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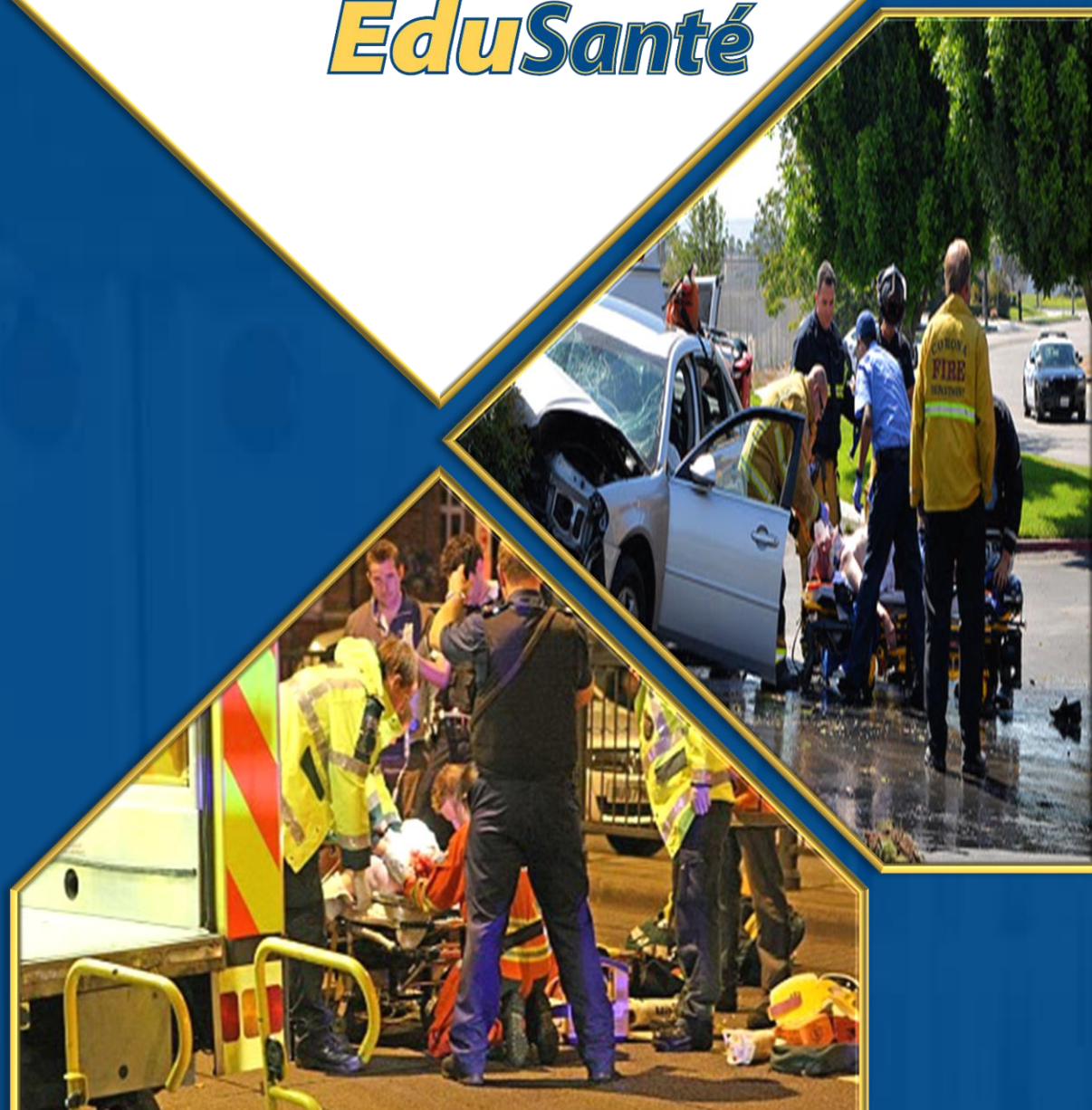
Thoracic Trauma

Primary Care Paramedicine



Module: 11

Section: 02

Lecture Outline

- Introduction
- Pathophysiology
- Assessment
- Management
- Documentation

Introduction

- The thoracic cavity contains many vital structures
  - Heart, great vessels, esophagus, tracheobronchial tree, and lungs
- Trauma to the thoracic cavity remains a significant cause of death and disability in the multiple injured patient.
- Thoracic trauma is cause of death in 25% multiple injured patients and is a contributing cause of death in an additional 25%

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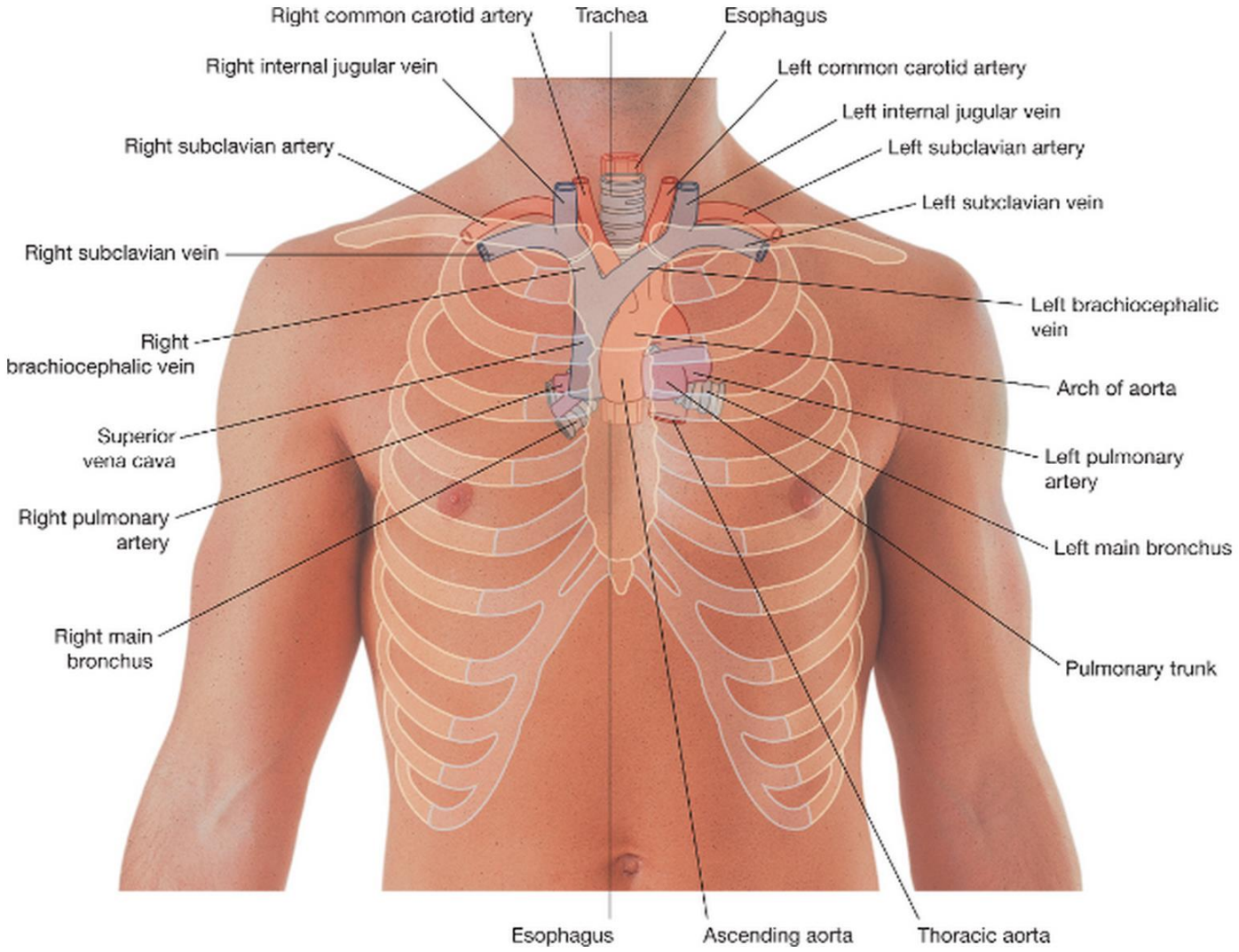
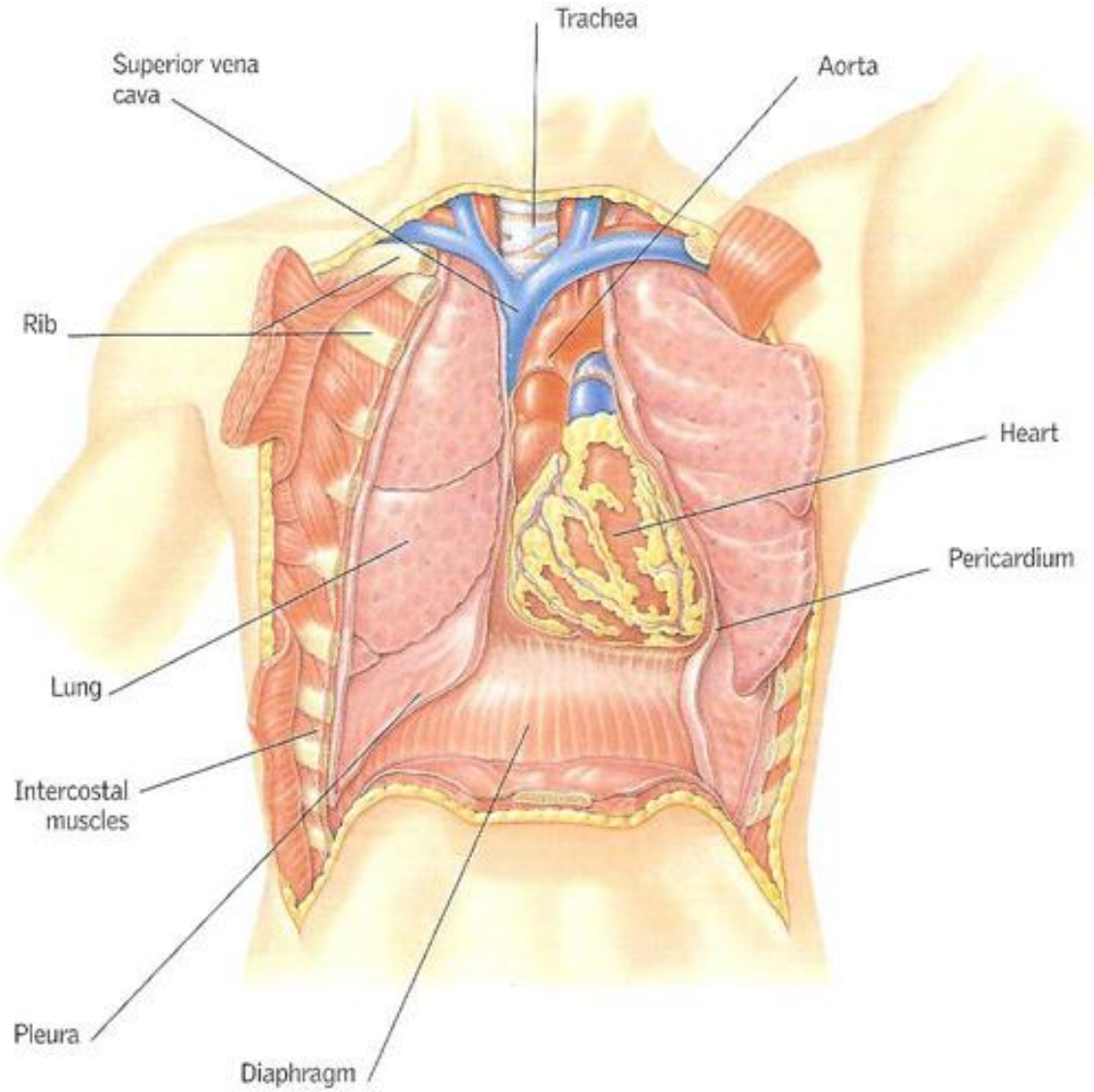
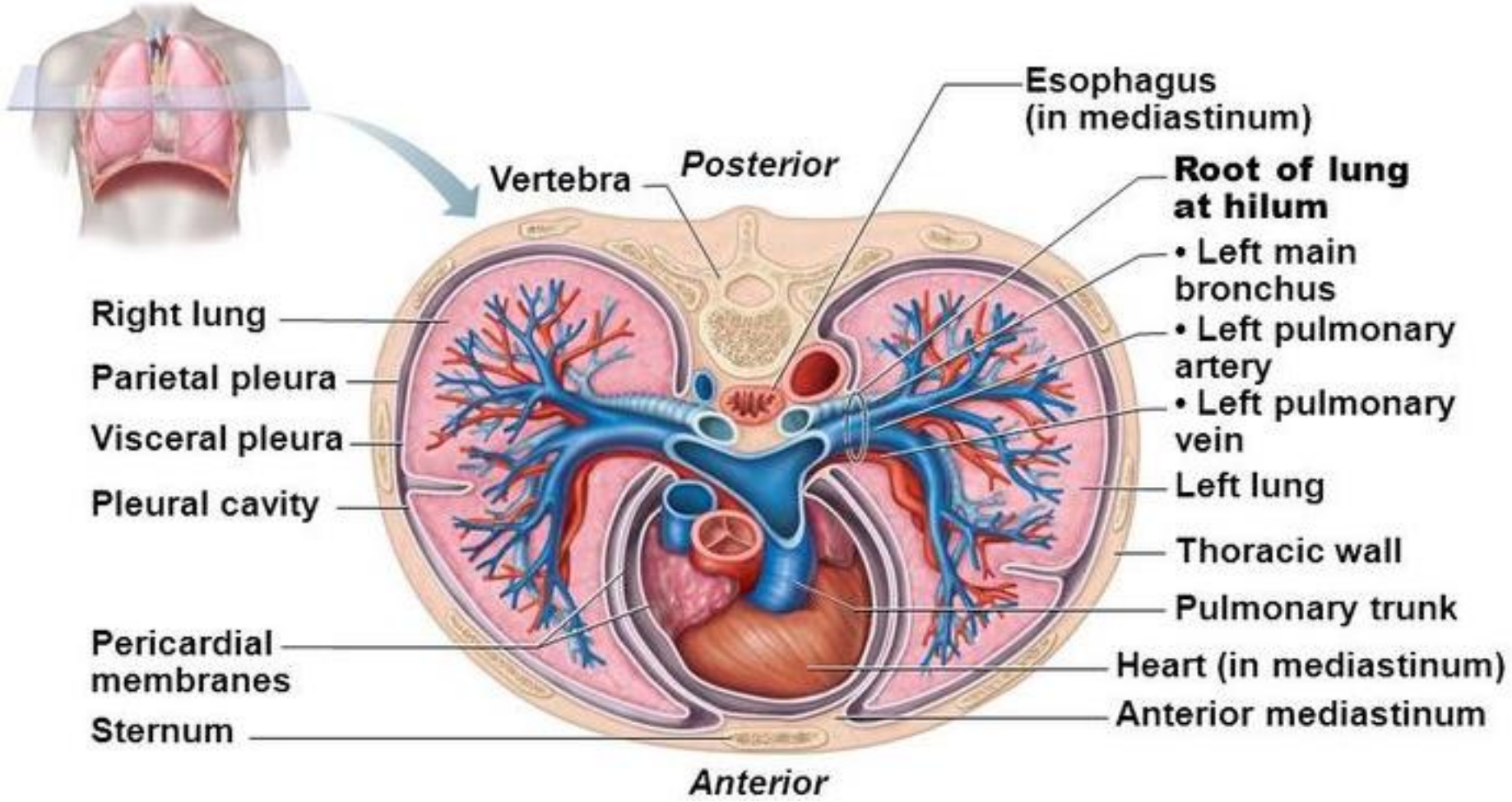
On the Surface



