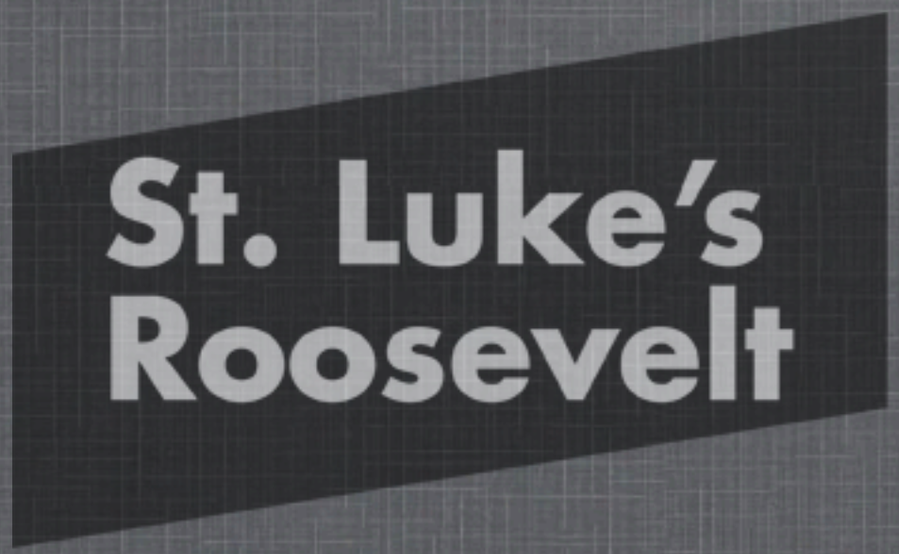
CHEST TRAUMA

NOT ALL IT'S CRACKED UP TO BE!

Jeffrey Rabrich, DO, FACEP, EMT-P
Medical Director



Academic Affiliate of
Columbia University College
of Physicians & Surgeons

Continuum Health Partners, Inc.

Level 1 Trauma Center

190K Visits / Yr.

900 Beds

9th Busiest ED in US

OBJECTIVES

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- Review epidemiology of thoracic trauma

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- Review anatomy and physiology as pertains to trauma

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- Review anatomy and physiology as pertains to trauma
- Review specific thoracic injuries and their management
- Review general approach to chest trauma
- Discuss current controversies in trauma

