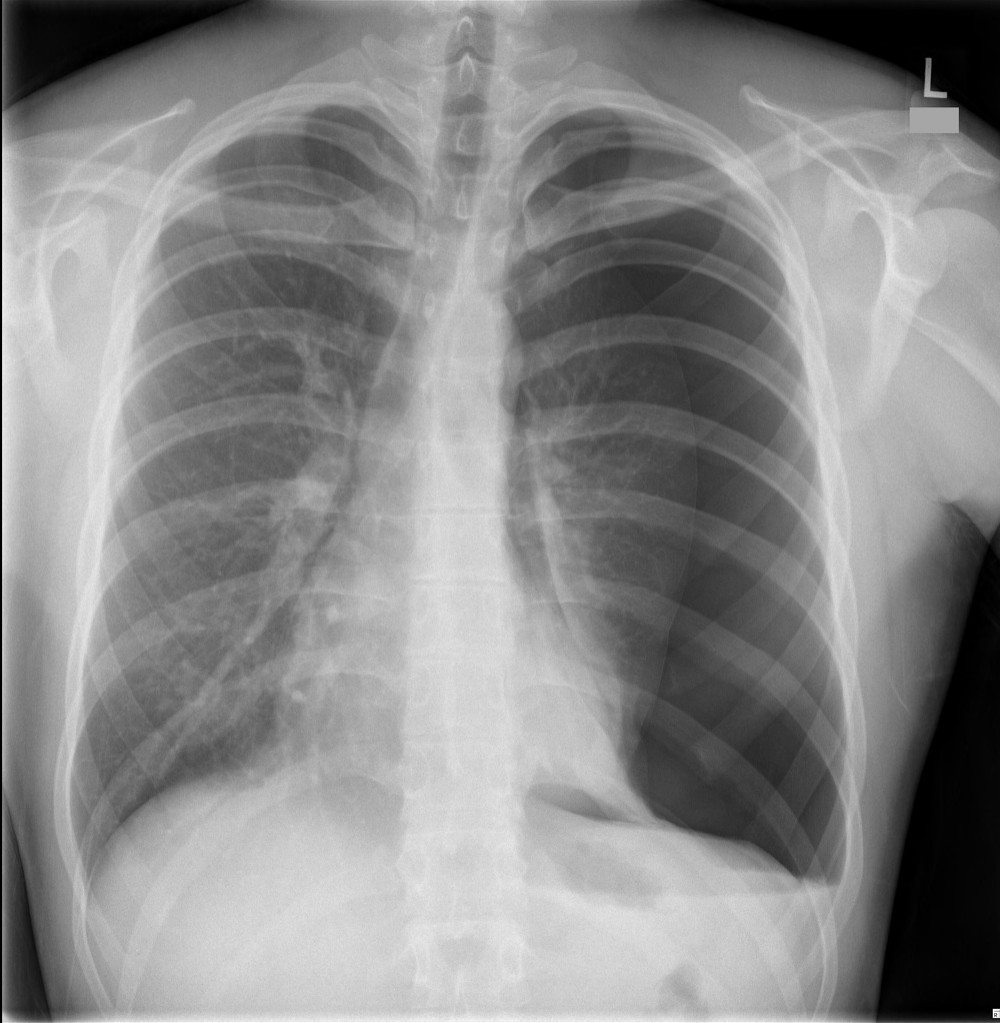


Shift mediastinum to opposite side



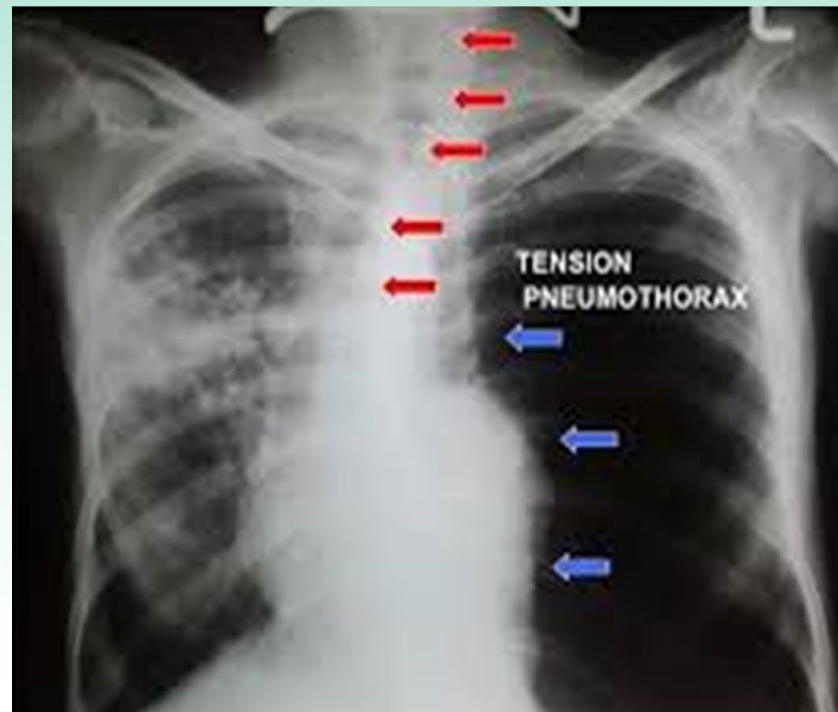
High intrathoracic pressures

# Risk for Tension Pneumothorax



- Extension from simple pneumothorax
- Tracheobronchial tree injuries
- Rib fractures
- Lung parenchyma injury
- Barotrauma
- Clogged/clamped chest tube

# Simple vs. Tension PTX







# Tension Pneumothorax

## Symptoms

- Respiratory distress
- Absent/decreased breath sounds on affected side
- Asymmetric chest movement
- Jugular vein distention
- Tracheal deviation (late sign)
- Shock (late sign)
- Diagnosis should be made on clinical presentation

# Tension Pneumothorax

## Treatment

- Immediate needle decompression
  - Large-caliber needle
  - Between 4<sup>th</sup> and 5<sup>th</sup> intercostal space midaxillary line
- Chest tube insertion
  - Tube thoracostomy
  - Insert at 4<sup>th</sup> or 5<sup>th</sup> intercostal space between the anterior and midaxillary line



# Open Pneumothorax

## “Sucking Chest Wound”

- Pain
- Difficulty breathing
- Tachypnea
- Decreased breath sounds on the affected side
- Noise movement of air





# Open Pneumothorax

## Treatment

- Chest tube is the emergent treatment.
- Monitor for re-expansion of lung or for development of tension pneumothorax.



# Massive Hemothorax

- Accumulation of a large amount of blood ( $> 1.5$  L) in the pleural space
- Common in penetrating trauma with hilar or systemic vessel disruption
- May be caused by major blunt chest trauma
- CXR will show unilateral “white out”





# Massive Hemothorax

## Treatment

- Chest tube placement
- Set up for autotransfusion if appropriate
- Administer blood as indicated
- Potential thoracotomy

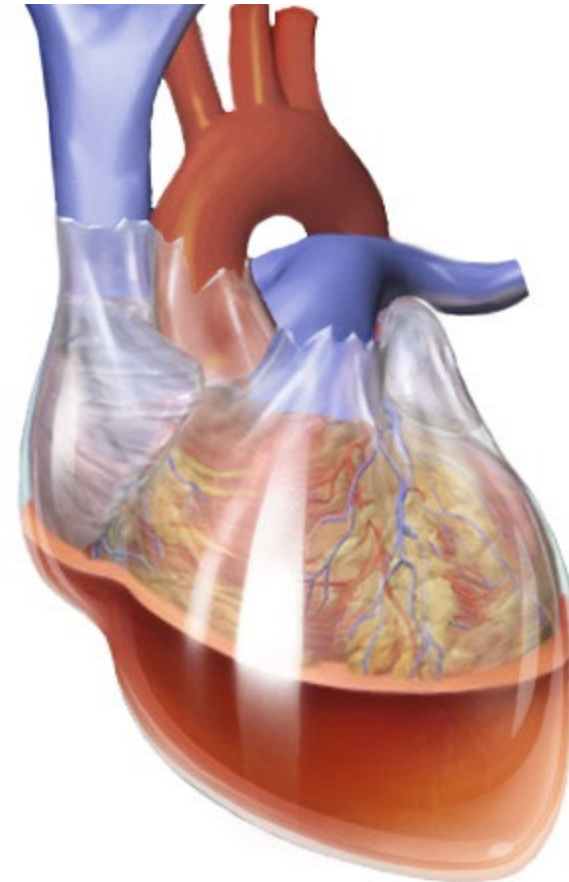


# Cardiac Tamponade

Commonly result of penetrating trauma

## Symptoms:

- Reluctant to lie flat
- Feeling of “impending doom”
- May have “Beck’s triad”
  - Distended neck veins
  - Hypotension
  - Muffled heart sounds
- +Fast exam