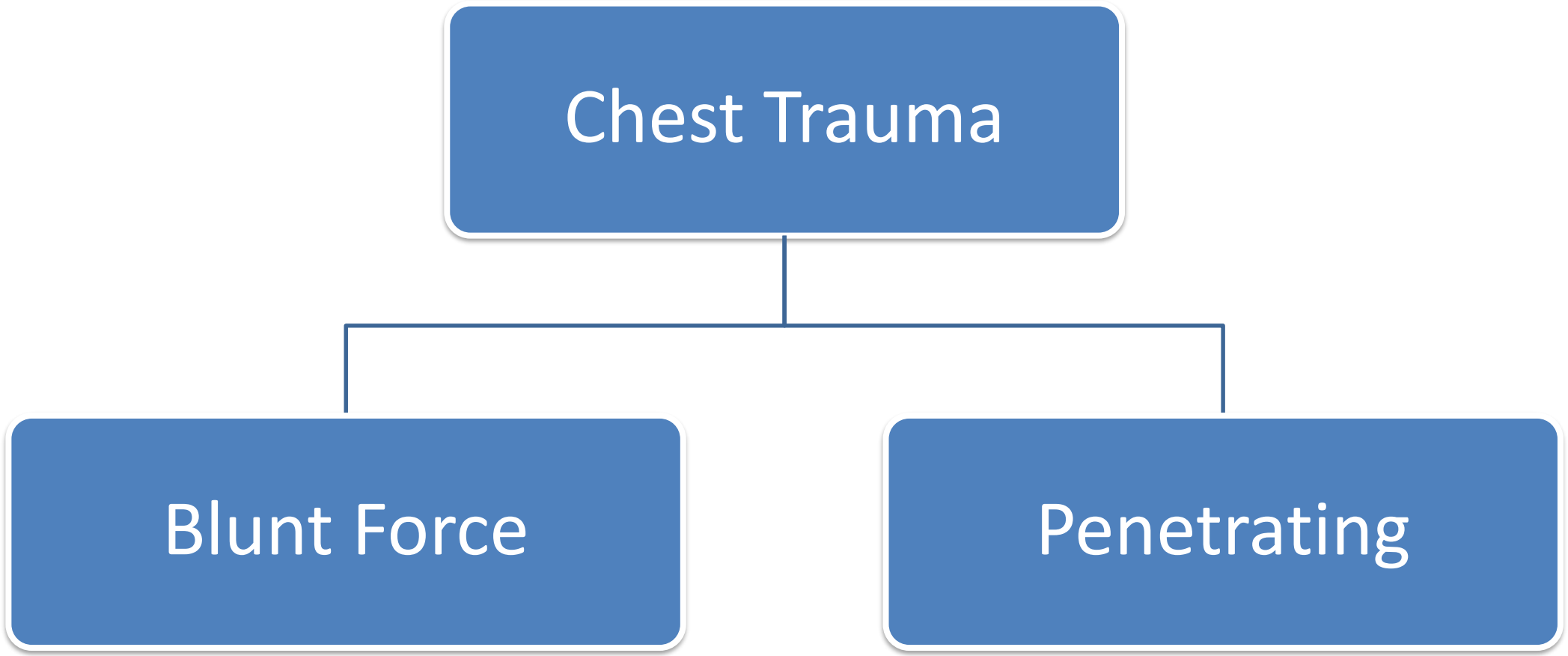
Thoracic Anatomy



Thoracic Anatomy



Mechanism of Injury



Blunt Force Trauma

- Results from kinetic energy forces transmitted through the tissues
- Blasts
  - Pressure wave causes tissue disruption
  - Tear blood vessels & disrupt alveolar tissue
  - Disruption of tracheobronchial tree
  - Traumatic diaphragm rupture
- Crush (compression)
  - Body is compressed between an object and a hard surface
  - Direct injury of chest wall and internal structures

Blunt Force Trauma

- Deceleration
  - Body in motion strikes a fixed object
  - Blunt trauma to chest wall
  - Internal structures continue in motion
    - Ligamentum Arteriosum shears aorta
- Age Factors
  - Pediatric Thorax
    - More cartilage allows it to absorbs forces
    - Increased likelihood of underlying injuries
  - Geriatric Thorax
    - Calcification and osteoporosis increases likelihood of fractures

Blunt Force

Penetrating Trauma

- Low Energy
  - Arrows, knives, handguns
  - Injury caused by direct contact and cavitation
- High Energy
  - Military, hunting rifles and high powered hand guns
  - Extensive injury due to high pressure cavitation

Penetrating Trauma
Low vs. High Energy

Penetrating Trauma

- Shotgun
  - Injury severity based upon the distance between the victim and shotgun & caliber of shot
  - Type I: >7 meters from the weapon
    - Soft tissue injury
  - Type II: 3-7 meters from weapon
    - Penetration into deep fascia and some internal organs
  - Type III: <3 meters from weapon
    - Massive tissue destruction

Penetrating Trauma

Type 1

Type 2

Type 3

Chest Wall Injuries

- Intact chest required for adequate ventilation
  - Respiratory insufficiency
- Most common injuries encountered in blunt chest trauma
  - Contusions
  - Rib fractures
  - Sternal fractures/dislocations
  - Flail chest

Signs and Symptoms of Chest Wall Injuries

- Blunt or penetrating trauma to chest
- Erythema
- Ecchymosis
- Dyspnea
- Pain on breathing
- Limited breath sounds
- Hypoventilation
- Crepitus
- Paradoxical movement of chest wall

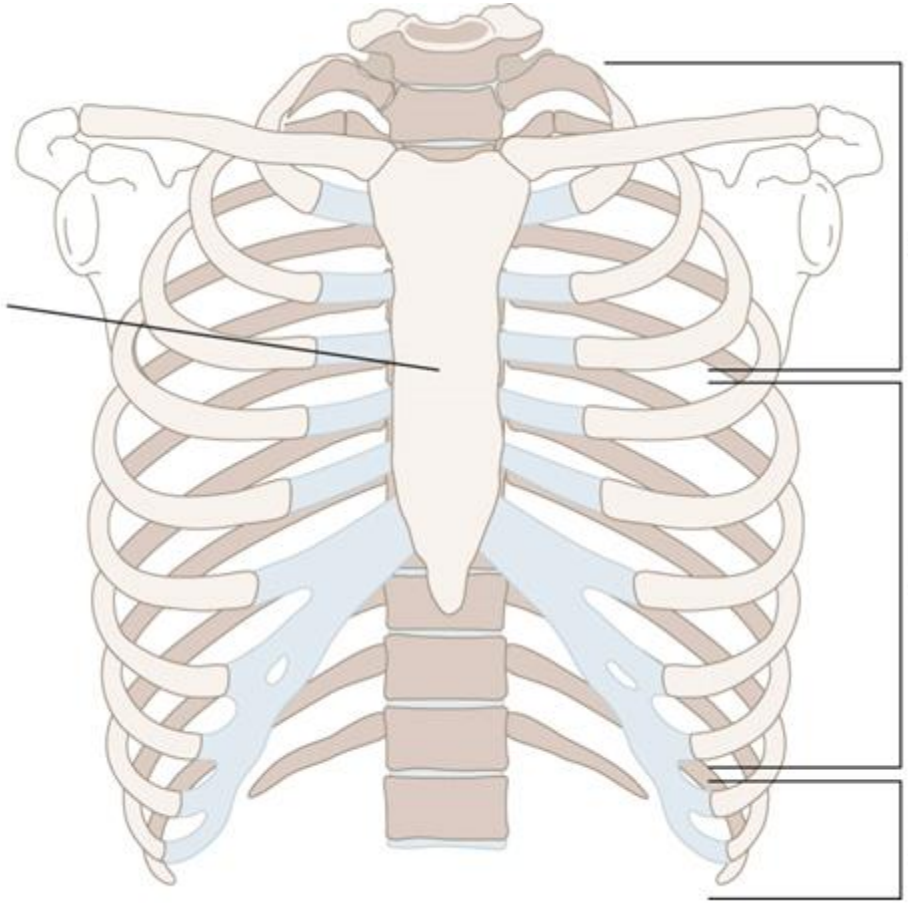
Contusions

- Most common chest wall injury
- Injury to soft tissue covering thoracic cage
  - Pain with respiratory effort
  - May lead to hypoventilation
  - At risk patients with pre-existing conditions
- Erythema, ecchymosis

Rib Fractures

- > 50% of significant chest trauma cases due to blunt trauma
- Compressional forces flex and fracture ribs at weakest points
- Hypoventilation is common due to pain
- Mortality goes up with:
  - Number of fractures
  - Extremes of age
  - Associated disease

Rib Fractures



Great force is required for sternal fractures.