THORACIC TRAUMA

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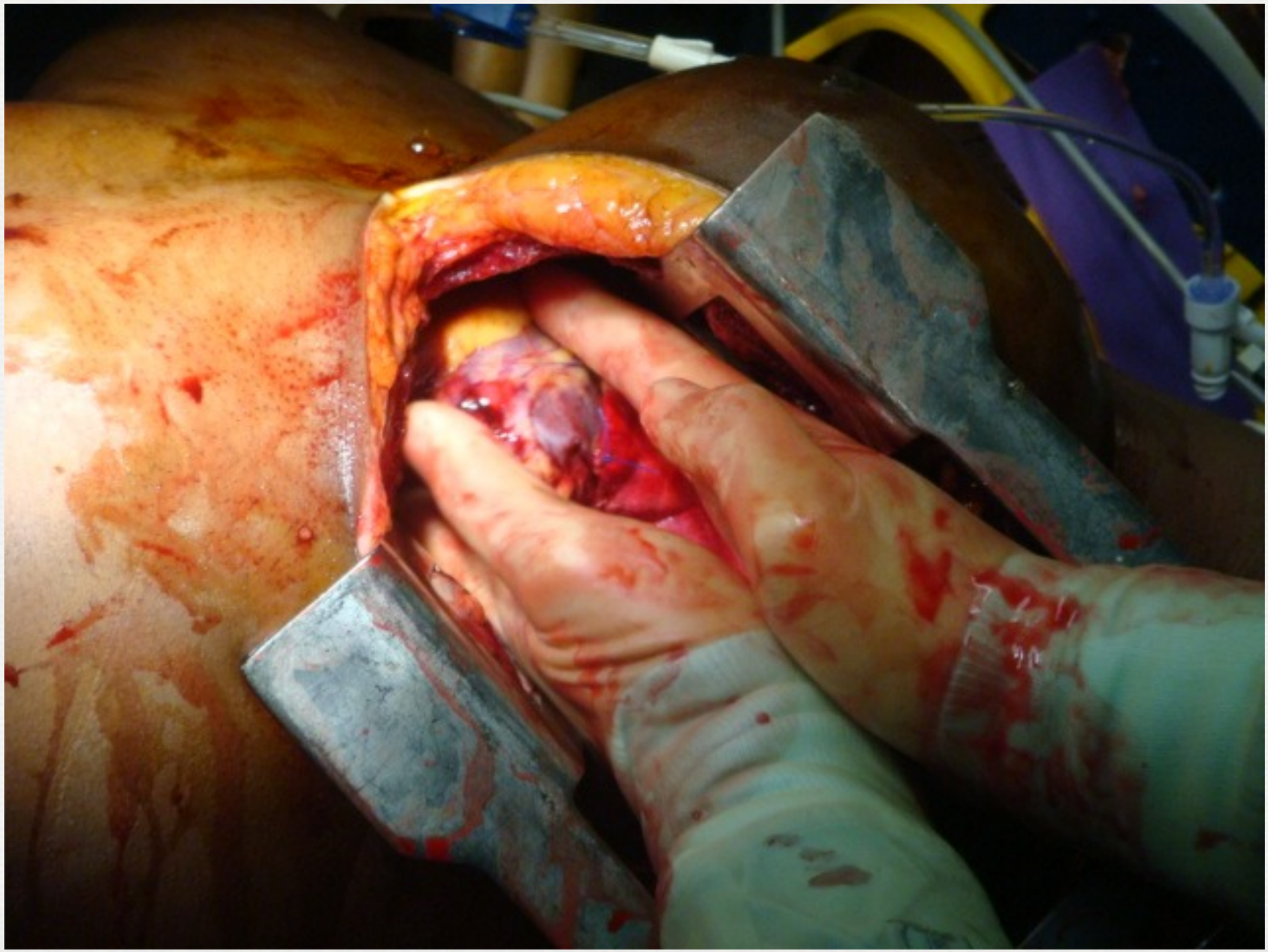
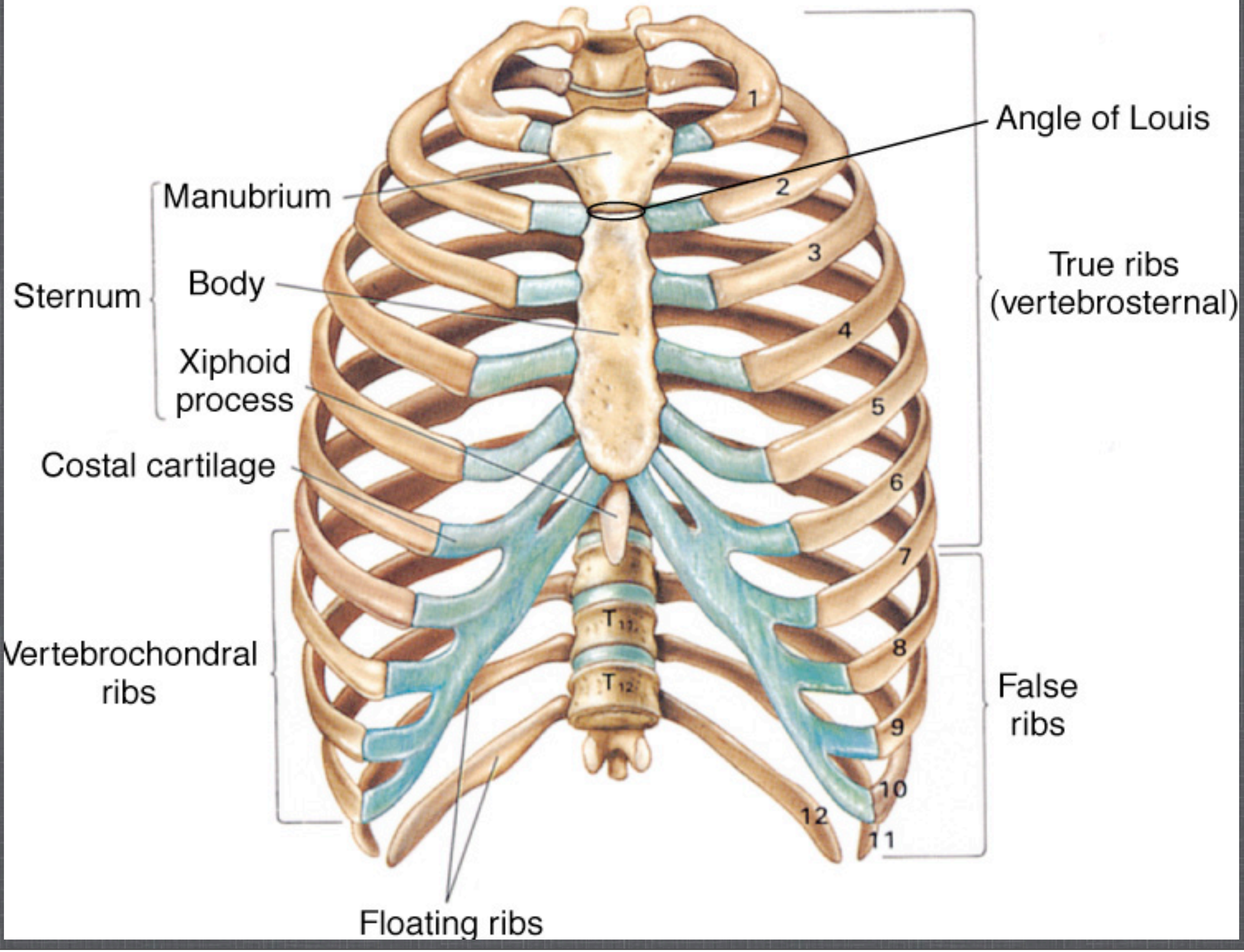
- Blunt much more common than penetrating (70-80%)
- Vast majority are now managed non-operatively