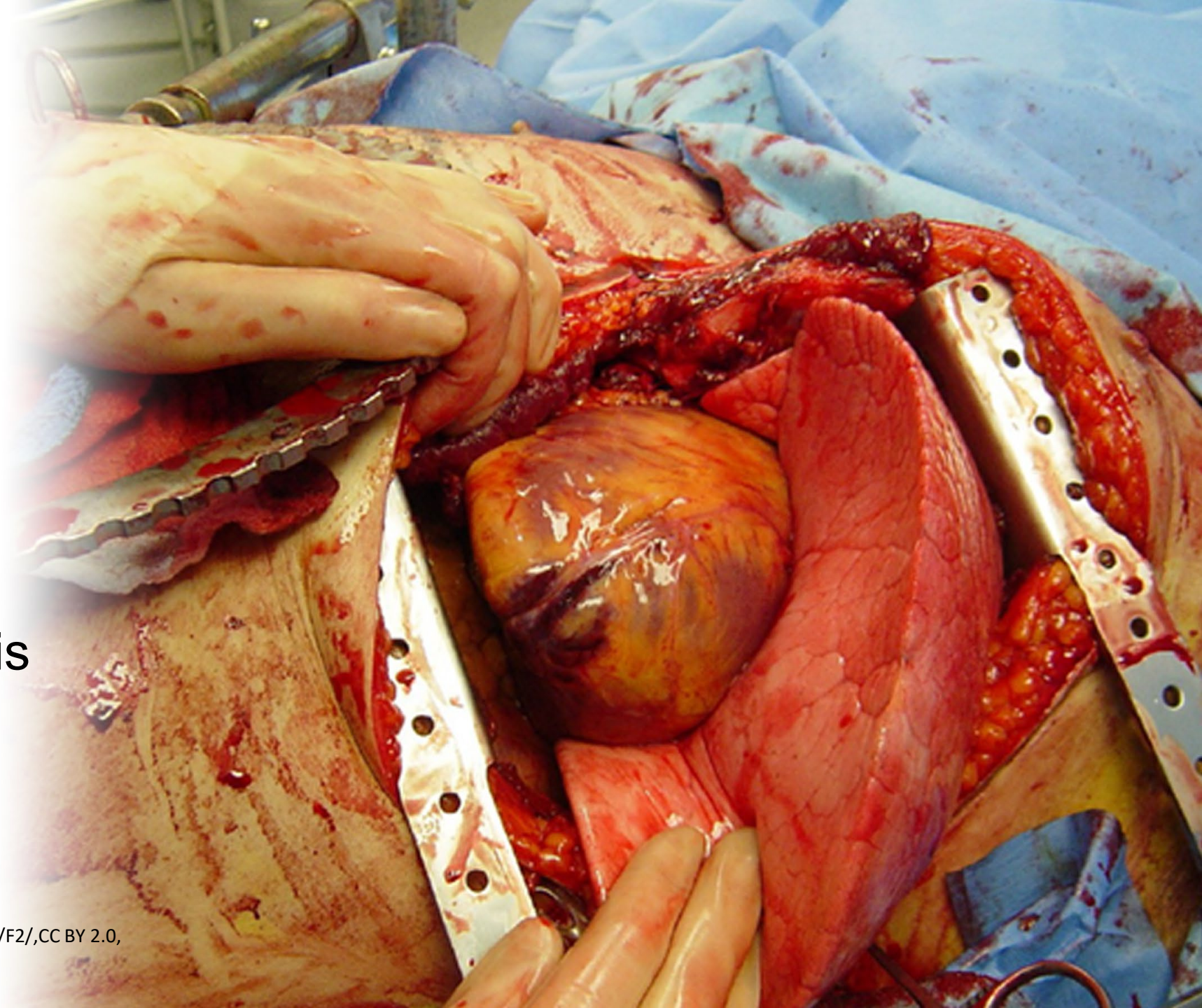
# Cardiac Tamponade



# Cardiac Tamponade

## Treatment

- Emergent thoracotomy or sternotomy
- Pericardiocentesis



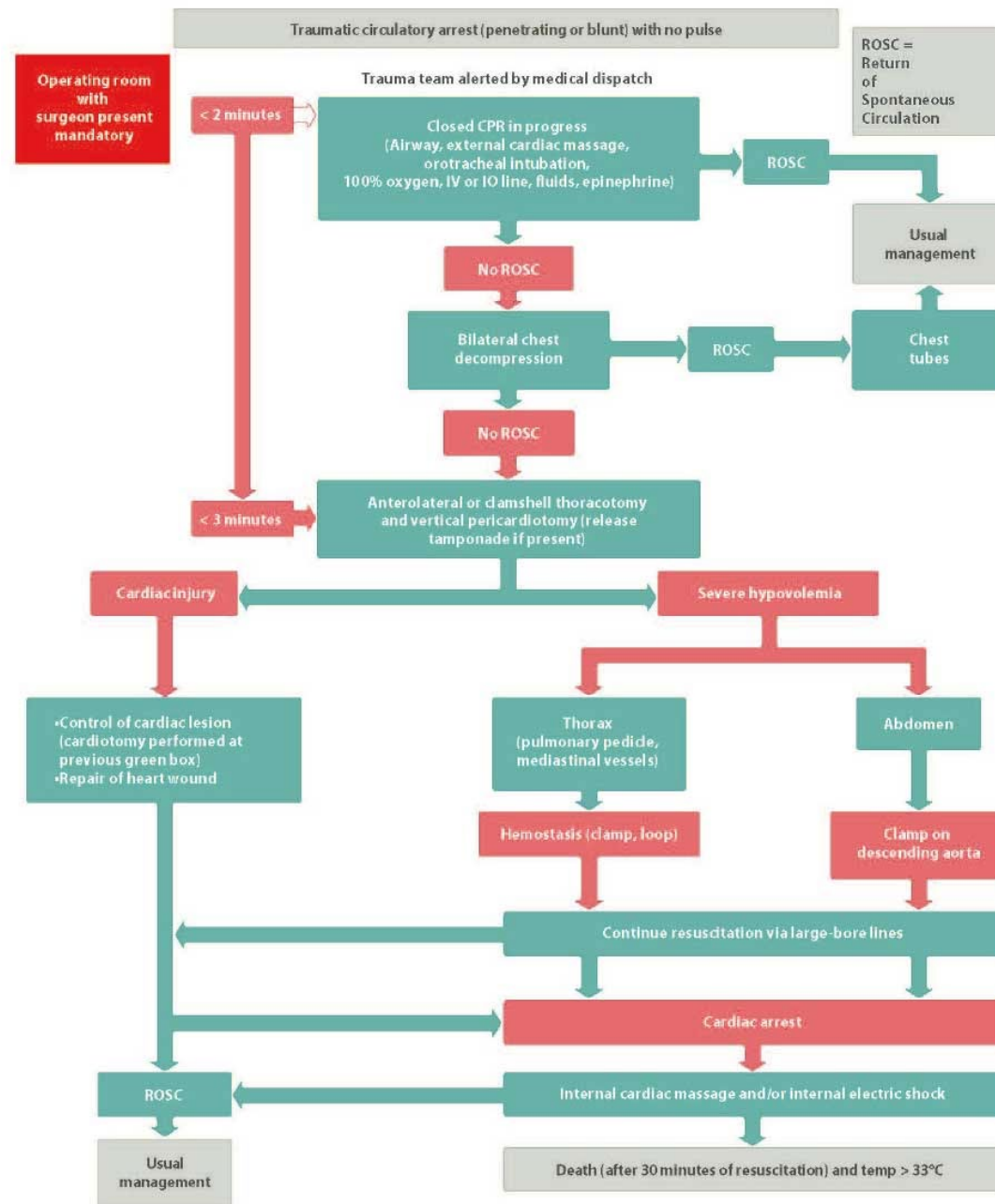




# Traumatic Circulatory Arrest

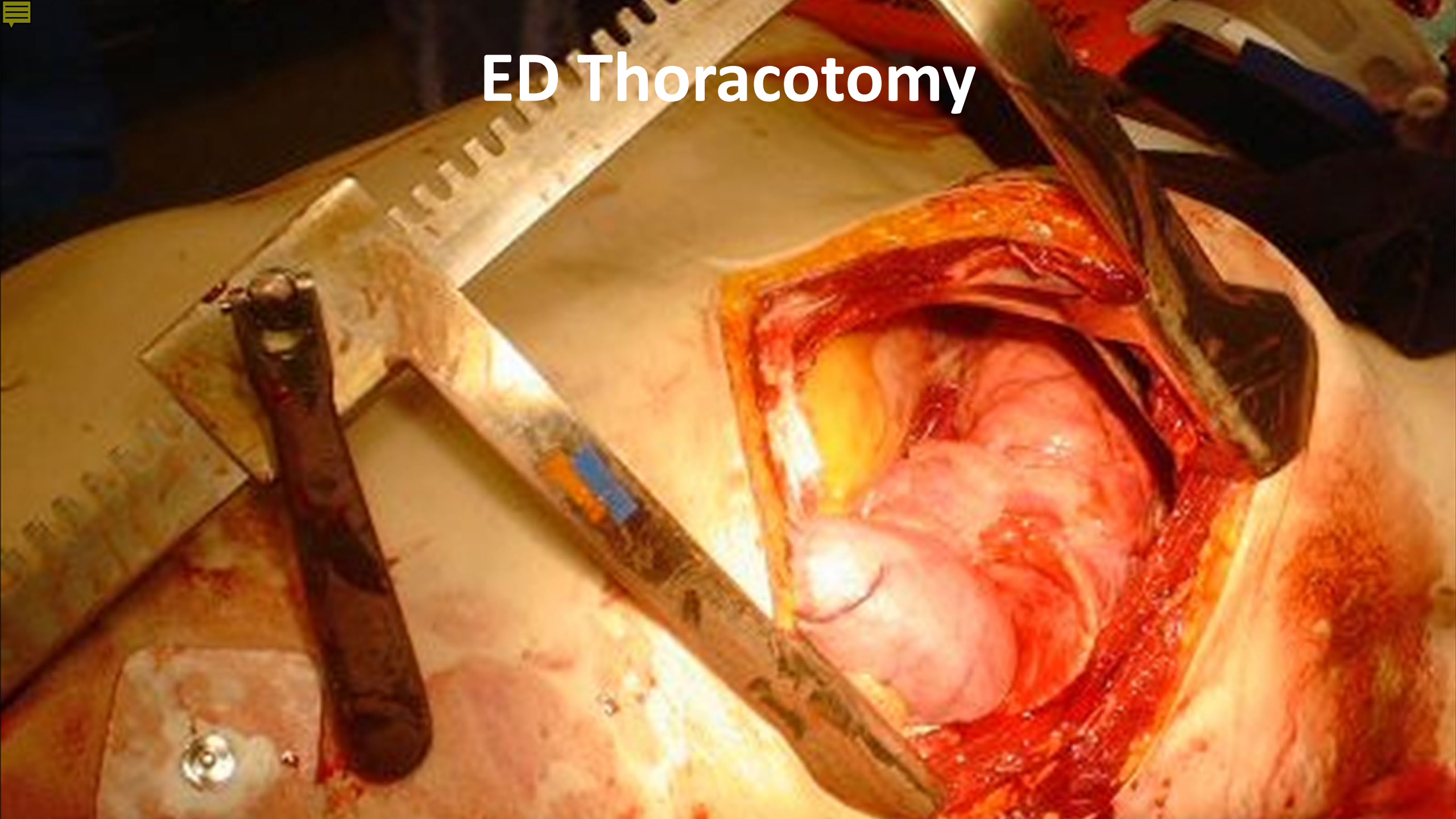
## Causes:

- Severe hypoxia
- Tension pneumothorax
- Profound hypovolemia
- Cardiac tamponade
- Cardiac herniation
- Severe myocardial contusion



Algorithm for management of traumatic circulatory arrest. ECM = external cardiac massage; OTI = orotracheal intubation; IVL = intravenous line; IOL = intraosseous line.