Ribs 1–3 are well protected by shoulder bones and muscles.

Ribs 4- **8** are most frequently fractured.

Ribs **9** –12 are relatively mobile and fracture less frequently.

Rib Fractures

- Ribs 1-3
  - Require great force to fracture
  - Possible underlying lung injury
- Ribs 4-8
  - Least protected
  - Most commonly fractured
- Ribs 9-12
  - Less likely to be fractured
  - Transmit energy of trauma to internal organs
  - If fractured, suspect liver and spleen injury

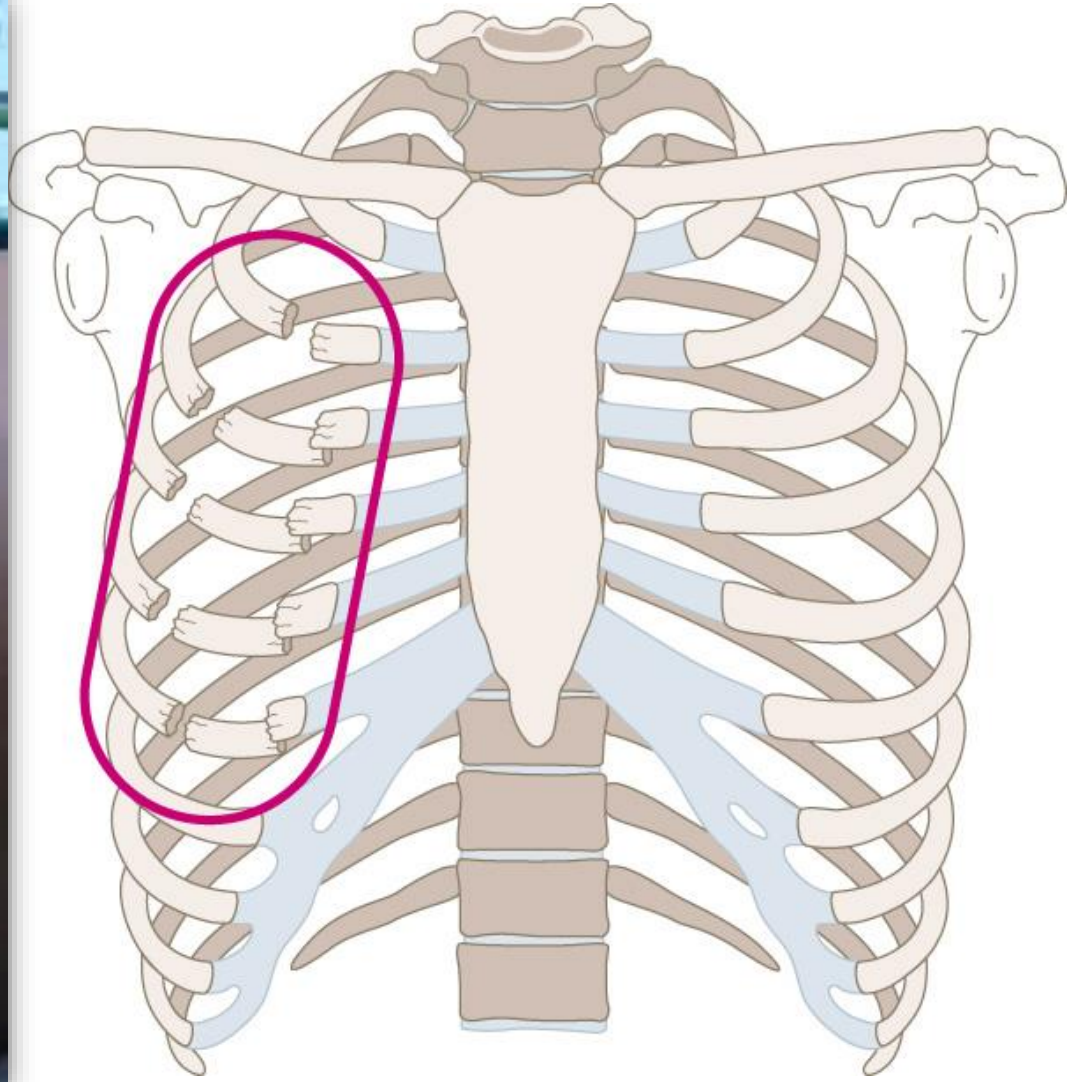
Sternal Fracture & Dislocation

- Associated with severe blunt anterior trauma
- Area well protected
  - Fractures result from severe impacts
  - Typical mechanism is a direct blow (e.g. steering wheel)
- Low incidence (5-8%)
- Mortality high (25-45%) because of underlying injuries
  - Myocardial contusion
  - Pericardial tamponade
  - Cardiac rupture
  - Pulmonary contusion
- Dislocation uncommon but same MOI as fracture
  - Tracheal depression if posterior

Flail Chest

- Segment of the chest that becomes free to move with the pressure changes of respiration
- Three or more adjacent rib fracture in two or more places
- Serious chest wall injury with underlying pulmonary injury
  - Reduces volume of respiration
  - Adds to increased mortality

Flail Chest



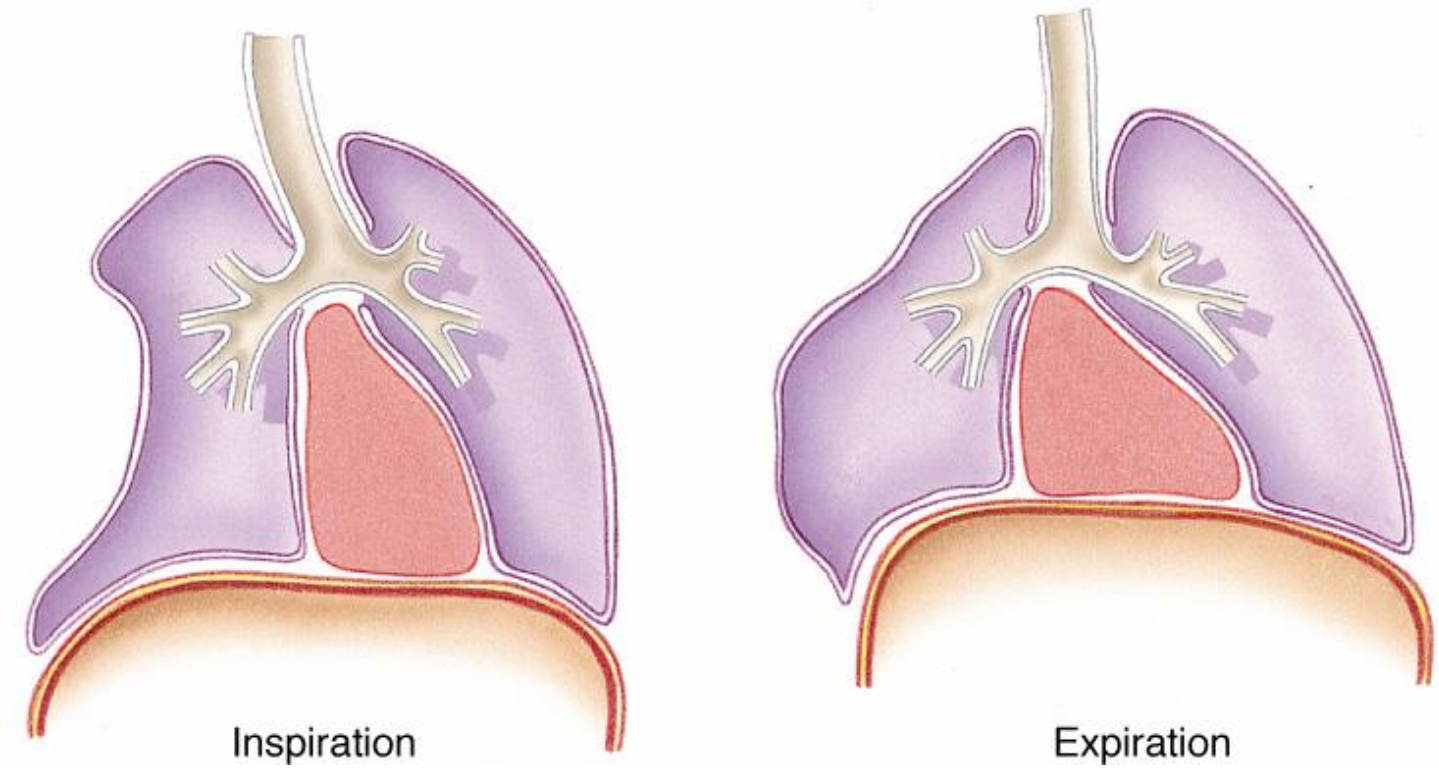
Flail Chest

Flail Chest

- Paradoxical flail segment movement
- Chest muscles will initially splint the flail segment
  - Over time muscles will fatigue
  - Flail segment will become more evident
- Positive pressure ventilation can restore tidal volume