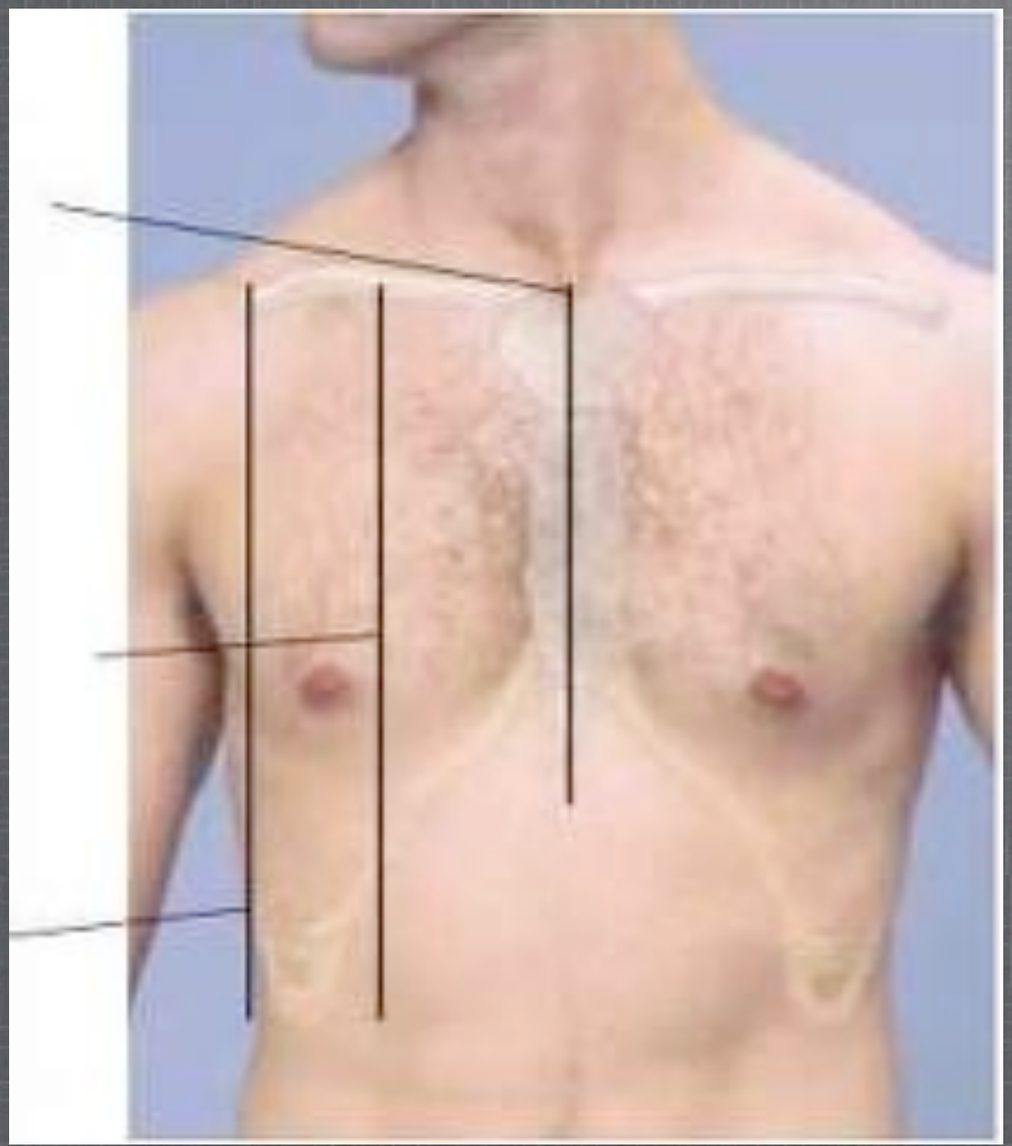
ANATOMY

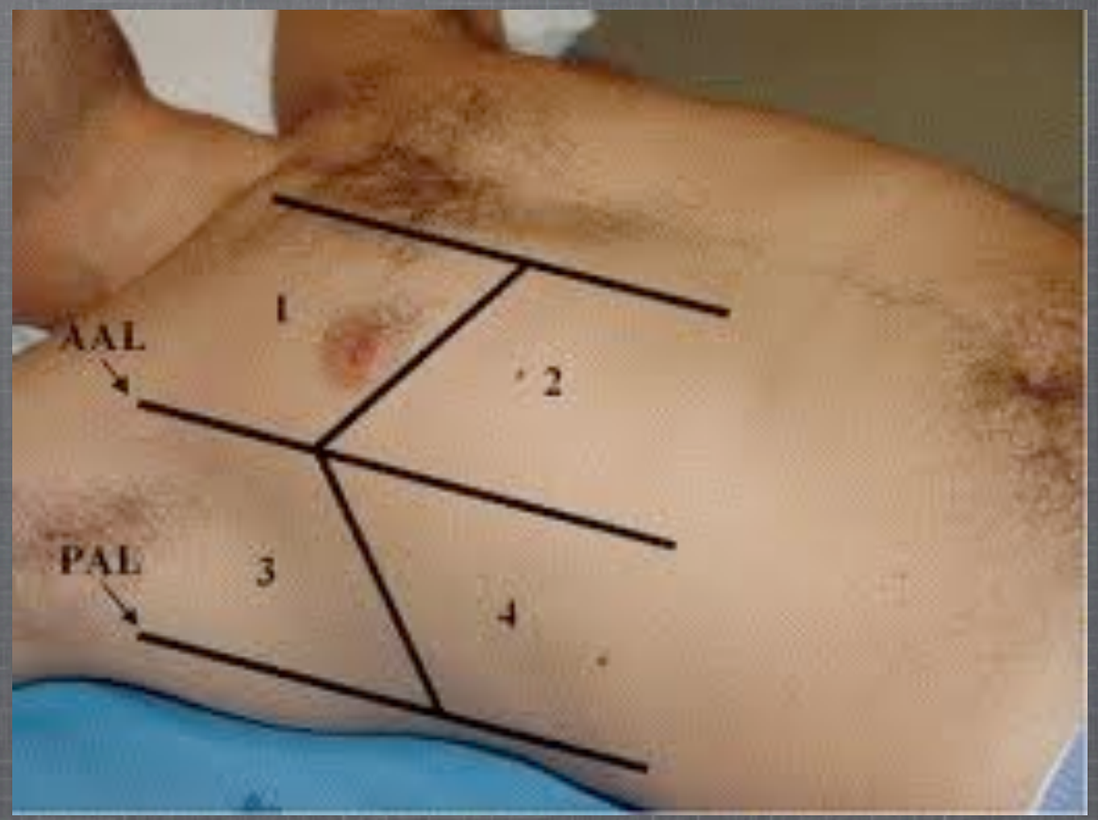


CHEST WALL

- Thoracic Skeleton
  - 12 Pairs of C-shaped ribs
    - Ribs 1-7: Join sternum at cartilaginous end points
    - Ribs 8-10: Join sternum at combined cartilage
    - Ribs 11-12: No anterior attachment
- Sternum
  - Manubrium, Body, Xiphoid


Angle of Louis
Manubrium
Sternum
Body
Xiphoid process
Costal cartilage
True ribs (vertebrosternal)
1
2
3
4
5
6
7
8
9
10
11
12
T11
T12
Vertebrochondral ribs
False ribs
Floating ribs





SURFACE LANDMARKS ON CHEST

CHEST WALL

CHEST WALL

- Intercostal Space
  - Below names rib (2nd ICS is below 2nd rib)
  - Neurovascular bundle

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  - Neurovascular bundle
- Thoracic inlet
  - superior opening formed by curvature of first rib

CHEST WALL

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  - Neurovascular bundle
- Thoracic inlet
  - superior opening formed by curvature of first rib
- Thoracic outlet
  - Inferior opening (12th rib, xiphosternal joint)