# ED Thoracotomy







# Potentially Life Threatening

**Pneumothorax**

**Hemothorax**

**Pulmonary Contusion**

**Flail Chest**

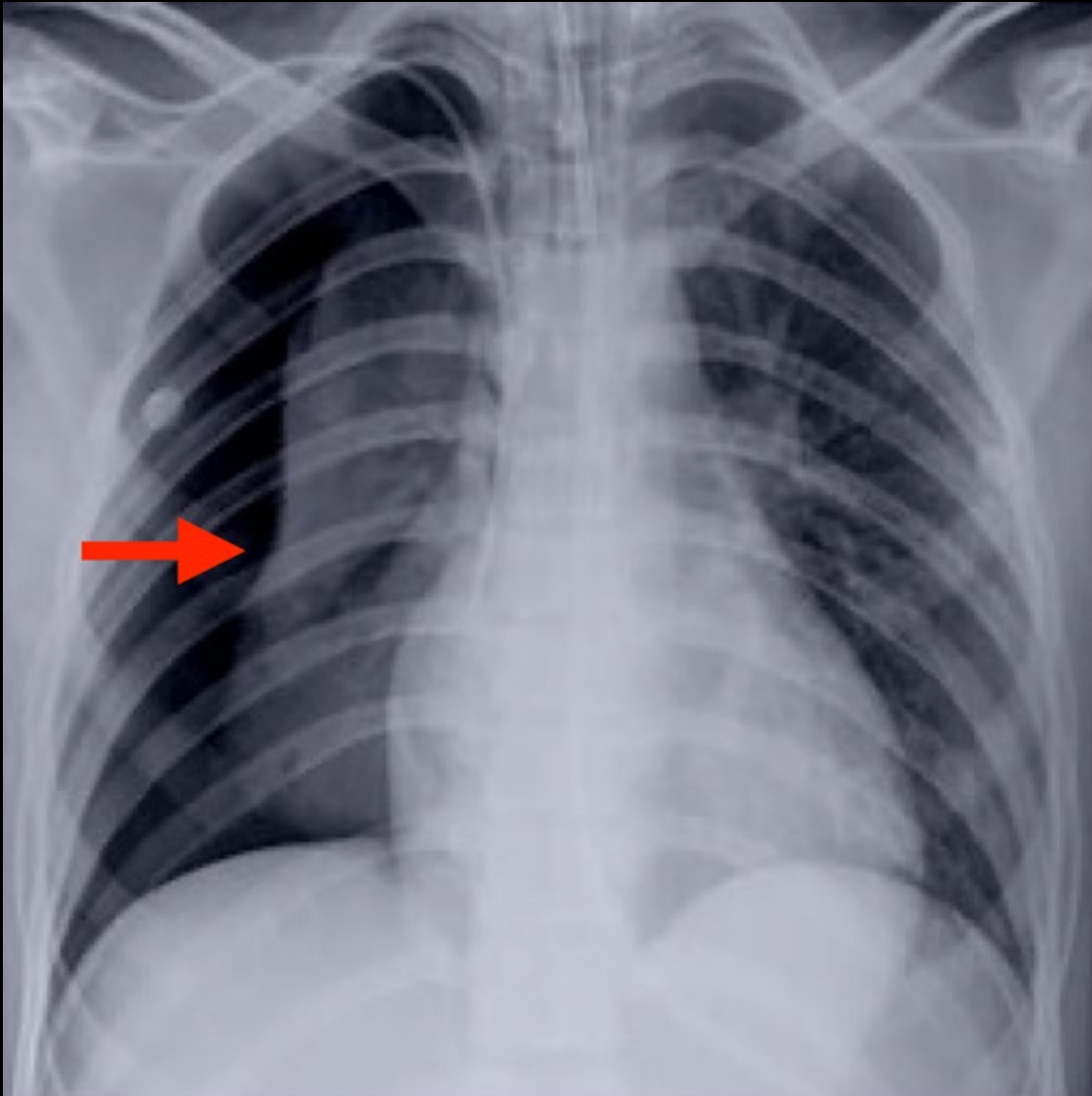
**Blunt Cardiac Injury**

**Aortic Disruption**

**Diaphragmatic Injury**

**Esophageal Rupture**

# Pneumothorax



## **Etiology:**

- **Blunt**
- **Penetrating**

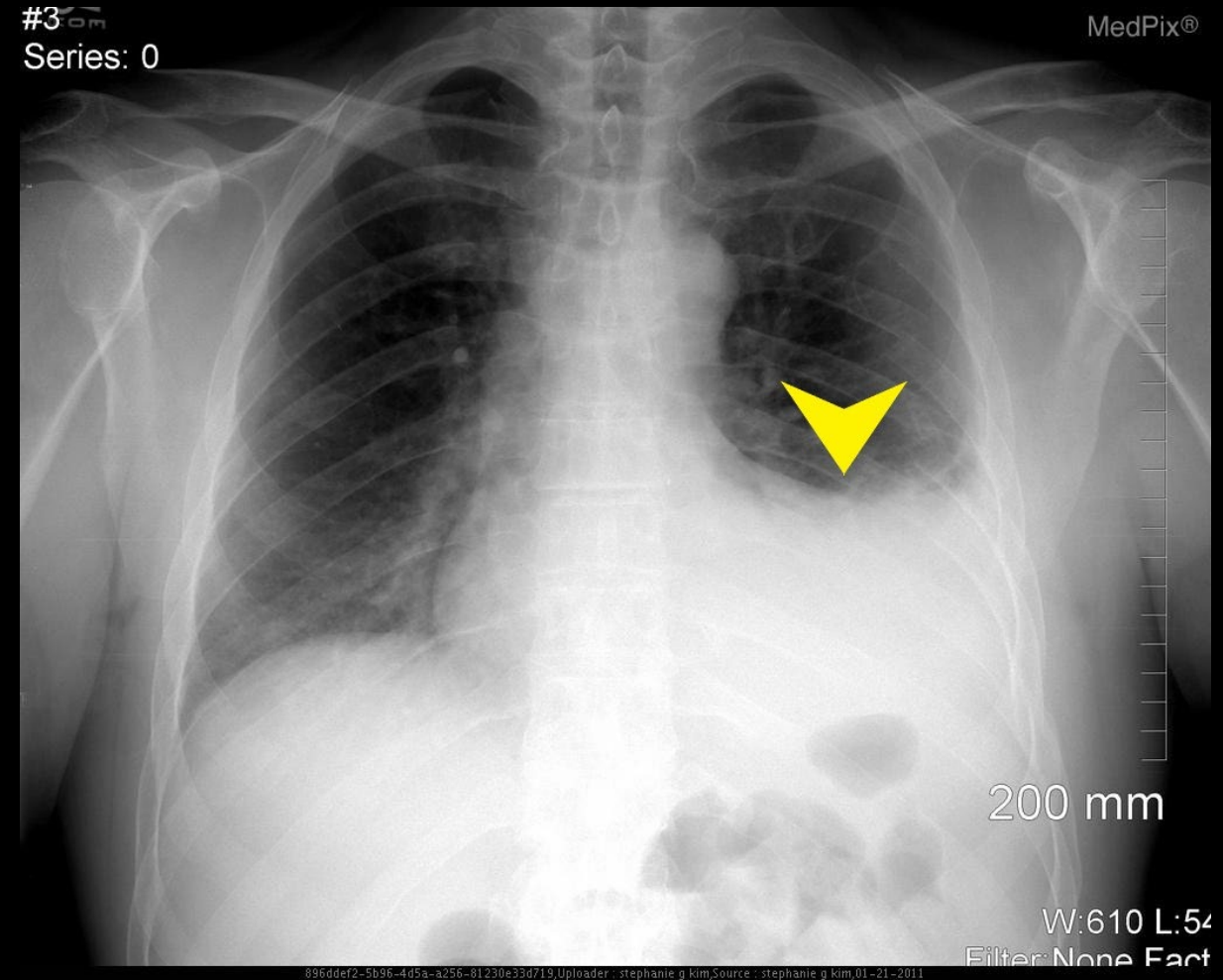
## **Collection of Air in:**

- **Pleural space**
- **Visceral pleura**
- **Parietal pleura**

# Hemothorax

## Etiology:

- Lung laceration
- Intercostal vessel laceration
- Internal mammary artery laceration
- Thoracic spine fracture/dislocation
- Collection of Blood or other fluid in pleural cavity (< 1500ml)



Xray showing left sided hemothorax (yellow arrowhead) secondary to multiple rib fractures after fall from skiing (Picture courtesy: MedPix)





# Pleural Space Management

- Small pneumo/hemothorax may be monitored with serial chest x-rays.
  - Usually spontaneously reabsorbs
- Chest tube required for moderate to large pneumo/hemothorax.
  - Monitor output for amount and color.
  - Monitor air leaks.
  - Assess insertion site and connections.
- Apply supplemental oxygen.