Flail segment

- Paradoxical movement of the chest wall seen in a flail segment



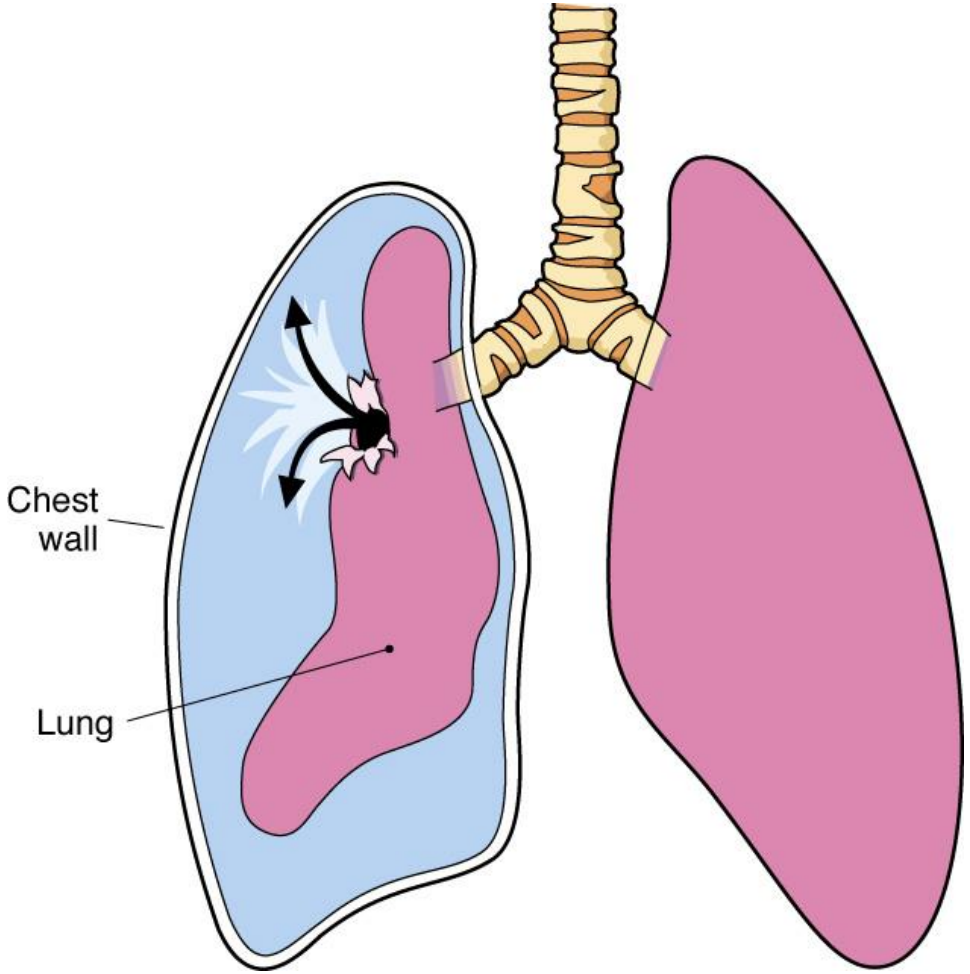
Pulmonary Injuries

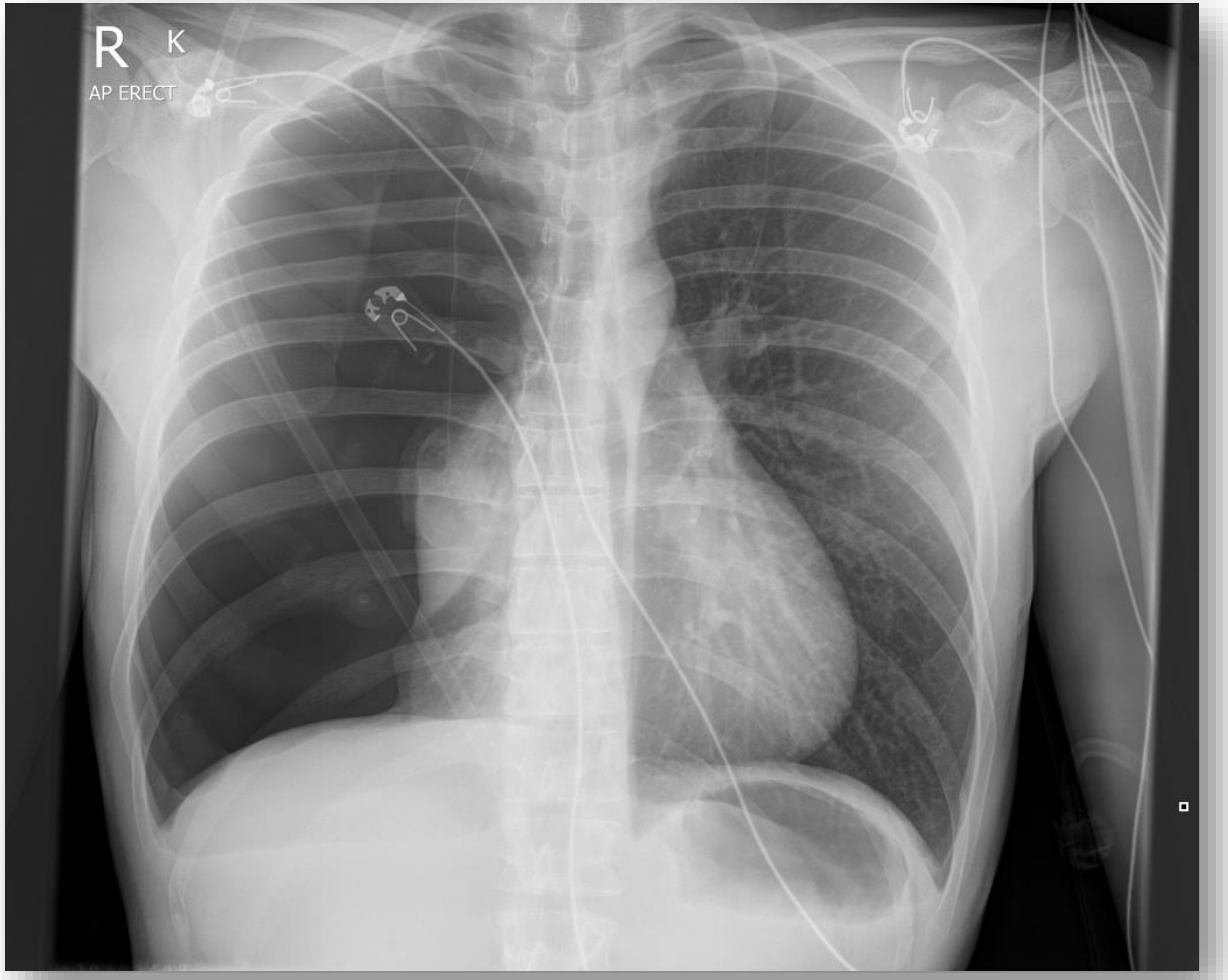
- Injuries to
  - Lung tissue
  - System that holds lungs to interior of the thoracic cavity
- Injuries:
  - Simple pneumothorax
  - Open pneumothorax
  - Tension pneumothorax
  - Hemothorax
  - Pulmonary contusion

Simple Pneumothorax

- Lung tissue is disrupted and air leaks into the pleural space
- Typical mechanism is a paper bag syndrome
- Progressive Pathology
  - Air accumulates in pleural space
  - Lung collapses
  - Alveoli collapse (atelectasis)
  - Reduced oxygen and carbon dioxide exchange
  - Ventilation/Perfusion Mismatch
    - Increased ventilation but no alveolar perfusion
- Reduced respiratory efficiency results in hypoxia

Simple Pneumothorax

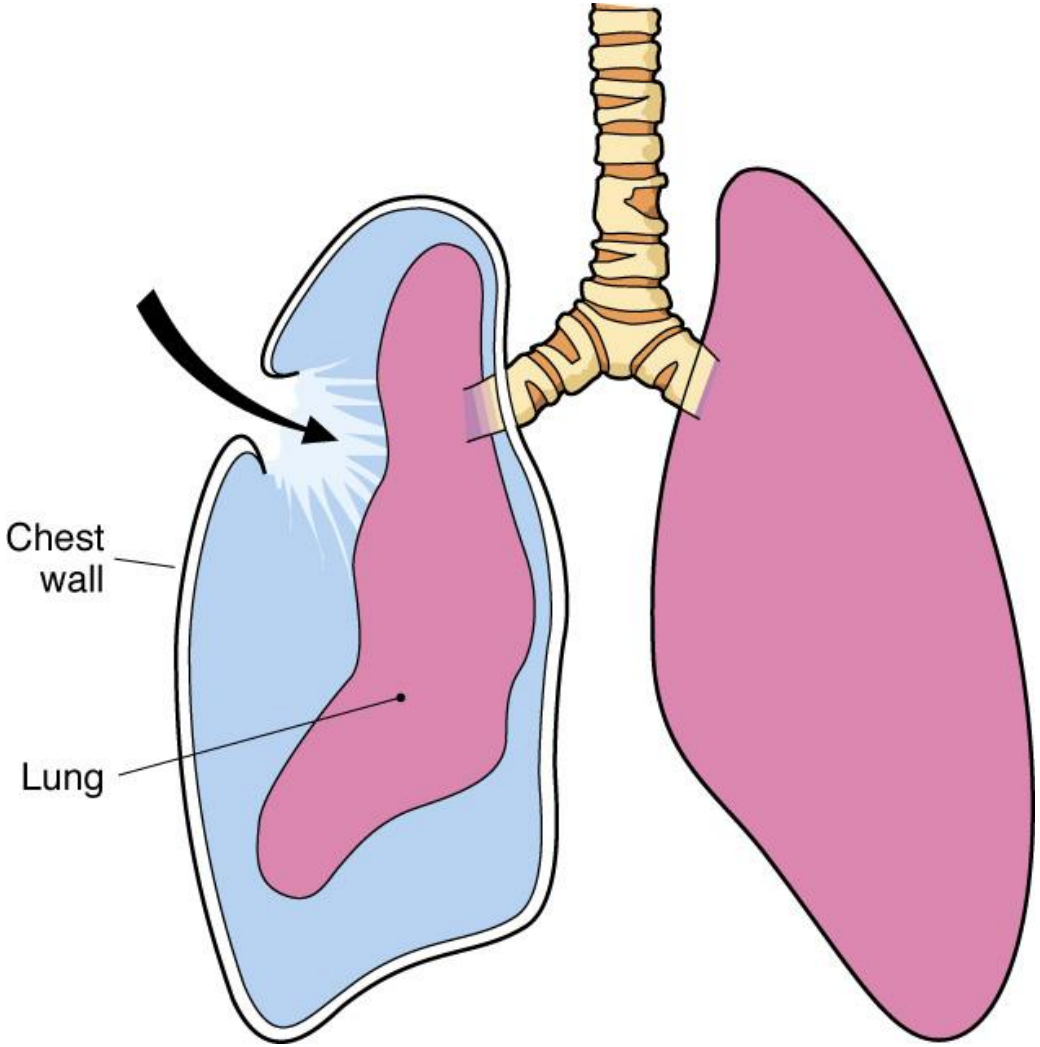




Open Pneumothorax

- Free passage of air between atmosphere and pleural space
- Air replaces lung tissue
- Mediastinum shifts to uninjured side
- Air will be drawn through wound if wound is 2/3 diameter of the trachea or larger
- Signs and symptoms
  - Penetrating chest trauma
  - Sucking chest wound
  - Frothy blood at wound site
  - Severe dyspnea
  - Hypovolemia