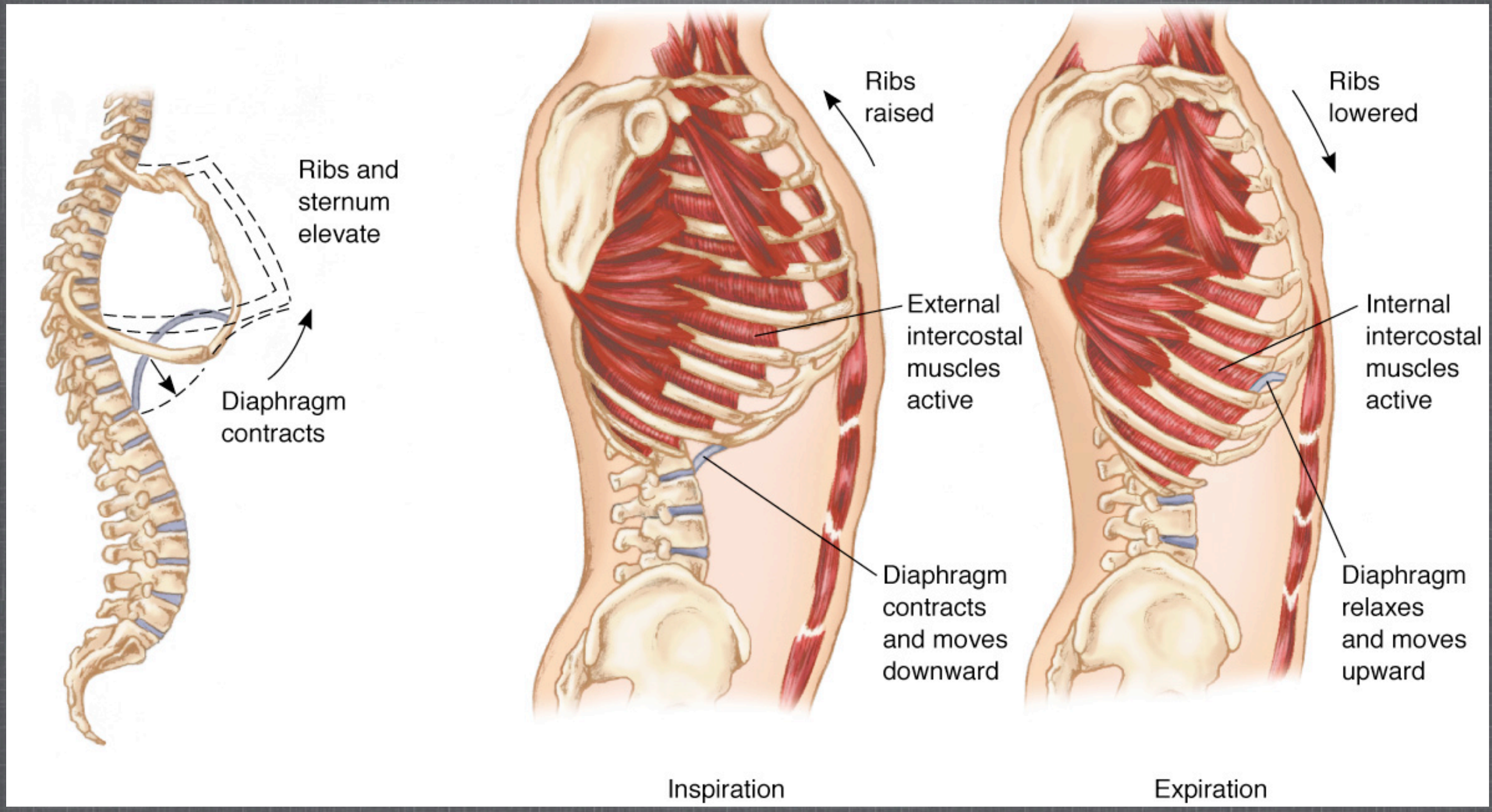
ANATOMY

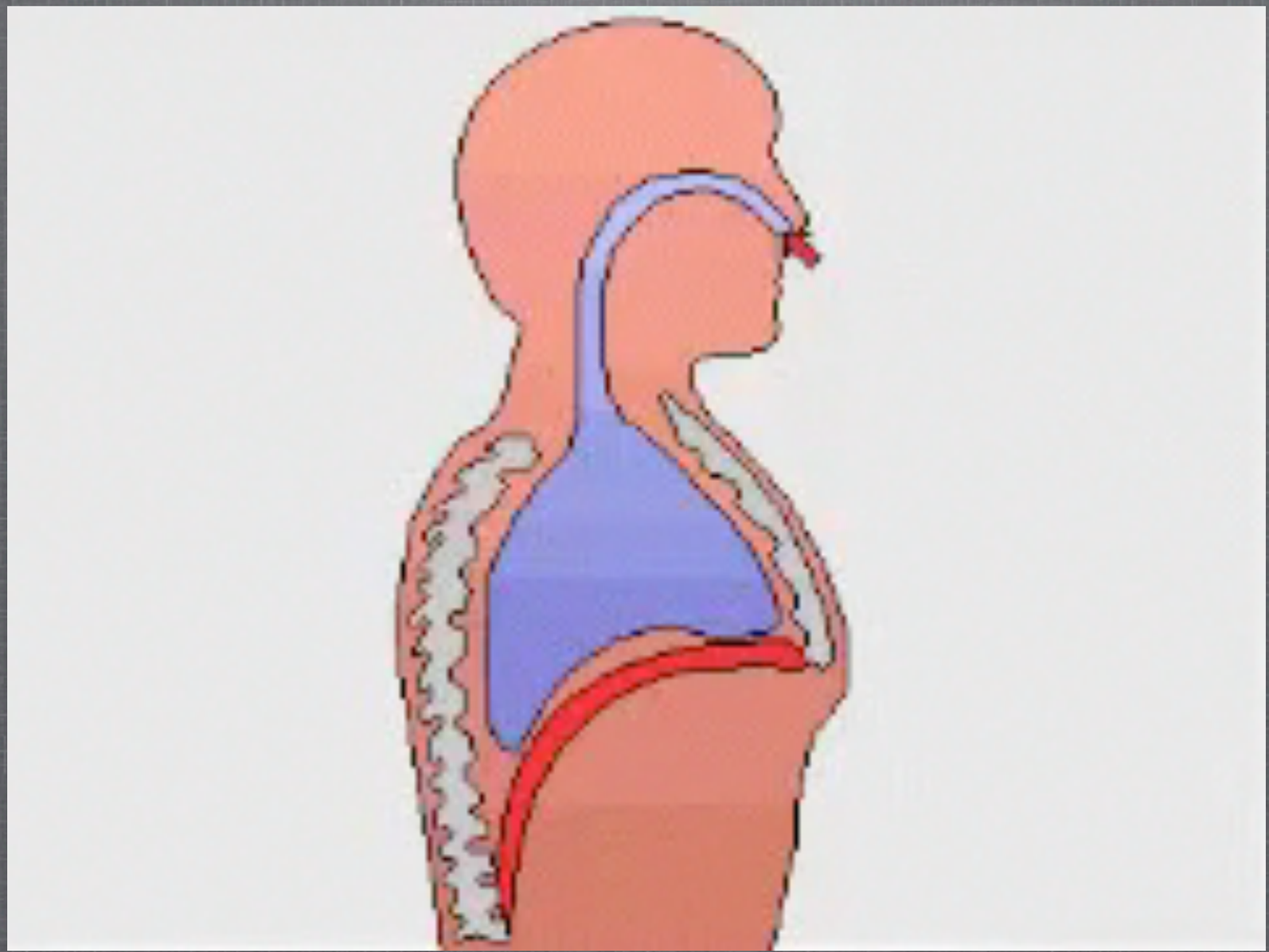
- Diaphragm
  - Dome-like muscular structure
  - Separates thorax from abdomen
  - Attached to lower ribs, anteriorly extends as high as 4th rib
  - Major muscle of respiration