# Chest Tube Insertion

## Complications

- Laceration of intrathoracic and/or abdominal organs
- Pleural infection
- Damage to intercostal nerve, artery, vein
- Intercostal neuritis/neuralgia
- Incorrect tube position
- Persistent PTX





# Chest Tube Management

- Chest x-ray post insertion
- Monitor chest tube output
- Provide amount of suction per physician's order
- Chest tube dressing per hospital protocol
- Evaluate effectiveness of chest tube







# Troubleshooting Chest Tube

## **CT falls out:**

- Apply dressing with pressure at end-expiration
- Ensure tight seal with tape
- Call physician immediately
- Monitor patient's condition

## **No drainage with continued presence of HTX**

- Assess tubes for kinks, disconnection
  - Do not milk tubing
- Raise HOB and lower pleurovac
- Turn patient to affected side
- Consider patient's condition

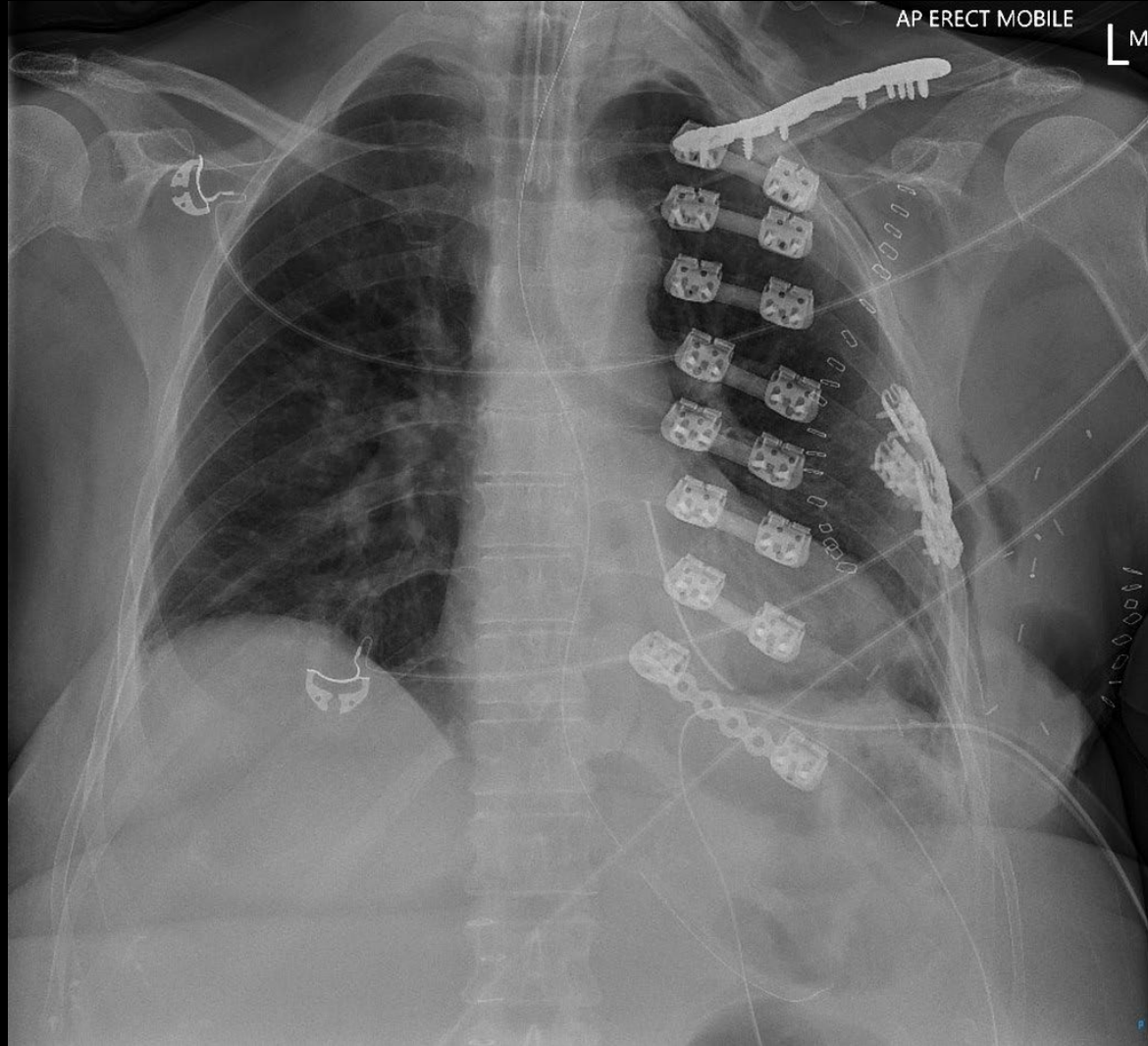


# Flail Chest

- Usually results from direct, high-energy impact
- Two or more adjacent ribs fractured at two (or more) points
- Paradoxical motion
- Labored breathing
- Ventilation and perfusion mismatch



# Flail Chest



## Treatment

- Humidified oxygen
- Cautious fluid resuscitation
- Intubate if respiratory distress
- Control pain
- Potential for operative fixation
  - Rib plating

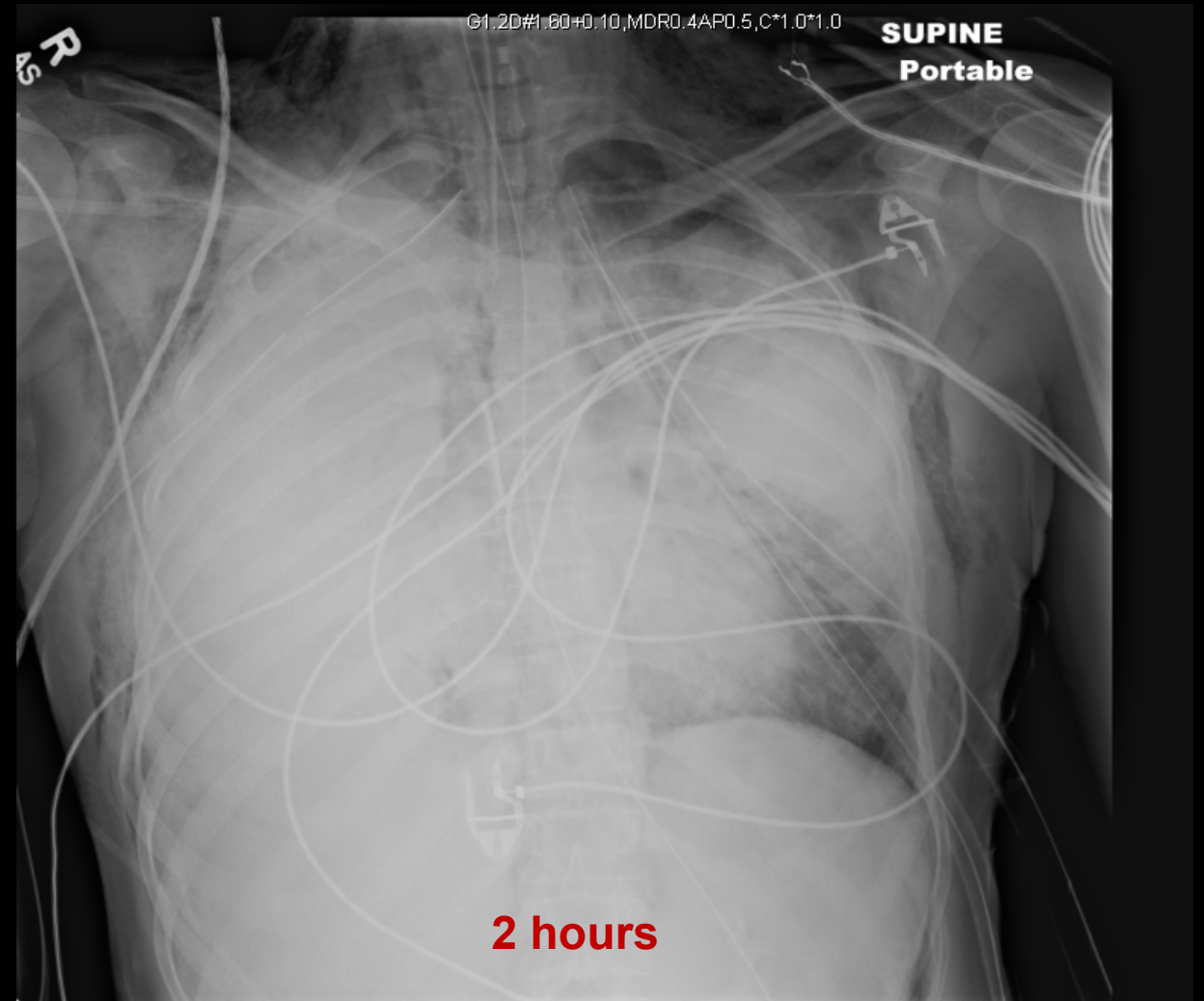
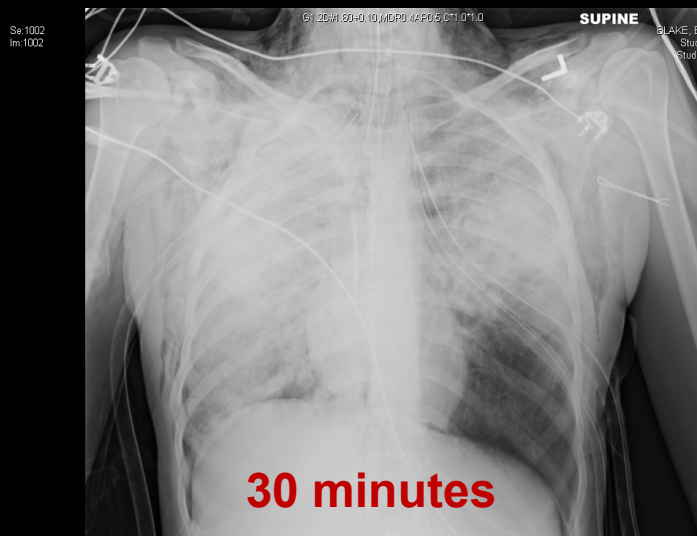




# Pulmonary Contusion

- Bruising of the lung tissue
- Occurs over time following thoracic trauma
- Blood and other fluids accumulate in lung tissue
- This interferes with ventilation and leads to hypoxia.