Open Pneumothorax

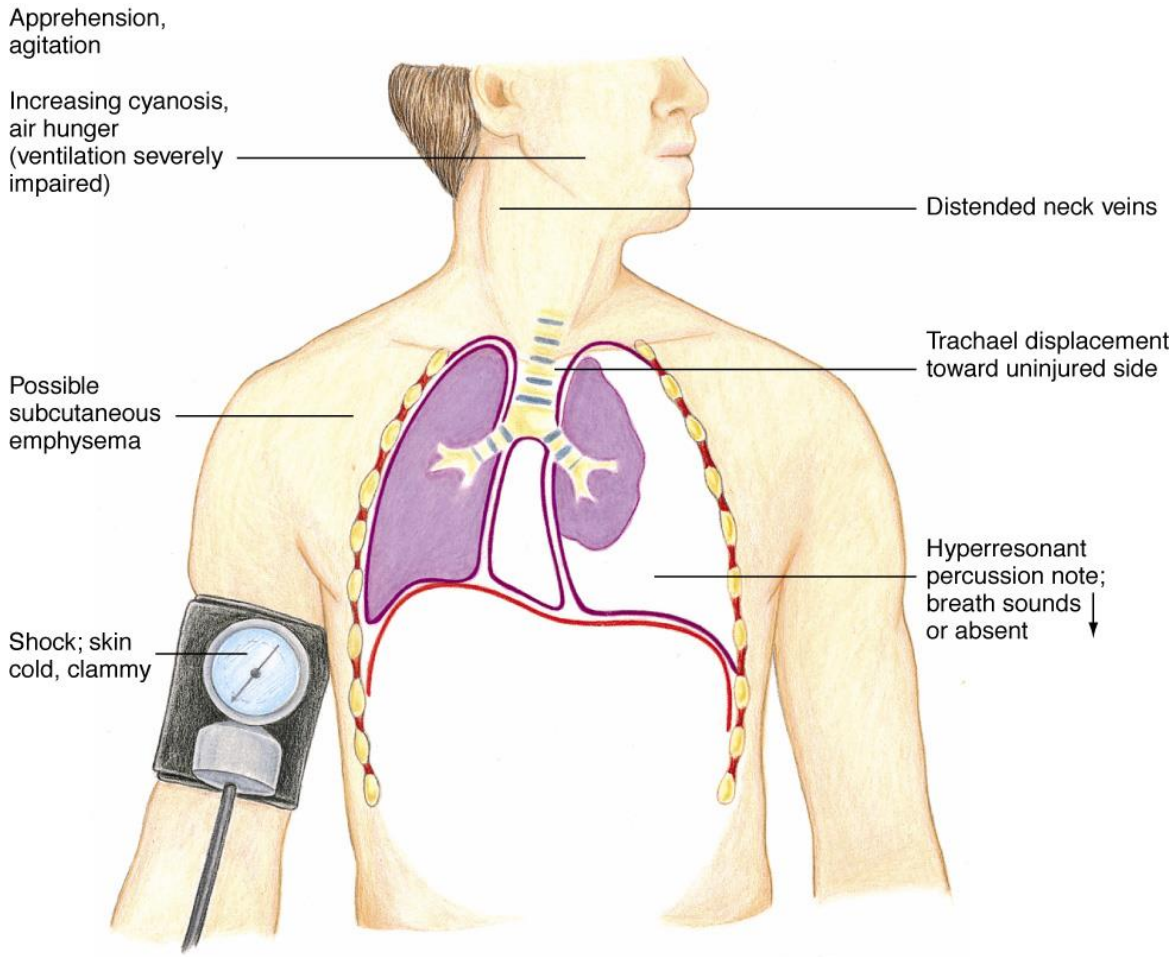


Tension Pneumothorax

- Progression of a spontaneous, simple or open pneumothorax
- Creates a on-way pressure valve within the thorax
- Generates/maintains pressure greater than atmospheric pressure
  - Reduces effectiveness of respiration
  - Air is unable to escape from inside the pleural space
  - Compresses on other structures in the chest

Tension Pneumothorax

- Physical findings of a tension pneumothorax



Sign and Symptoms

- Serious and immediate life-threat
- Dyspnea
  - Tachypnea at first
- Progressive ventilation/perfusion mismatch
  - Atelectasis on uninjured side
- Hypoxemia
- Hyperinflation of injured side of chest
- Hyperresonance of injured side of chest

Sign and Symptoms

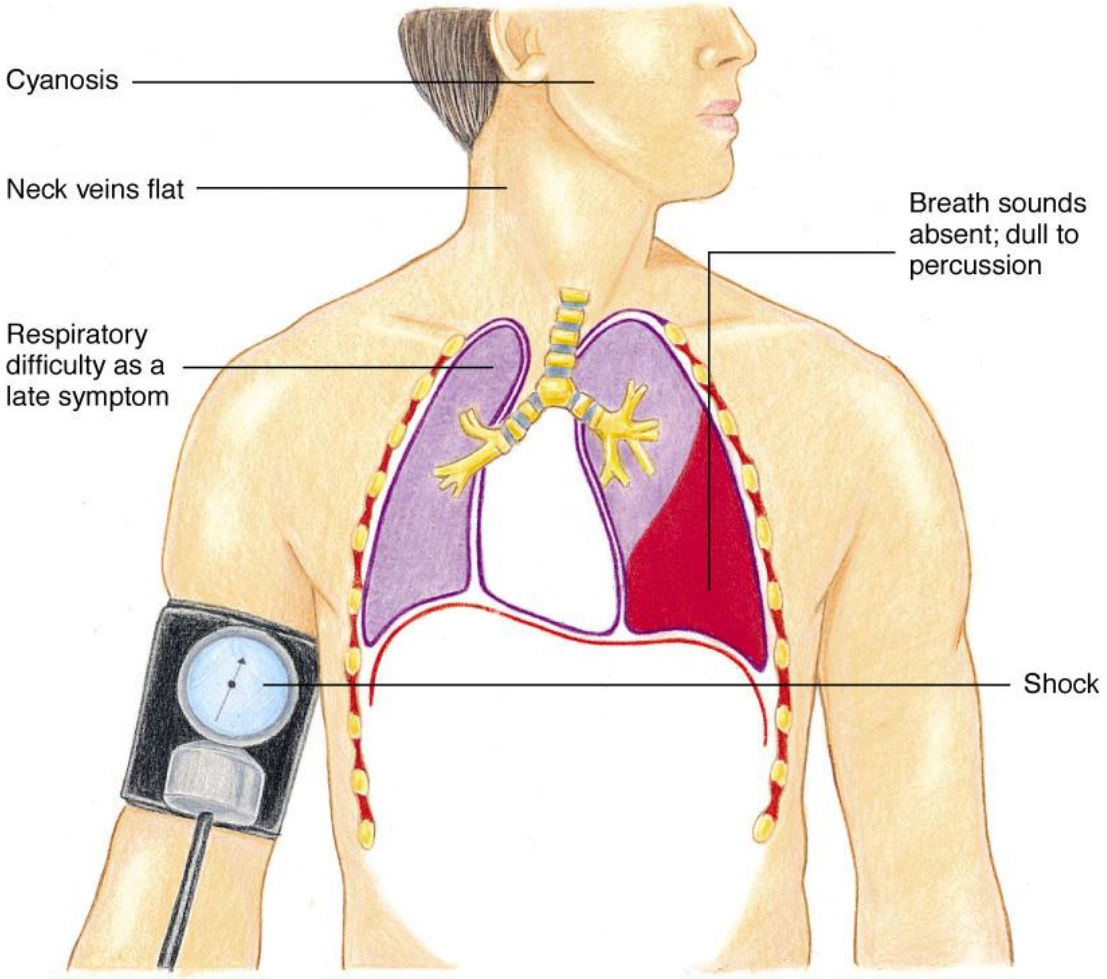
- Diminished then absent breath sounds on injured side
- Cyanosis
- Diaphoresis
- AMS
- JVD
- Hypotension
- Hypovolemia
- Tracheal shift (late sign)

Hemothorax

- Accumulation of blood in the pleural space
  - Serious hemorrhage may accumulate 1,500 mL of blood
  - Each side of thorax may hold up to 3,000 mL
- Mortality rate of 75%
- Blood loss in thorax causes a decrease in tidal volume
  - Ventilation/perfusion mismatch and shock
- Typically accompanies pneumothorax
  - Hemopneumothorax

Hemothorax

- Physical findings of a hemothorax



Sign and Symptoms

- Blunt or penetrating chest trauma
- Shock
  - Dyspnea
  - Tachycardia
  - Tachypnea
  - Diaphoresis
  - Hypotension (flat jugular veins)
- Dull to percussion over injured side

Pulmonary Contusion

- Soft tissue contusion of the lung
- 30-75% of patients with significant blunt chest trauma
- Frequently associated with rib fracture
- Microhemorrhage
  - May account for 1- 1 ½ L of blood loss in alveolar tissue
- Progressive deterioration of ventilatory status
- Hemoptysis typically present

Sign and Symptoms

- Blunt or penetrating chest trauma
- Increasing dyspnea
- Hypoxia
- Increasing crackles
- Diminishing breath sounds
- Hemoptysis
- Signs and symptoms of shock

Cardiovascular Injuries

- Subset of thoracic trauma that leads to the most fatalities
- Myocardial contusion
- Pericardial tamponade
- Myocardial aneurysm or rupture

Myocardial Contusion

- Occurs in 76% of patient with sever blunt thoracic trauma
- Heart is relatively mobile within the chest
  - Strikes the anterior chest during blunt trauma
  - May be compressed between sternum and thoracic spine
- Right atrium and ventricle is commonly injured
- Injury may reduce strength of cardiac contractions
  - Reduced cardiac output
- Electrical disturbances due to irritability of damaged myocardial cells

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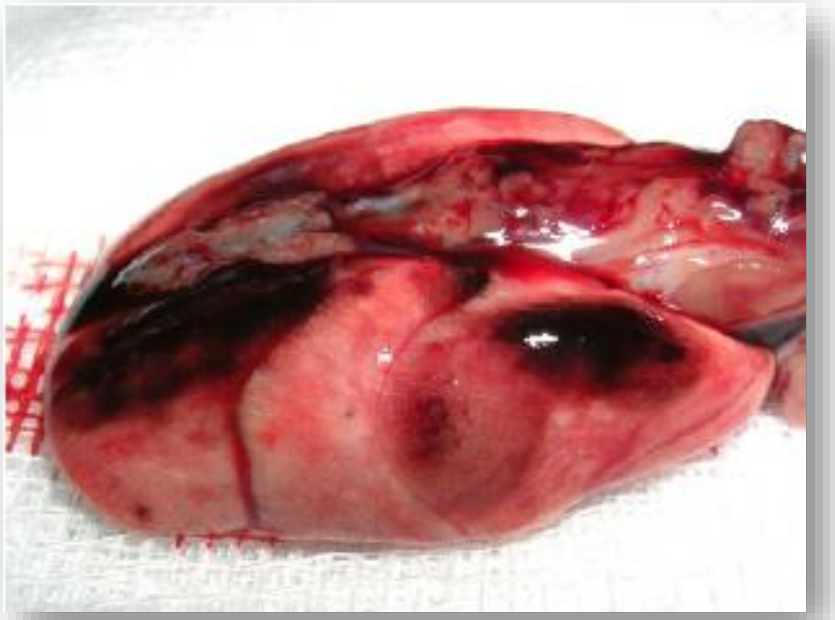
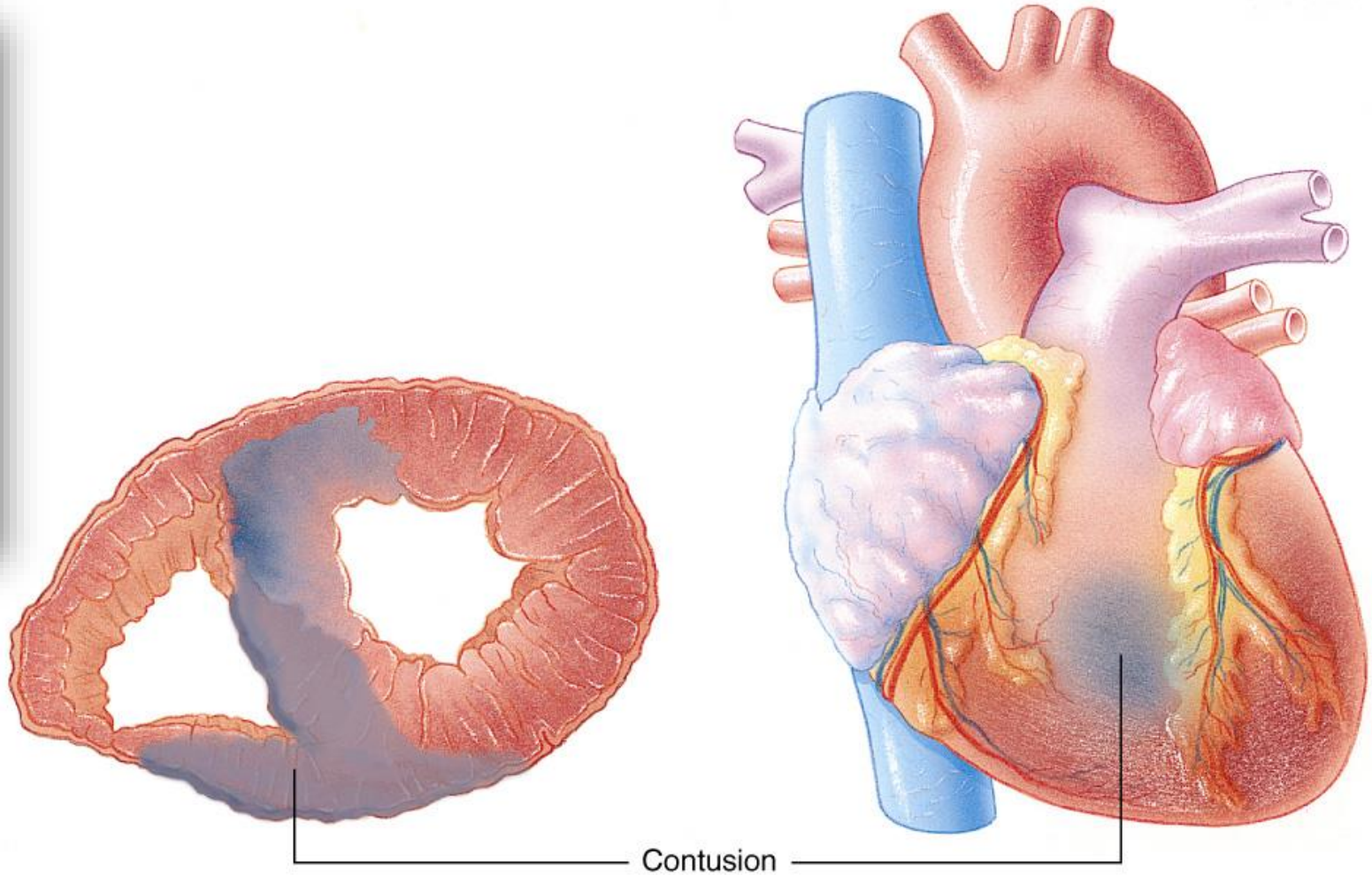
Myocardial Contusion