ASSOCIATED MUSCULATURE

- Muscles of respiration
  - Diaphragm
  - External intercostals
  - internal intercostals
  - sternocleidomastoid

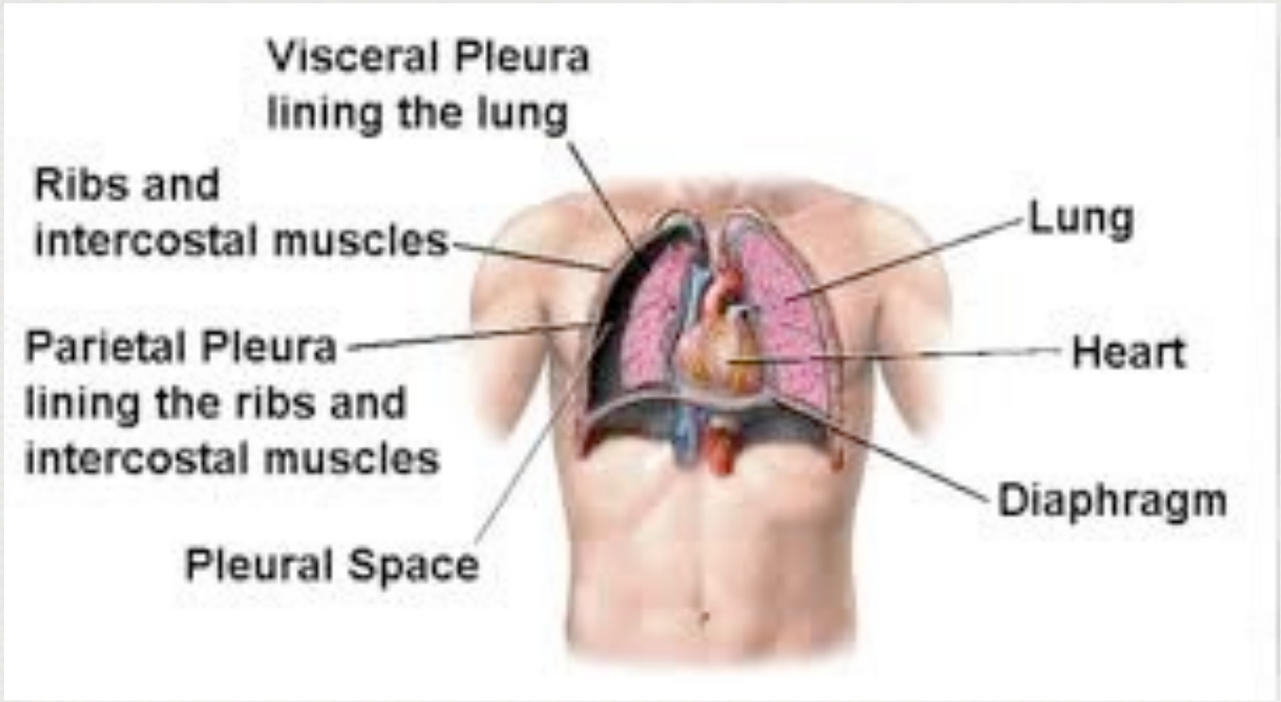
RESPIRATORY MUSCLES

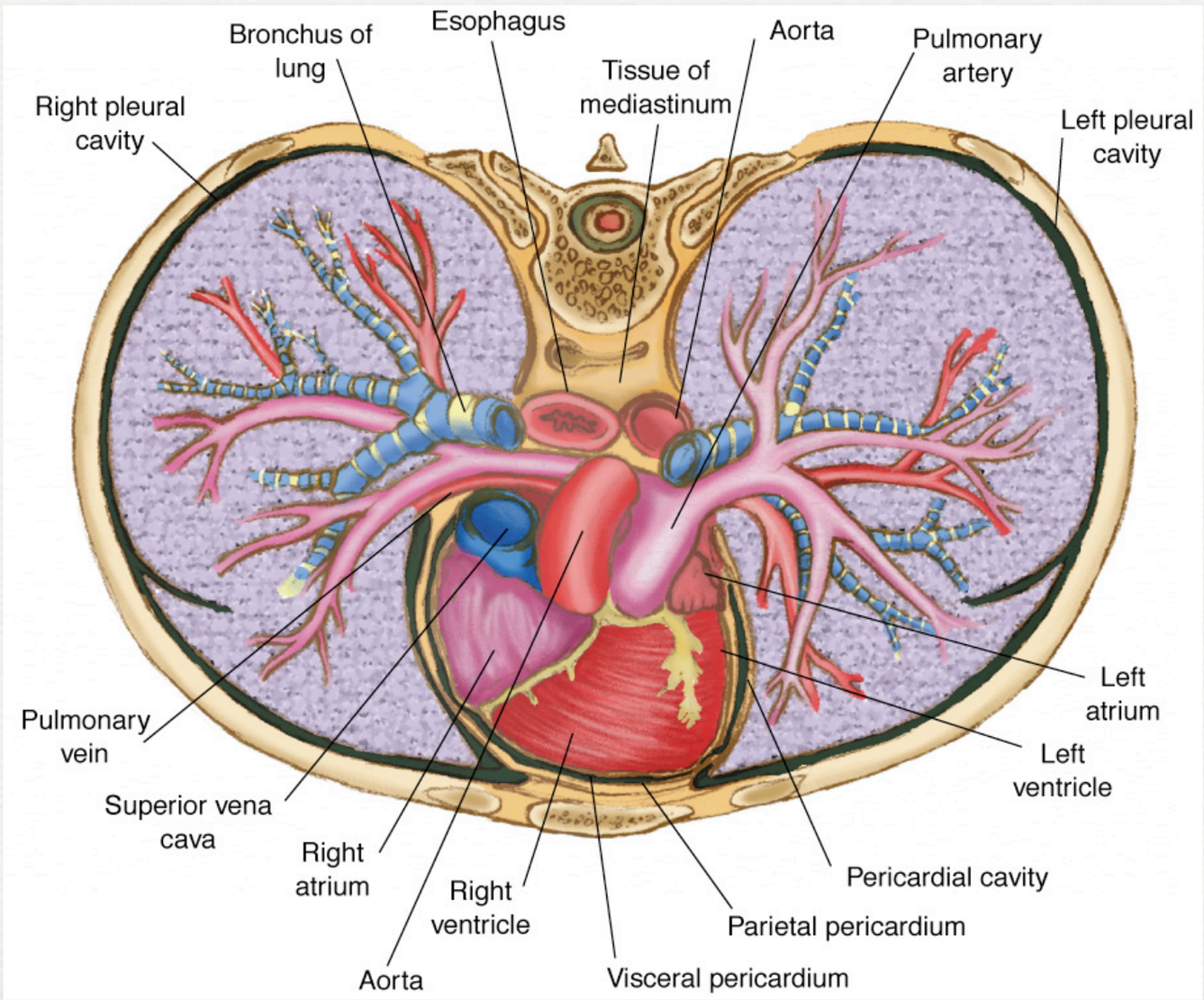




VENTILATION MECHANICS

WHAT IS THE MOST ANTERIOR CARDIAC STRUCTURE?


Visceral Pleura
lining the lung
Ribs and
intercostal muscles
Lung
Parietal Pleura
lining the ribs and
intercostal muscles
Heart
Diaphragm
Pleural Space


Bronchus of
lung
Esophagus
Aorta
Pulmonary
artery
Tissue of
mediastinum
Right pleural
cavity
Left pleural
cavity
Left
atrium
Pulmonary
vein
Left
ventricle
Superior vena
cava
Right
atrium
Pericardial cavity
Right
ventricle
Parietal pericardium
Aorta
Visceral pericardium

MAJOR STRUCTURES

MAJOR STRUCTURES

- Mediastinum

MAJOR STRUCTURES

- Mediastinum
  - Aorta

MAJOR STRUCTURES

- Mediastinum
  - Aorta
  - Heart

MAJOR STRUCTURES

- Mediastinum
  - Aorta
  - Heart
  - Pulmonary Artery /Veins

MAJOR STRUCTURES

- Mediastinum
  - Aorta
  - Heart
  - Pulmonary Artery /Veins
  - Tracheobronchial tree