# Pulmonary Contusion





# Assessment and Treatment

- Hypoxemia and respiratory compromise
- Bloody sputum, secretions
- Chest x-ray: patchy infiltrates or consolidation hours after injury
- Oxygen therapy and aggressive pulmonary toilet
- Judicious use of fluids in resuscitation
- Ventilator strategies



# Blunt Cardiac Injury

- Mild tenderness to chamber rupture
- Types of injuries
  - Compression
  - Deceleration
  - Blast
  - Direct impact





# Assessment

- Chest pain
- Arrhythmias
- Electrocardiogram
- Echo
- Lab panel
- Patients with changes/abnormalities must be monitored for the first 24 hours



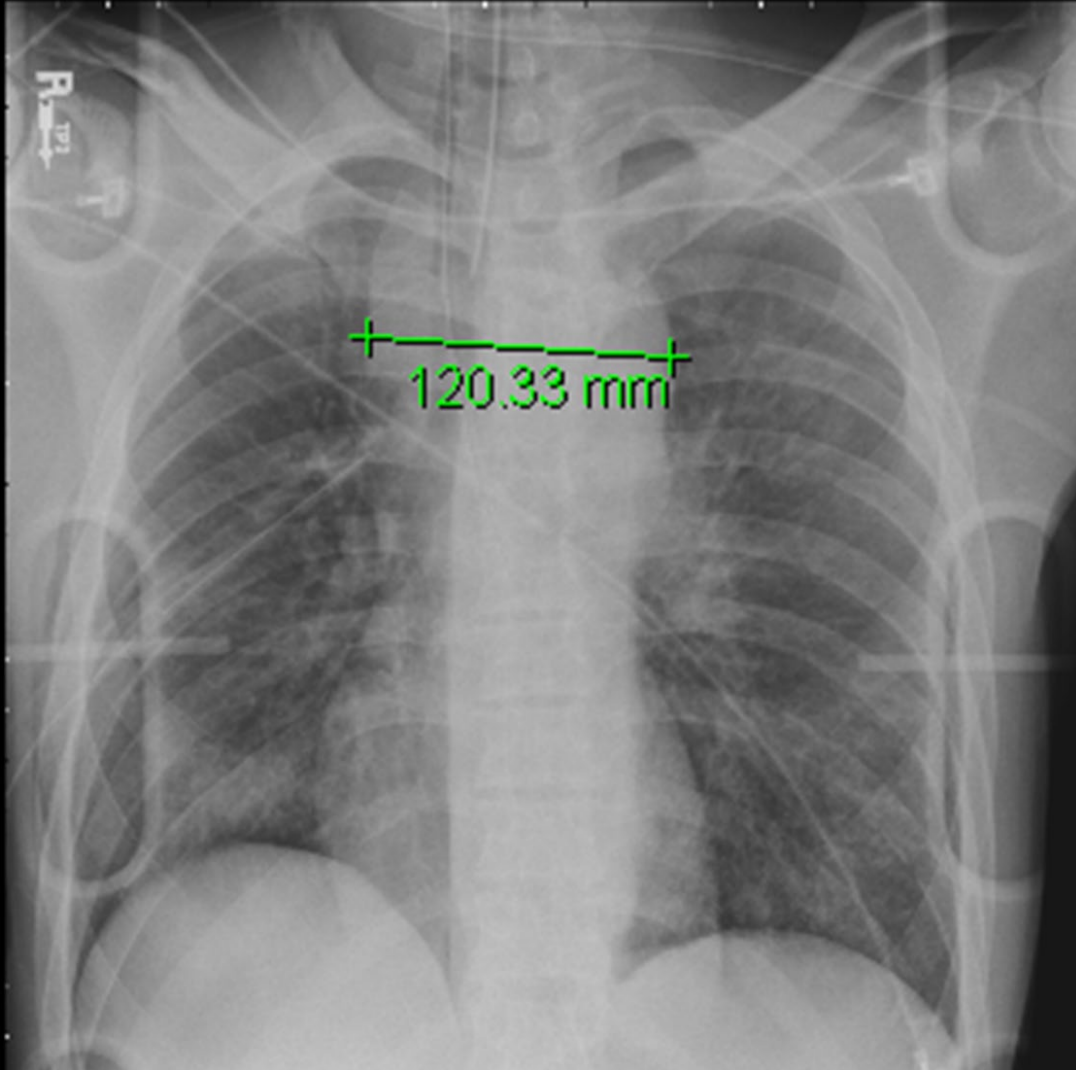


# Traumatic Aortic Disruption

- Common cause of death at scene
- Survivors may have incomplete laceration or hematoma
- Most common site is distal to left subclavian artery
- Not always with specific symptoms
- Maintain high index of suspicion for deceleration type of injuries



# Traumatic Aortic Disruption

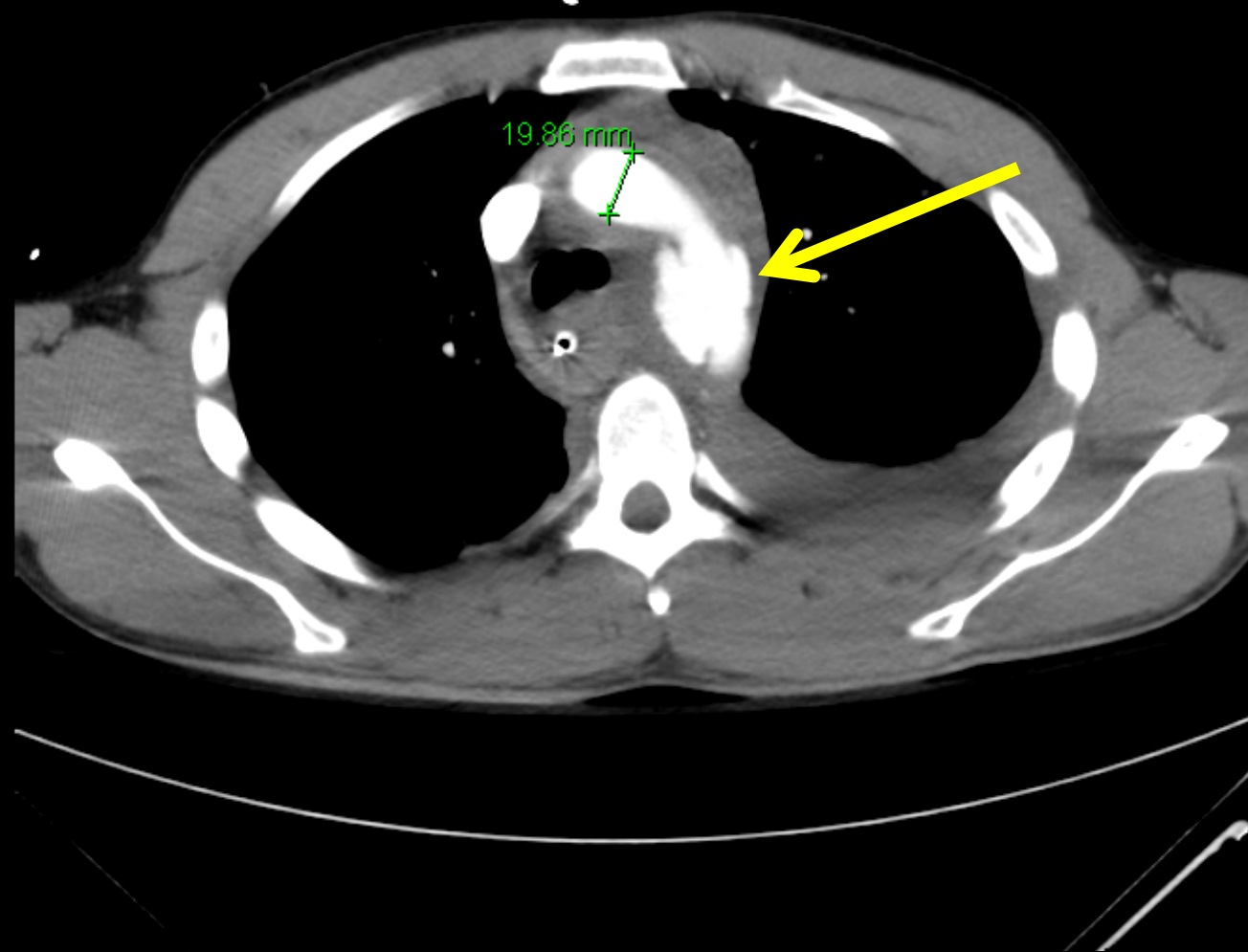


## Assessment

- Patient complaints
- Clinical signs

## Diagnostics

- CXR – widened mediastinum
- CT angiography
- Transesophageal echocardiography





# Traumatic Aortic Disruption

## Treatment

- Heart rate and blood pressure control
  - HR < 80, MAP goal 60-70 mmHg
- Pain relief
- Open repair
- Endovascular repair
  - Most common
  - Excellent short-term outcomes