Myocardial Contusion

Progressive Problems

- Hematoma
- Hemoperitoneum
- Myocardial necrosis
- Dysrhythmias
- Heart failure and/or cardiogenic shock

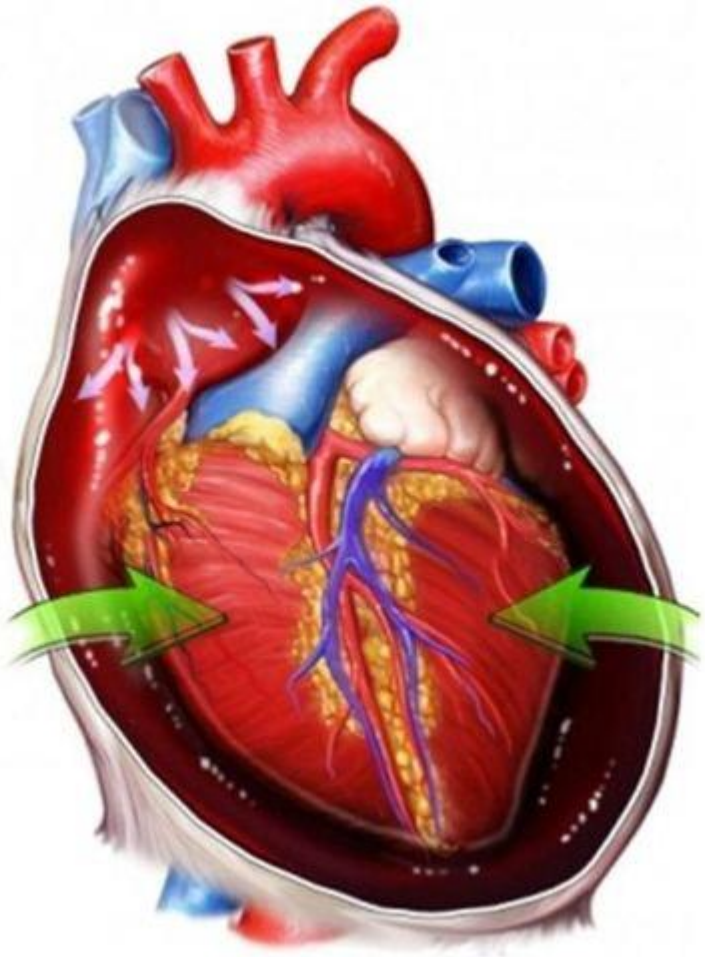
Signs and symptoms

- Blunt injury to the chest
- Bruising of chest wall
- Rapid (irregular) heart rate
- Severe nagging pain unrelieved by rest or oxygen

Pericardial Tamponade

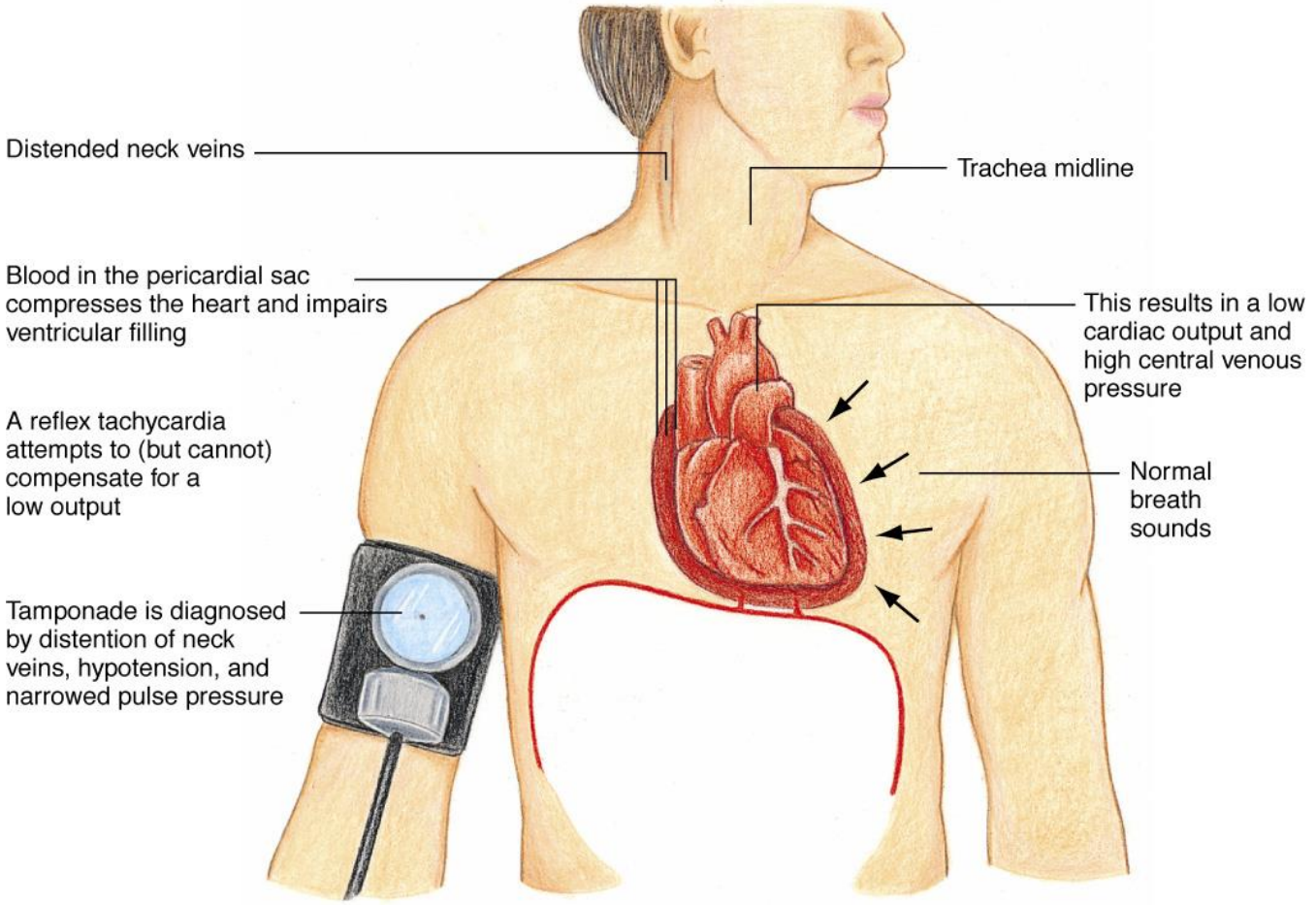
- Restriction to cardiac filling caused by blood or other fluid within the pericardium
- Occurs in <2% of all serious chest trauma
  - Very high mortality
- Results from tear in the coronary artery or penetration of myocardium
  - Blood seeps into pericardium and is unable to escape
  - 200-300 ml of blood can restrict effectiveness of cardiac contractions
  - Removing as little as 20 ml can provide relief

Pericardial Tamponade



Pericardial Tamponade

- Physical findings of pericardial tamponade



Signs and Symptoms

- Dyspnea
- Possible cyanosis
- Beck's Triad
  - Distended jugular veins (JVD)
  - Distant heart sounds
  - Decreased arterial pressure
    - Hypotension or narrowing pulse pressure
- Weak, thready pulse
- Shock

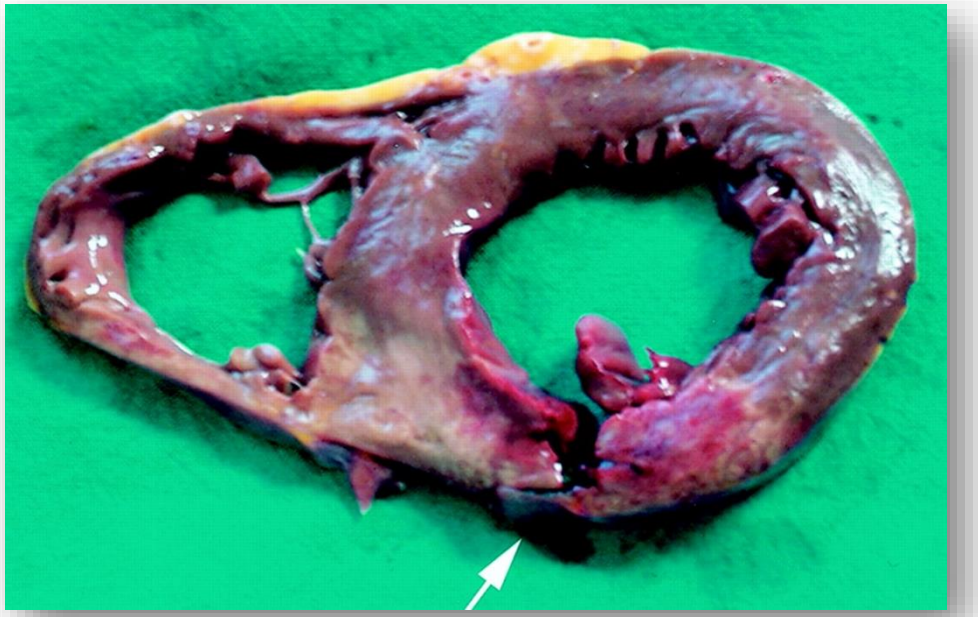
Signs and Symptoms

- Kussmaul's sign
  - Decrease or absence of JVD during inspiration
- Pulsus Paradoxus
  - Drop in SBP >10 during inspiration
  - Due to increase in CO_2 during inspiration
- Electrical Alterans
  - P, QRS, & T amplitude changes in every other cardiac cycle
- PEA

Myocardial Aneurysm or Rupture

- Occurs almost exclusively with extreme blunt thoracic trauma
- Secondary due to necrosis resulting from MI
- Signs and symptoms
  - Severe rib or sternal fracture
  - Possible signs and symptoms of cardiac tamponade
  - Signs & symptoms of right or left heart failure
  - Absence of vital signs