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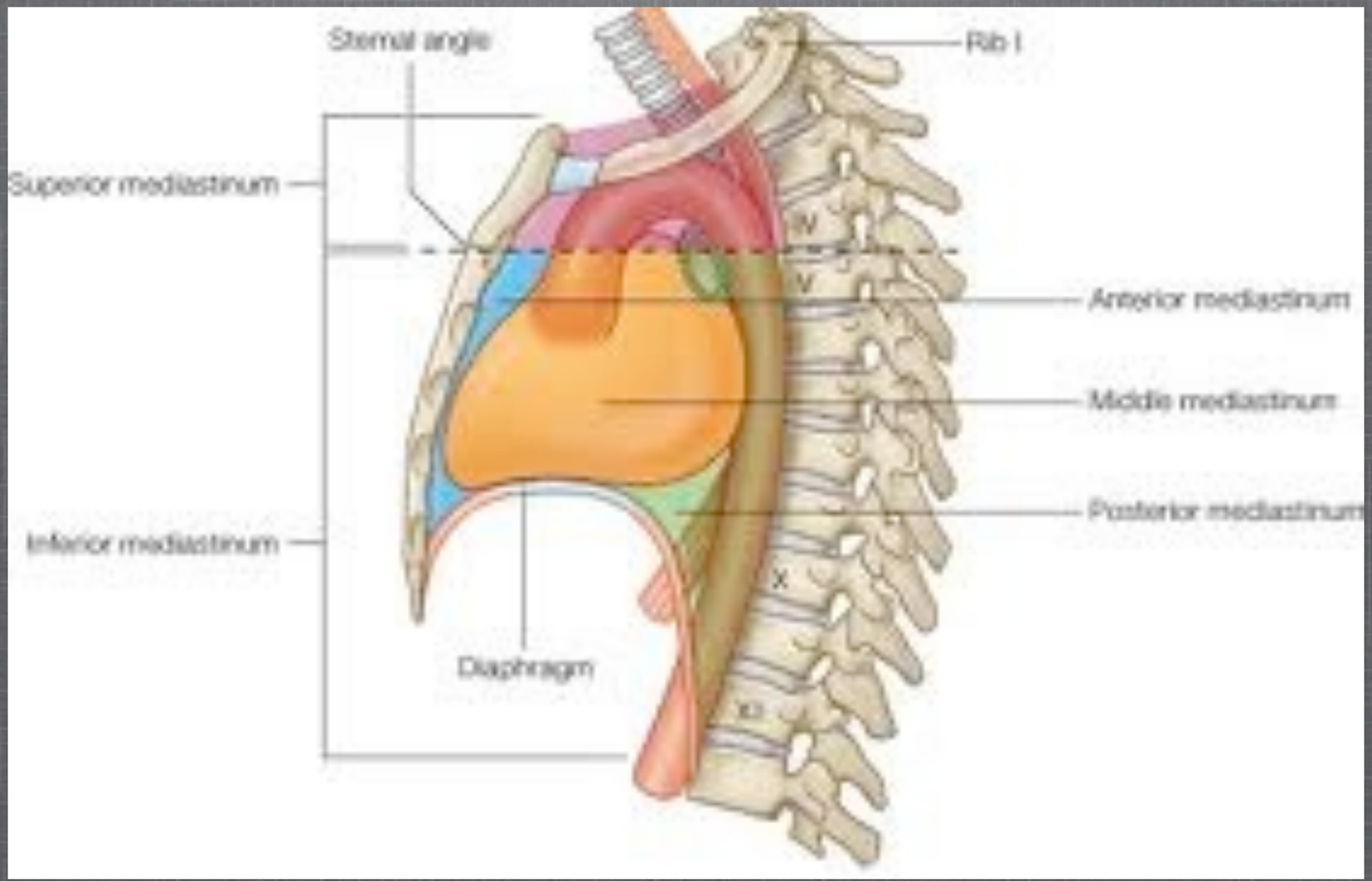
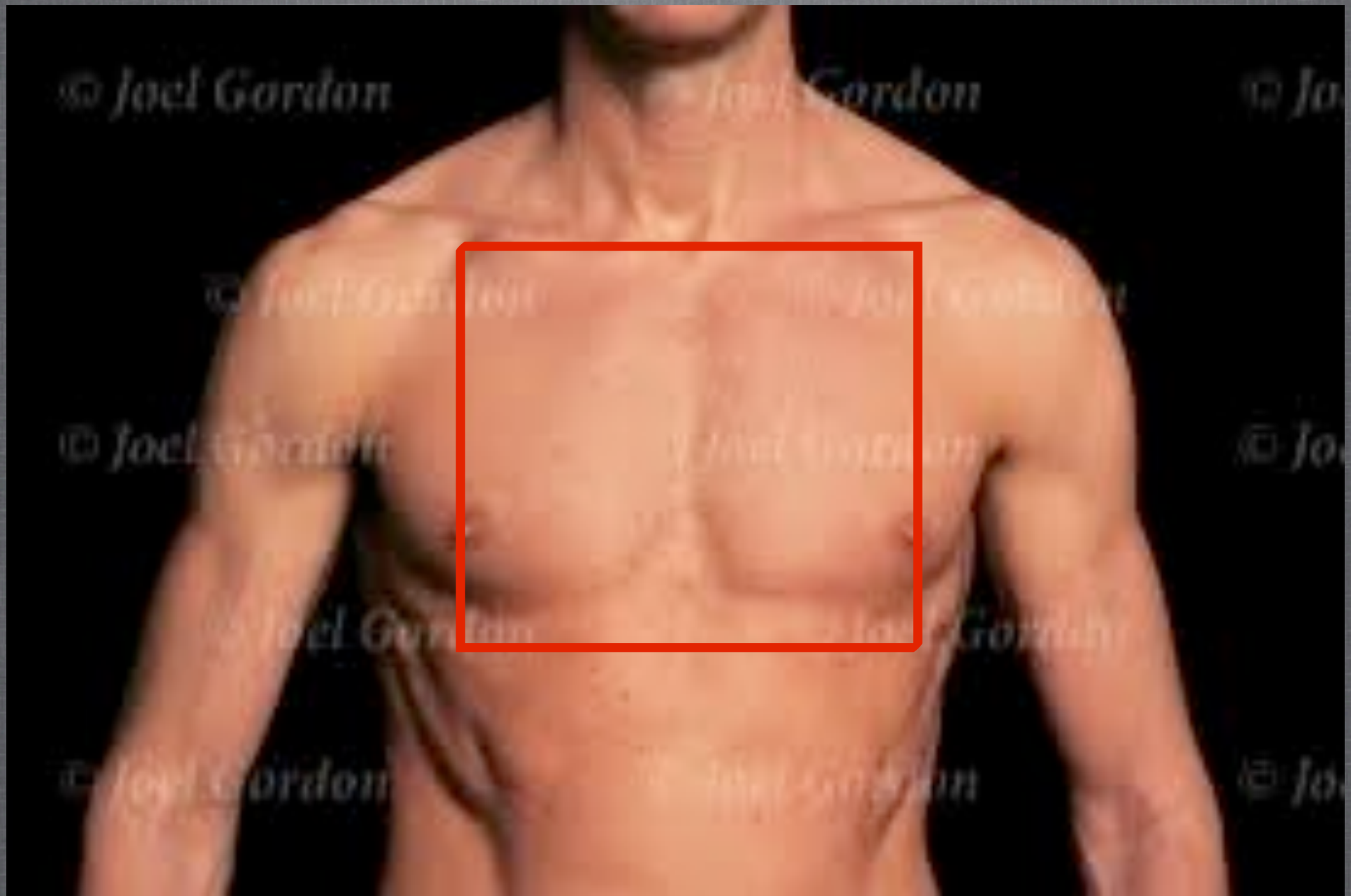
  - esophagus