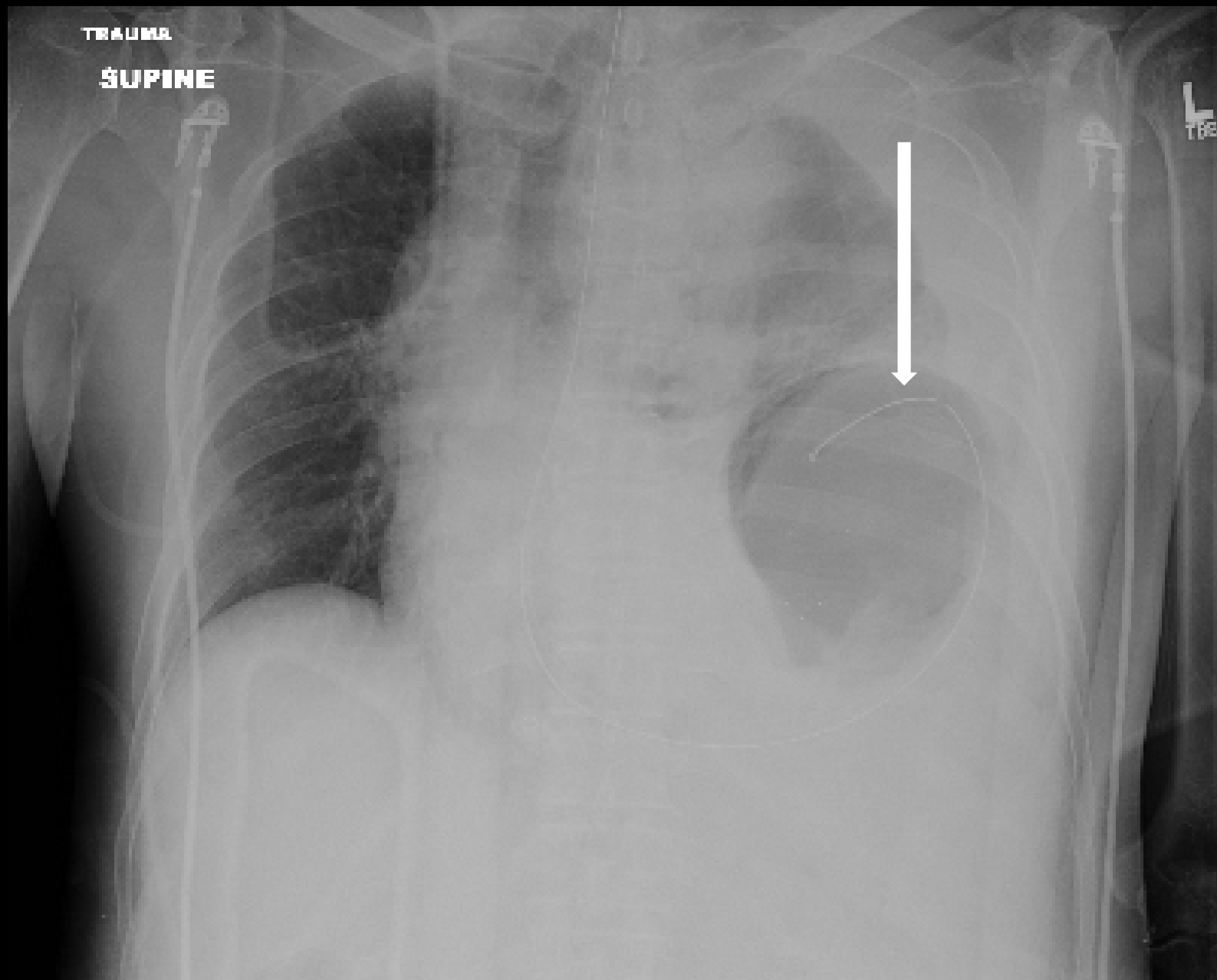




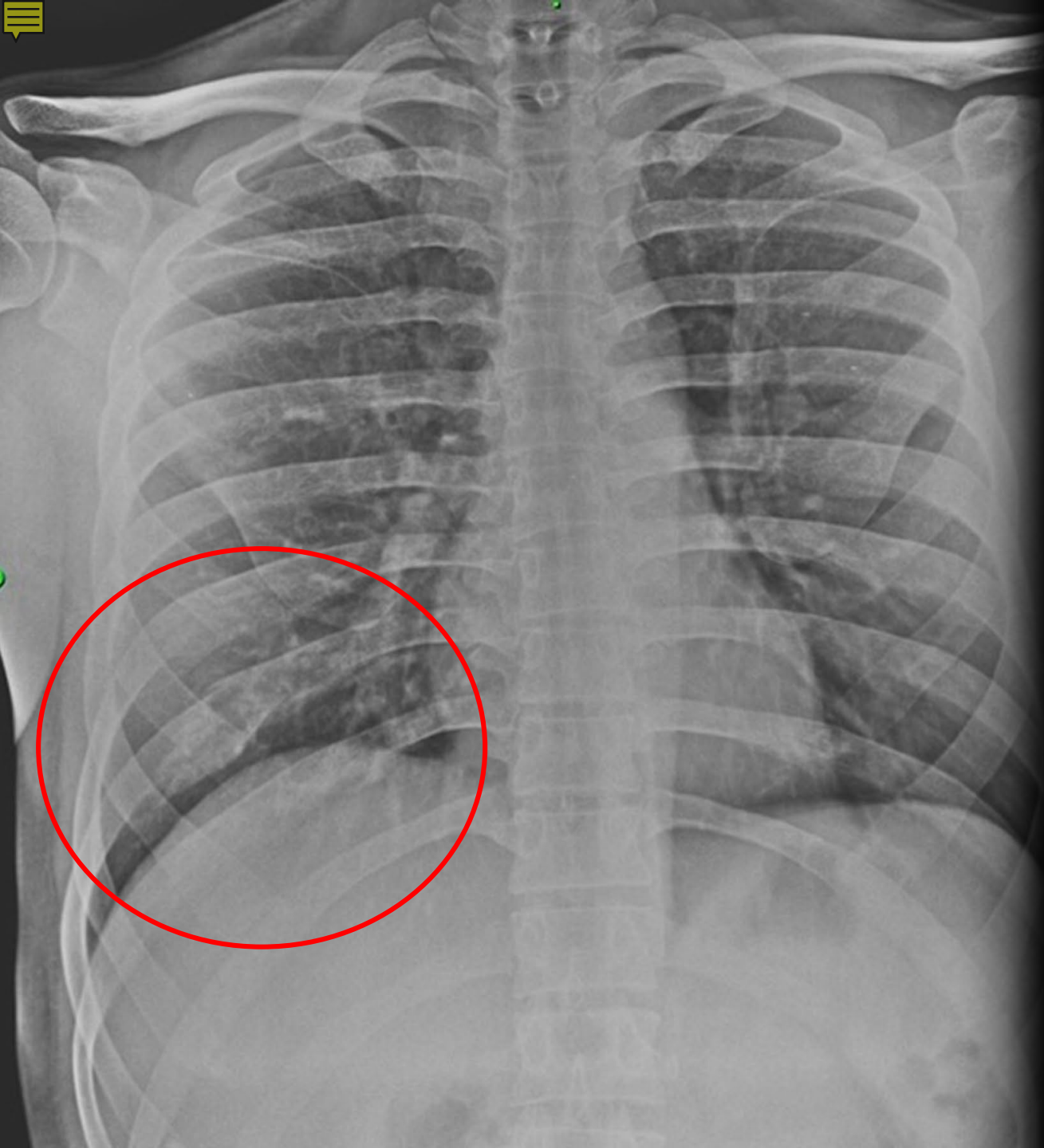


# Blunt Diaphragmatic Injury

- Usually result from high-speed MVC or severe blow to abdomen
- Initial chest x-ray may be normal.
- Suggestive findings:
  - Abnormal nasogastric tube placement
  - Ipsilateral hemidiaphragm elevation
  - Abdominal visceral herniation







# Rib Fractures

- 1<sup>st</sup> & 2<sup>nd</sup> rib fracture
  - High impact trauma
  - Suspect neck or great vessel injury
- 4<sup>th</sup>-9<sup>th</sup> rib fracture
  - Most common site of fractures
  - Suspect lung injury
- 9<sup>th</sup>-11<sup>th</sup> rib fracture
  - Suspect hepatosplenic injury





# Clinical Challenges

- Mechanical factors
- Rib fracture motion
- Prolonged pain
- Contracture of fractured segments
- Thoracic volume loss
- Persistent pain





# Rib Fractures

## Triad

- Inspiratory pain
- Shallow respirations
- Retained secretions

## Goal of Therapy

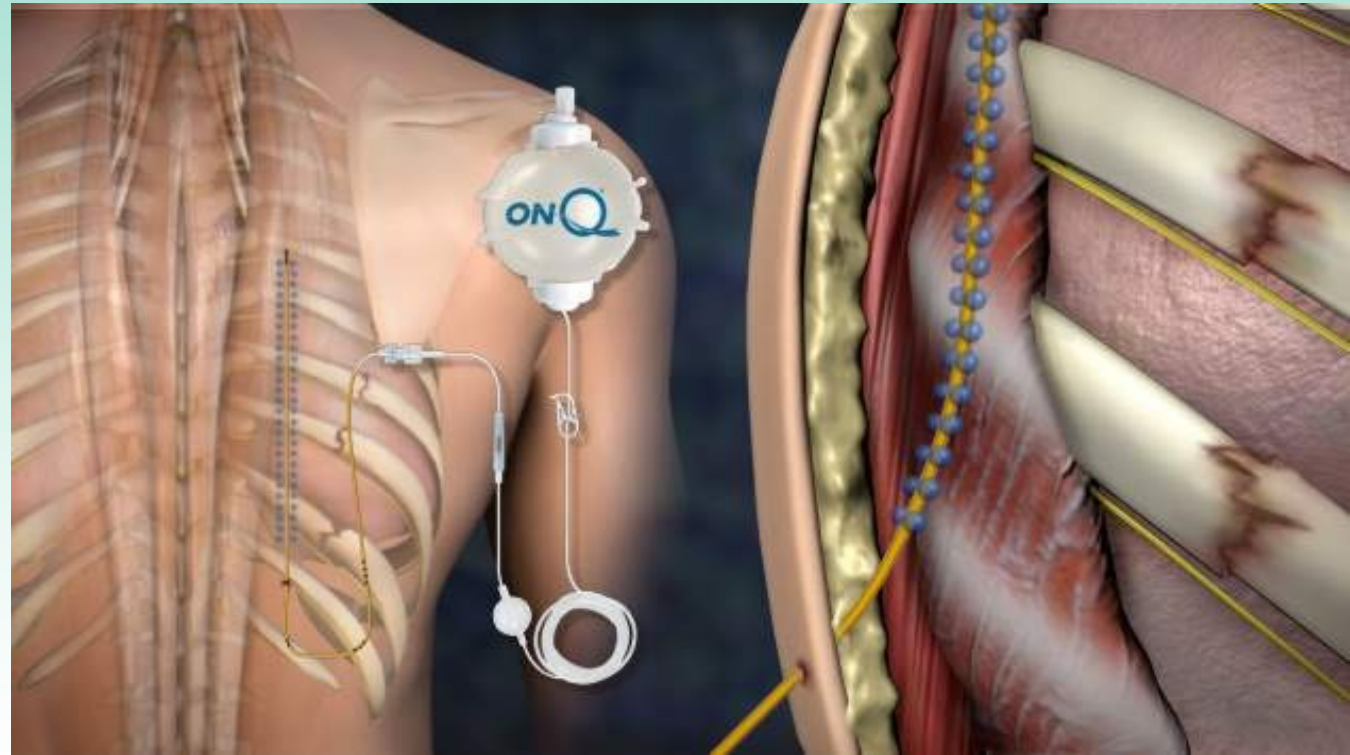
- Pain control
- Adequate pulmonary function
- Avoid potential complications