Myocardial Rupture



Traumatic Aneurysm or Aortic Rupture

- Aorta most commonly injured in severe blunt or penetrating trauma
  - 85-95% mortality
- Typically patients will survive the initial injury insult
  - 30% mortality in 6 hrs.
  - 50% mortality in 24 hrs.
  - 70% mortality in 1 week
- Injury may be confined to areas of aorta attachment
- Signs & Symptoms
  - Rapid and deterioration of vitals
  - Pulse deficit between right and left upper or lower extremities

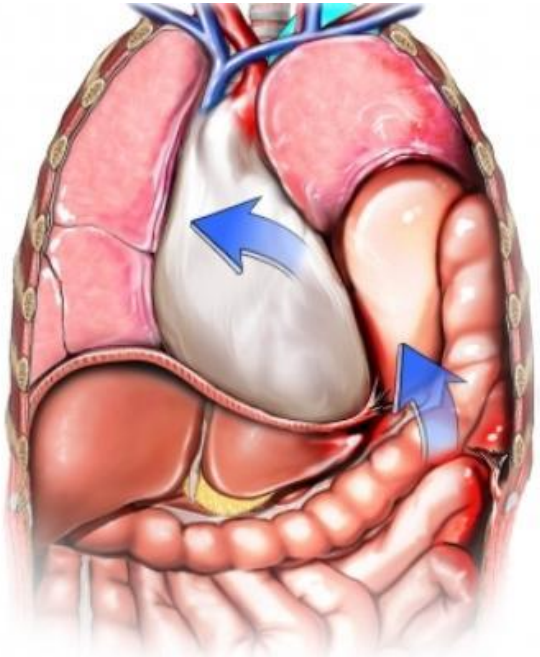
Other Vascular Injuries

- Rupture or laceration
  - Superior vena cava
  - Inferior vena cava
  - General thoracic vasculature
- Blood localizing in mediastinum
- Compression of:
  - Great vessels
  - Myocardium
  - Esophagus

- General signs and symptoms
  - Penetrating trauma
  - Hypovolemia and shock
  - Hemothorax or hemomediastinum

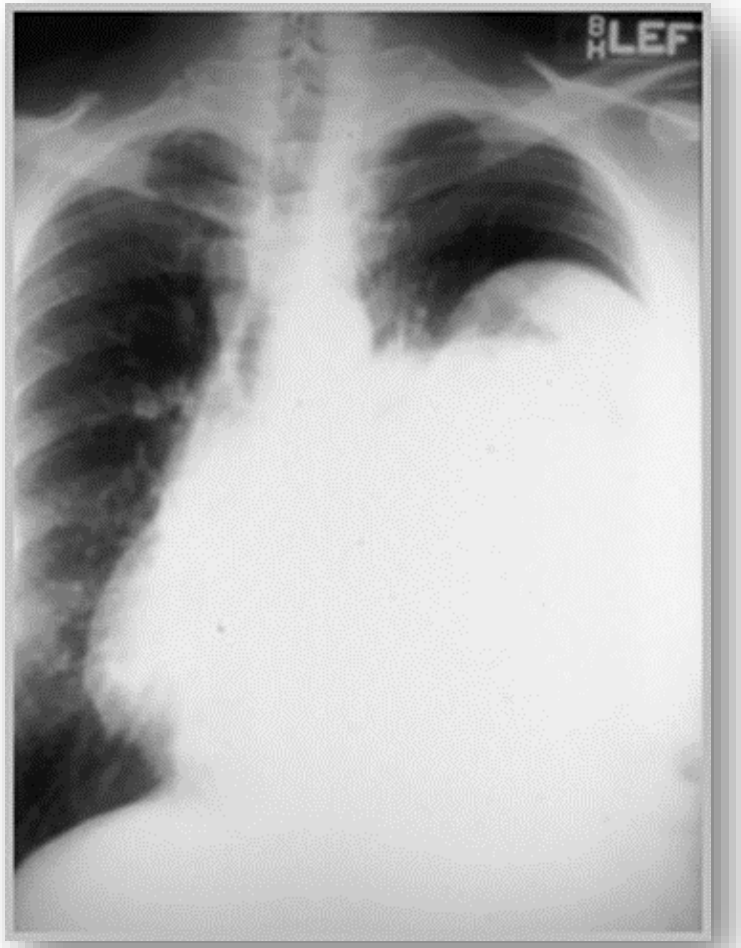
Diaphragmatic Rupture (Hernia)

- Occurs in high pressure blunt chest trauma and penetrating trauma
- Most common in patients with lower chest injury
- Most often occurs on left side
- Similar to tension presentation as pneumothorax



Signs and Symptoms

- Herniation of abdominal organs into thorax
- Restriction of ipsilateral lung
- Displacement of mediastinum
- Abdomen may appear hollow
- Bowel sounds may be noted in thorax
- Dyspnea, hypotension & JVD



Traumatic Esophageal Rupture

- Rare complication of blunt thoracic trauma
- 30% mortality
- Contents in esophagus/stomach may move into mediastinum
  - Serious Infection occurs
  - Chemical irritation
  - Damage to mediastinal structures
  - Air enters mediastinum
  - Subcutaneous emphysema and penetrating trauma present

Tracheobronchial Injury

- 50% of patients with injury die within 1 hr. of injury
- Disruption can occur anywhere in tracheobronchial tree
- Signs and symptoms
  - Dyspnea
  - Cyanosis
  - Hemoptysis
  - Massive subcutaneous emphysema
  - Suspect/evaluate for other closed chest trauma

Traumatic Asphyxia

- Results from severe compressive forces applied to the thorax
- Causes backwards flow of blood from right side of heart into superior vena cava and the upper extremities
- Signs and symptoms
  - Head and neck become engorged with blood
  - Skin becomes deep red, purple, or blue
  - Not respiratory related
  - JVD
  - Hypotension, hypoxemia, shock
  - Face and tongue swollen
  - Bulging eyes with conjunctival hemorrhage

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Traumatic Asphyxia

Thoracic Trauma Assessment: The Deadly Dozen

Immediate Life Threatening
"The Lethal six"

1. Airway Obstruction
2. Tension Pneumothorax
3. Pericardial Tamponade
4. Open Pneumothorax
5. Massive Hemothorax
6. Flail Segment

Potentially Life Threatening
"The Hidden Six"

1. Thoracic Aortic Disruption
2. Tracheobronchial Injuries
3. Myocardial Contusion
4. Diaphragmatic Injuries
5. Esophageal Injury
6. Pulmonary Contusion

ATTENTION

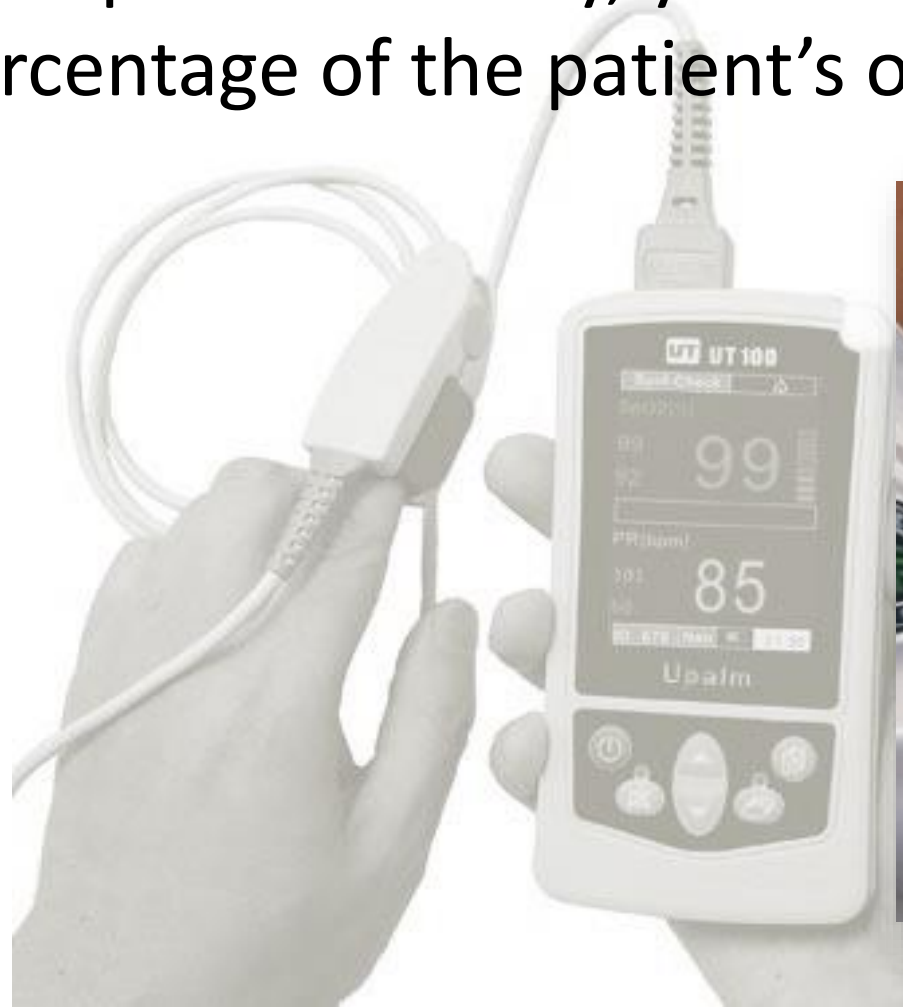
Always be Aware

Assessment of Thoracic Trauma

- Scene assessment
- Primary assessment – “The Lethal Six”
- Rapid trauma assessment
  - Look – Observe exposed chest
    - JVD, obvious injuries, expansion of chest
  - Listen – Auscultate chest
    - Bilateral and equal air entry
  - Feel – Palpate chest
    - Pain/tenderness, subcutaneous emphysema, stability
- Ongoing assessment – “The Hidden Six”

Pulse Oximetry

- With pulse oximetry, you can continuously monitor the percentage of the patient's oxygen saturation



Palpation

- Carefully palpate the thorax of a patient with a suspected injury to the region

Palpation

- Placing your hands on the lower thorax, you can feel for rise and fall of the chest during respiration

Auscultation

- Auscultate frequently
- Auscultate all lung lobes, both anteriorly and posteriorly (if possible)

General Management

- Ensure ABC's
  - High flow O_2 via NRB
  - Intubate if indicated
    - Consider ALS back up
  - Consider overdrive ventilation
    - If minute volume less than 6,000 mL
    - BVM at a rate of 12-16
  - May be beneficial for chest contusion and rib fractures
  - Promotes oxygen perfusion of alveoli and prevents atelectasis

General Management

- Anticipate myocardial compromise
- Shock management
- Serial auscultation
- Specific procedures

Interventions

PCP

- Full spinal immobilization
- Open airway
- Control significant bleeding
- Apply occlusive dressing
- Stabilize flail segments
- Administer IV fluids
- Administer analgesics
- Call for ACP
- Rapid Transport

ACP

- Endotracheal Intubation
- Chest needle decompression
- Administer TXA
- Administer controlled drug analgesics

Management

- Rib fractures
  - Supportive O_2 therapy
  - Consider analgesics for pain and to improve chest excursion
- Sternoclavicular Dislocation
  - Supportive O_2 therapy
  - Evaluate for concomitant injury