# Pain Management

## Options

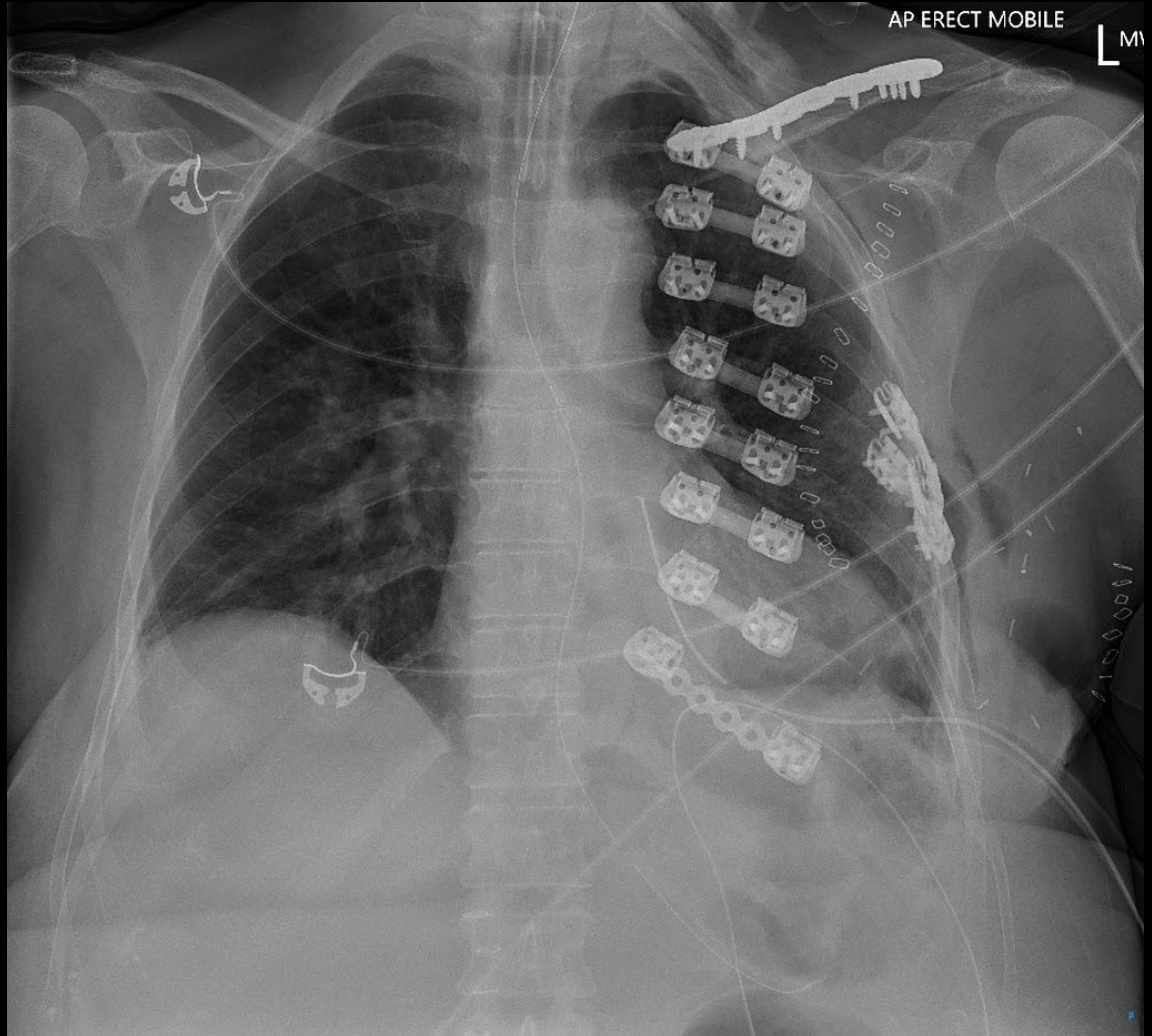
- Multi Modal Analgesia
  - Oral acetaminophen, NSAIDS
  - Oral Opioids
  - Pharm D or pain management consult
- Regional analgesia
- Operative fixation



Otto, 2016

# Operative Fixation

- Reduction in pain
- Ability to reconstruct chest wall
- Restore thoracic volume
- Decreased ventilator days
- Decreased hospital LOS
- Decreased neuralgia





# Subcutaneous Emphysema

- Airway injury
- Facial swelling
- Pneumothorax
- Blast injury



# Traumatic Asphyxia

- Crushing force to chest
- Cyanosis of head and neck
- Subconjunctival hemorrhage
- Hemotympanum
- Associated injuries





# Scapula and Clavicle Fractures

## Scapula

- Uncommon
- Clinical signs
  - Pain
  - Edema
  - Crepitus
- Management
  - Analgesia
  - Immobilization followed by PT

## Clavicle

- Common
- Clinical signs
  - Tenderness
  - Crepitus
  - Deformity
- Management
  - Shoulder immobilizer
  - ORIF





# Sternal Fracture

## Clinical Manifestations

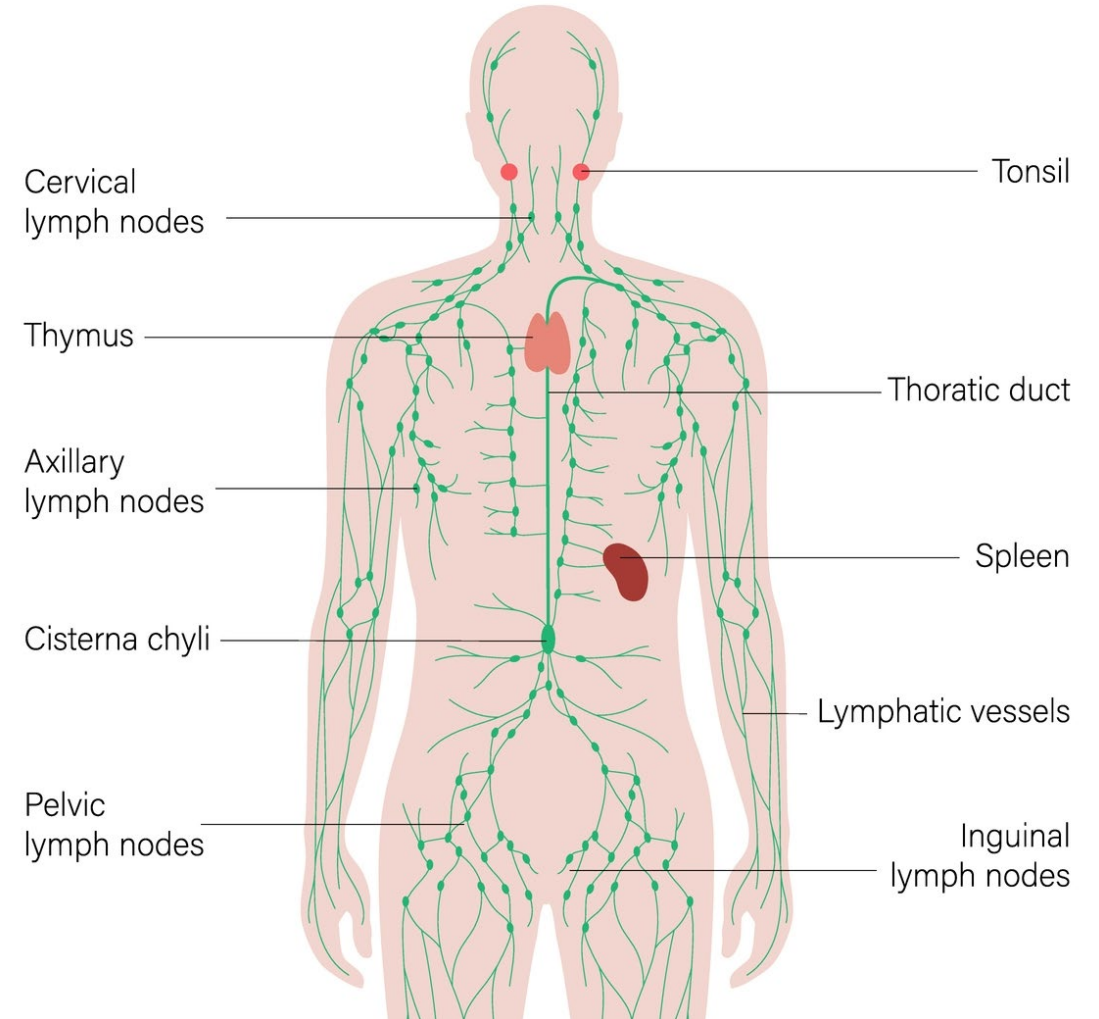
- Anterior chest pain
- Tenderness
- Palpable deformity
- Unstable fracture may result in flail chest
- ECG changes

## Management

- Cardiac monitoring
- Serial ECG to rule out myocardial insult
- Echocardiogram
- Pain Control

# Thoracic Duct Injury

- Uncommon
- Milky white fluid (\*Chyle)
  - May be clear if patient NPO
- Chylothorax
- Continued chest tube drainage coupled with nutritional support usually results in spontaneous closure in <1 month





# Secondary Thoracic Trauma Complications

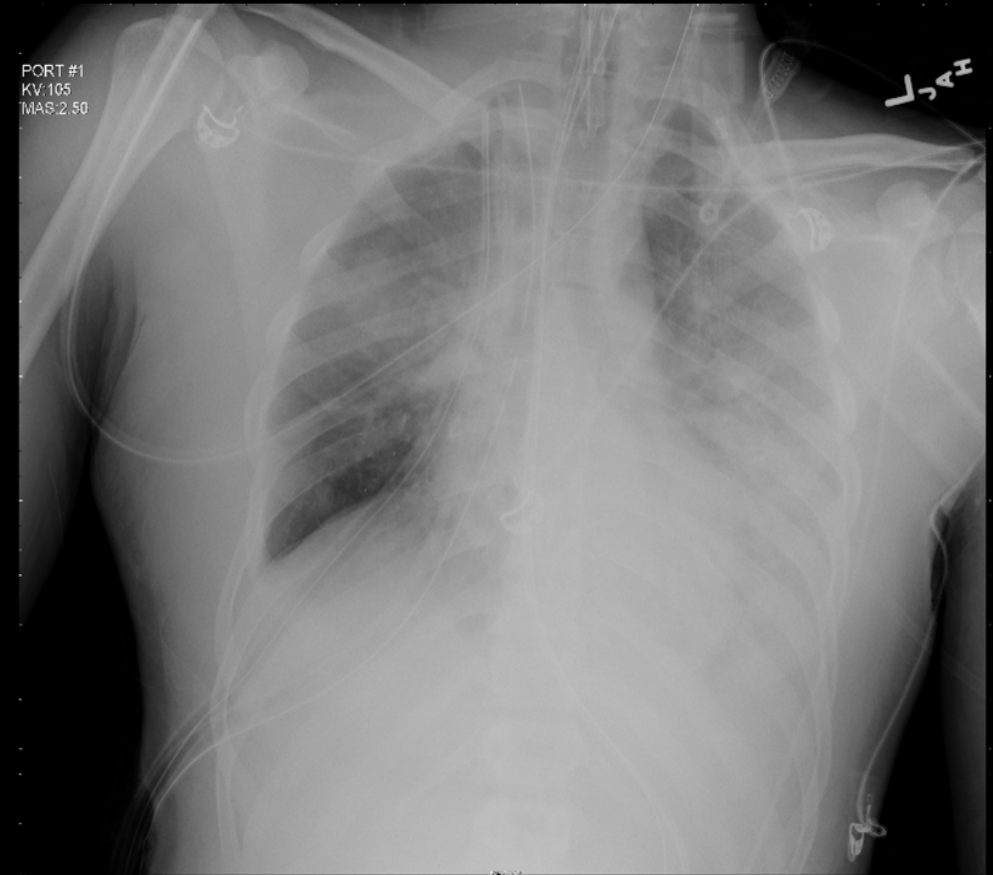
- Respiratory Failure
  - ALI
  - ARDS
- Pneumonia
- Empyema
- Persistent Air Leak
- Pneumatocele
- Air Embolism



# Acute Lung Injury (ALI) Acute Respiratory Distress Syndrome (ARDS)

## ALI/ARDS

- Acute onset of diffuse bilateral pulmonary infiltrates
- Vasculature and alveolar endothelium injured
- No evidence of hydrostatic pulmonary edema
- Severe Hypoxemia
- Treatment includes ventilatory strategies





# ALI vs ARDS

- **P/F ratio ALI**
  - $\text{PaO}_2:\text{FiO}_2$  200-300
- **P/F ratio ARDS**
  - $\text{PaO}_2:\text{FiO}_2 \leq 200$



# Pneumonia

- Trauma patient susceptible particularly if they are intubated
- VAP partially iatrogenic
- Especially common in patients with ARDS
- Multiple pathogens associated with VAP
- Indiscriminate use of antibiotics
- Optimal treatment is prevention to include:
  - Hand hygiene, gowning, gloving
  - Endotracheal hygiene per protocol
  - Minimizing duration time of intubation
  - Consideration of NIPPV vs intubation





# Empyema

- Risk of development remains high.
- Etiology includes inadequately drained pleural space, direct contamination from the penetrating injury or secondary infection such as a clotted HTX or diaphragm disruption.
- Suspect in chest trauma with an unexplained fever, leukocytosis or respiratory failure
- Early CT Scan if suspected
- Pathogen identification

# Pneumatocele

- Air collection in lung parenchyma
- Usually develops during mechanical ventilation
- Usually resolves following weaning from ventilator
- May need CT guided drainage



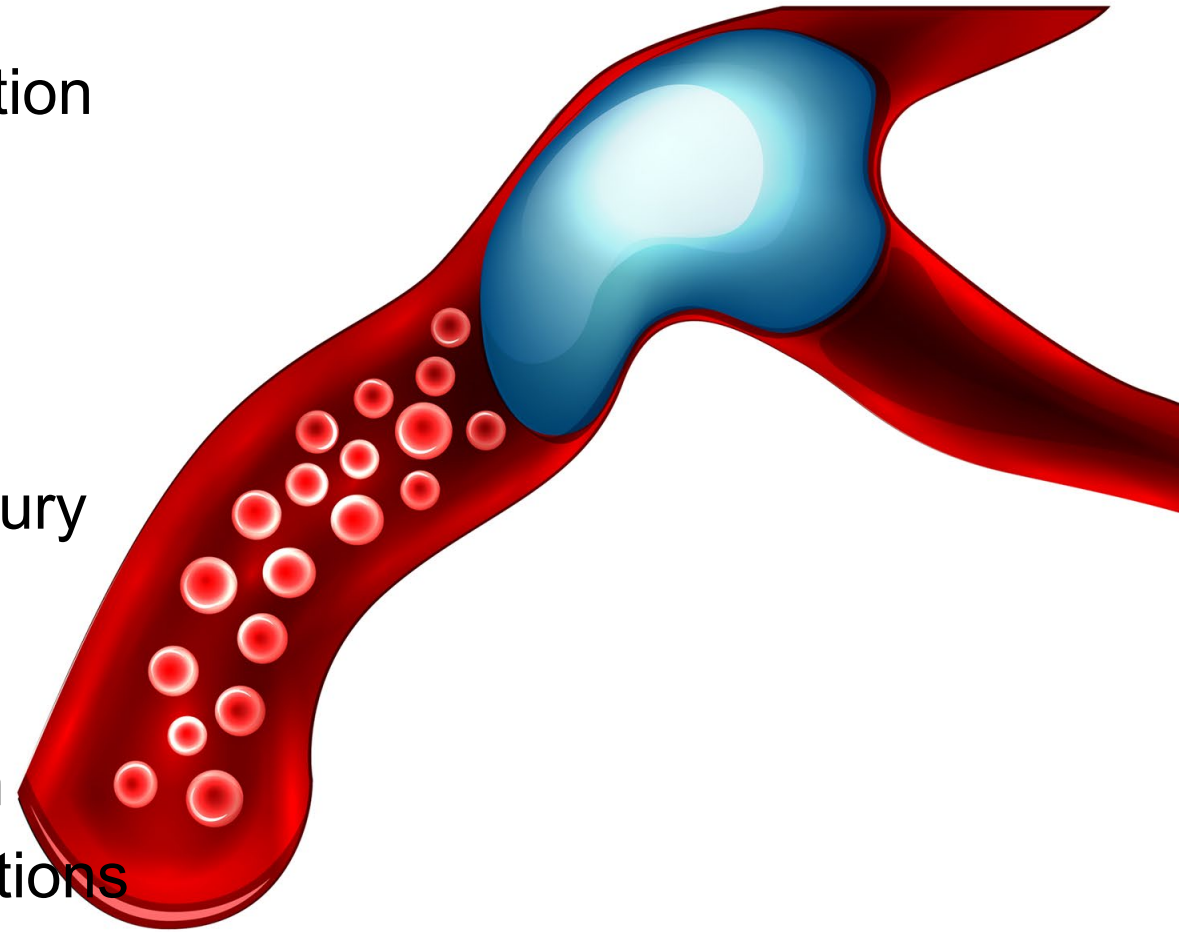
# Air Embolism

## Etiology

- Patient with large HTX requiring intubation with positive pressure
- Iatrogenic from central venous access procedures
- Fistula between pulmonary vein & bronchiole due to a penetrating lung injury results in systemic air embolism

## Symptoms

- Sudden cardiac or cerebral dysfunction
- Air in retinal vessels and arterial aspirations
- Hemoptysis
- Seizures







# Air Embolism

## Treatment

- Immediately place patient in Trendelenburg position
- Rotate patient to left lateral decubitus position
- Airway management
- Immediate thoracotomy and clamping of hilum to avoid propagation of air embolus before repair of injury
- Aspiration of air from cardiac chambers, aortic root and/or right coronary artery
- Cardiac massage



# Summary

- Identify and treat life-threatening injuries during primary survey.
- Maintain high level of suspicion for other injuries.
- Recognize potential complications.
- Describe treatment modalities.
- Pain management is integral to positive outcomes.