Management

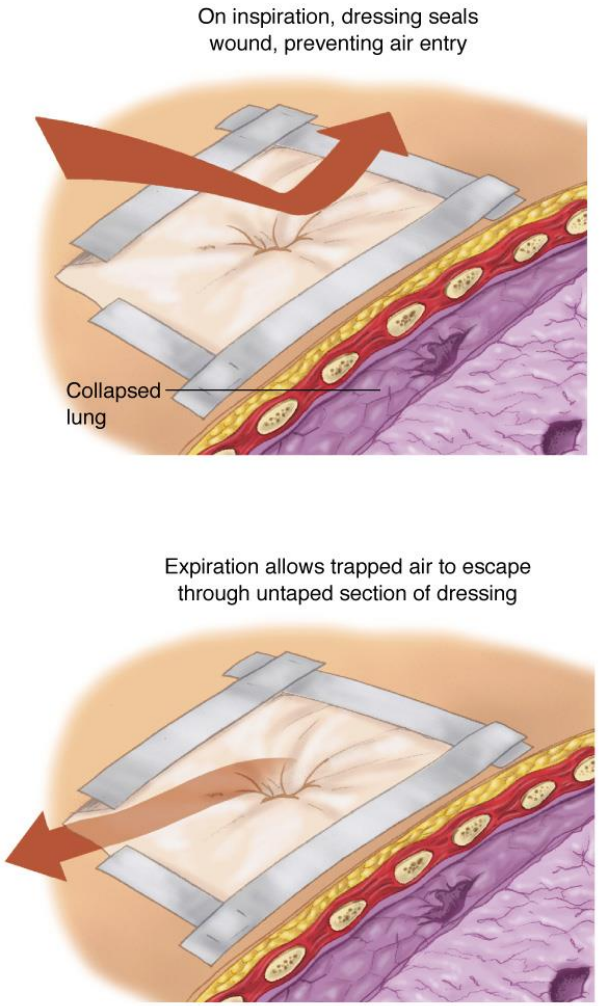
- Flail Chest
  - Place patient on side of injury
    - Only if spinal injury is not suspected
  - Expose injury site
  - Dress with bulky bandage against flail segment
    - Gentle splinting
    - Stabilizes fracture site
    - Sandbags are contraindicated
  - High flow O_2
  - Consider PPV or ET if decreasing respiratory status

Management

- Flail Chest should be treated with administration of oxygen and gentle splinting of the flail segment with a pillow or a pad

Management

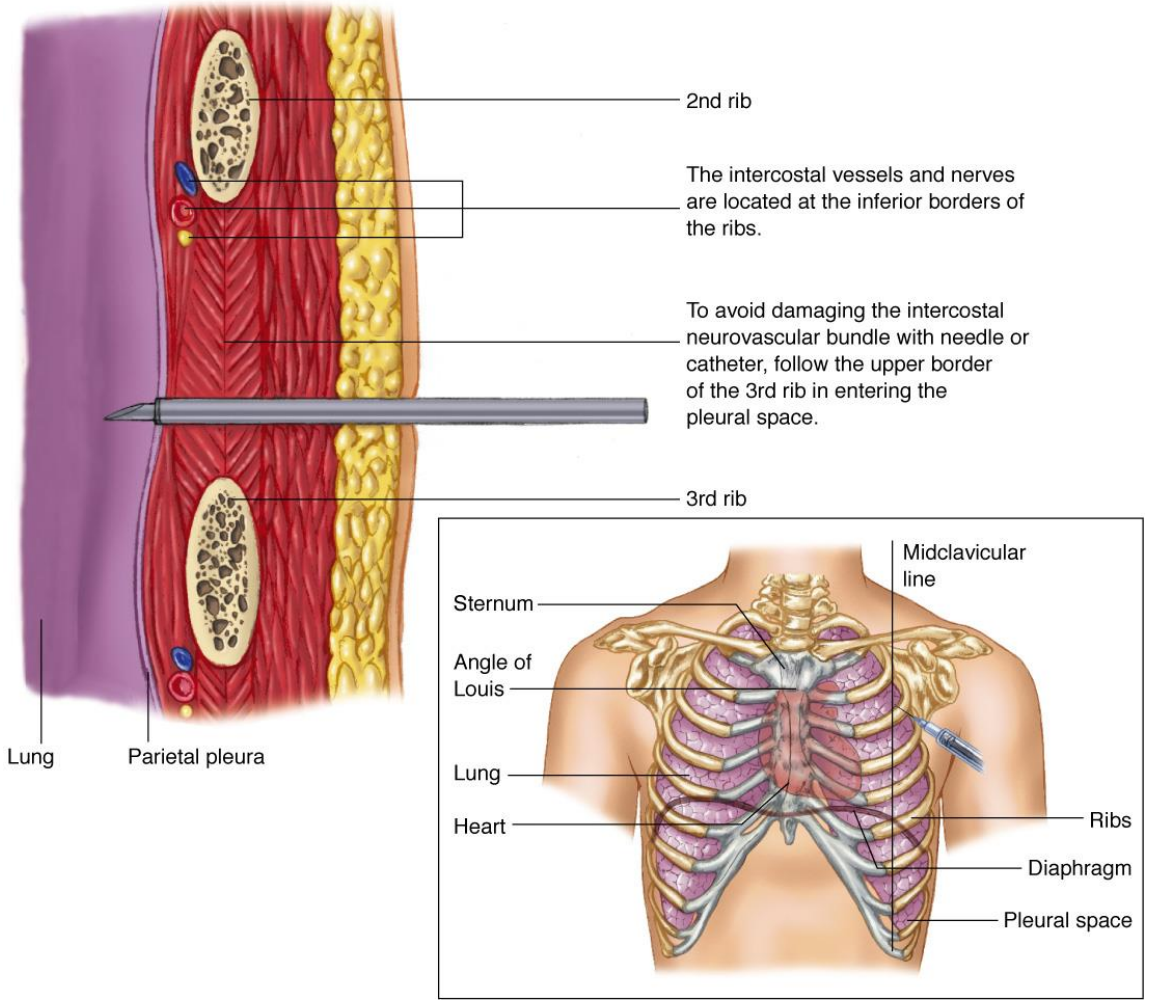
- Open Pneumothorax
  - High flow O_2
  - Cover site with sterile occlusive dressing taped on three sides
  - Progressive airway management if indicated



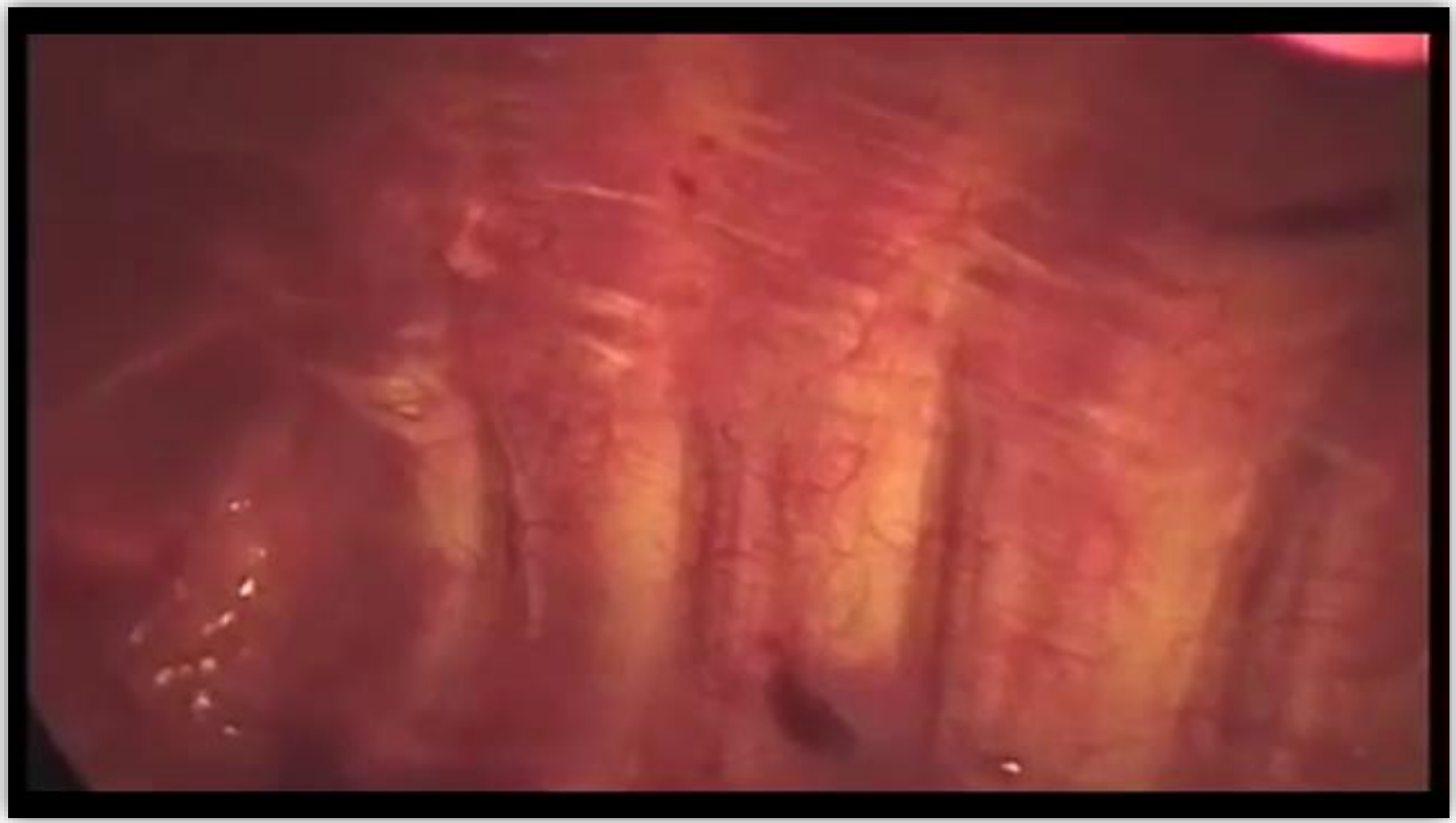
Tension Pneumothorax

- Confirmation
  - Auscultation and physical signs
- Oxygen therapy
  - Consider overdrive ventilations/intubation
- Pleural Decompression (ACP/CCP Only)
  - 2nd intercostal space in mid-clavicular line
  - Top of the 3rd rib
  - Consider multiple decompression sites if patient remains symptomatic
  - Large over the needle catheter: 14 ga
  - Create a one-way-valve: Glove tip or Heimlich valve

Needle Decompression



Lung Reinflation



Management

- Hemothorax
  - Supportive O_2 therapy
  - Fluid resuscitation
  - Evaluate breath sounds for fluid overload
- Myocardial Contusion
  - Monitor ECG
  - Alert for dysrhythmias
  - IV if anti-dysrhythmics are needed

Management

- Pericardial Tamponade
  - Supportive O_2 therapy
  - IV therapy
  - Consider pericardiocentesis if within scope/skill
- Aortic Aneurysm
  - Avoid jarring or rough handling
  - Initiate IV therapy enroute
    - Mild hypotension may be protective
    - Rapid fluid bolus if aneurysm ruptures
  - Keep patient calm

Management

- Tracheobronchial Injury
  - Airway management/consider intubation
  - Supportive O_2 therapy
  - Observe for development of tension pneumothorax and SQ emphysema
- Traumatic Asphyxia
  - Support airway
  - Supportive O_2 therapy, consider PPV with BVM
  - 2 large bore IV's
  - Evaluate and treat for concomitant injuries
  - Consider Sodium Bicarbonate for patients trapped (ACP/CCP Only)

Documentation

- Key Points
  - Scene findings
  - Mechanism of injury
  - Time of injury
  - Initial patient presentation
  - Complete physical exam inc. pertinent negatives
  - Treatment provided
  - Reassessment findings

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Summary

- Pathophysiology
- Assessment
- Management
- Documentation