THE MEDIASTINUM

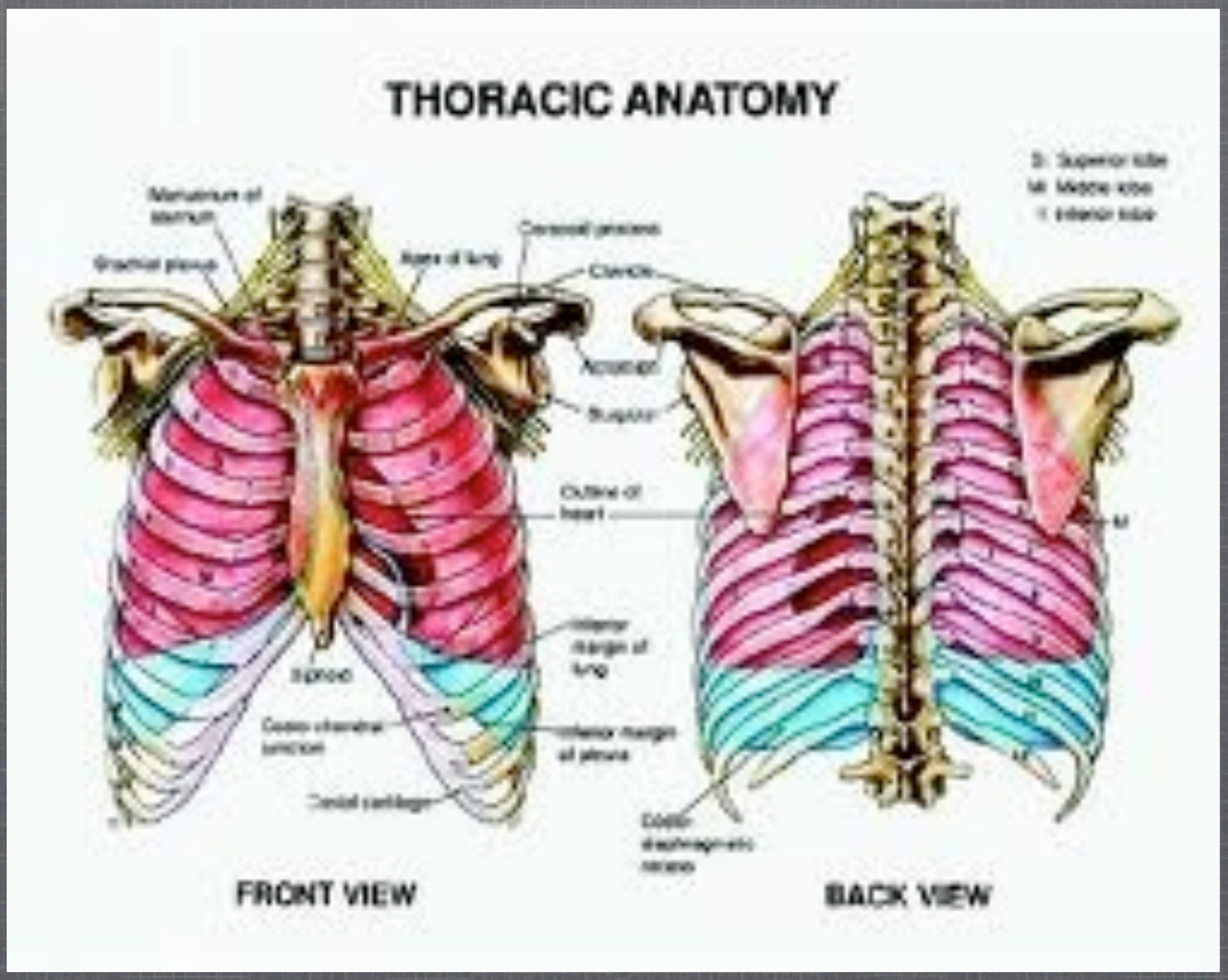
WHAT IS THE "BOX"?


© Joel Gordon

WHAT'S LEFT?

- Lungs
  - occupy the majority of the chest cavity
  - 3 lobes on right, 2 on left
  - covered by adherent visceral pleura
  - parietal pleura

THORACIC ANATOMY



MECHANISMS OF TRAUMA

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  - Blast - pressure wave causes injury
  - Crush - chest is compressed between objects
  - Deceleration - “the 3 collisions”

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  - Stab wounds (Knife, ice pick)
  - Impaled objects
  - Divided into high energy and low energy

AGE CONSIDERATIONS

- pediatrics - more cartilaginous leads to more soft tissue injury and less fracture
- geriatric - osteoporosis leads to more fractures, more serious injury with seemingly trivial trauma

SKELETAL INJURIES

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- Clavicle fractures

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  - Signs and symptoms include pain, swelling, deformity.
  - Treatment is sling (+/- swathe)


S
INTERNAL
LEFT
R
L
I

RIB FRACTURES

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- Rare in children, if present must suspect non-accidental trauma

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- More common with increasing age
- Concern for underlying injury
- Requires significant force
- Most commonly due to blunt force trauma

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- Ribs 3-8 most commonly fractured
- Fracture of ribs 1-2 highly concerning for associated injury.

RIB FRACTURES

- Rib 1-2
  - Very short, thick ribs, requiring tremendous force to fracture. same deal with scapula fracture
  - Must have concern for vascular injury (aorta, pulmonary vessels)
  - Treat aggressively even if injury not apparrent


L

SIGNS AND SYMPTOMS

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- Treatment
  - oxygen, pain management
  - Do NOT splint

SEQUELAE

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- Atelectasis

SEQUELAE

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SEQUELAE

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- Most rib fractures heal without consequence
- Keys to treatment are pain management and incentive spirometry

MULTIPLE RIBS

- Generally 3 or more consecutive rib fractures are cause for admission and observation
- As number of fractures increases so does pain and splinting, leading to other concerns
- Associated injury such as pulmonary contusion becomes more likely

TRANSPORT CONSIDERATION

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- Positive pressure ventilation may be needed
- Consider ALS backup for analgesia if available

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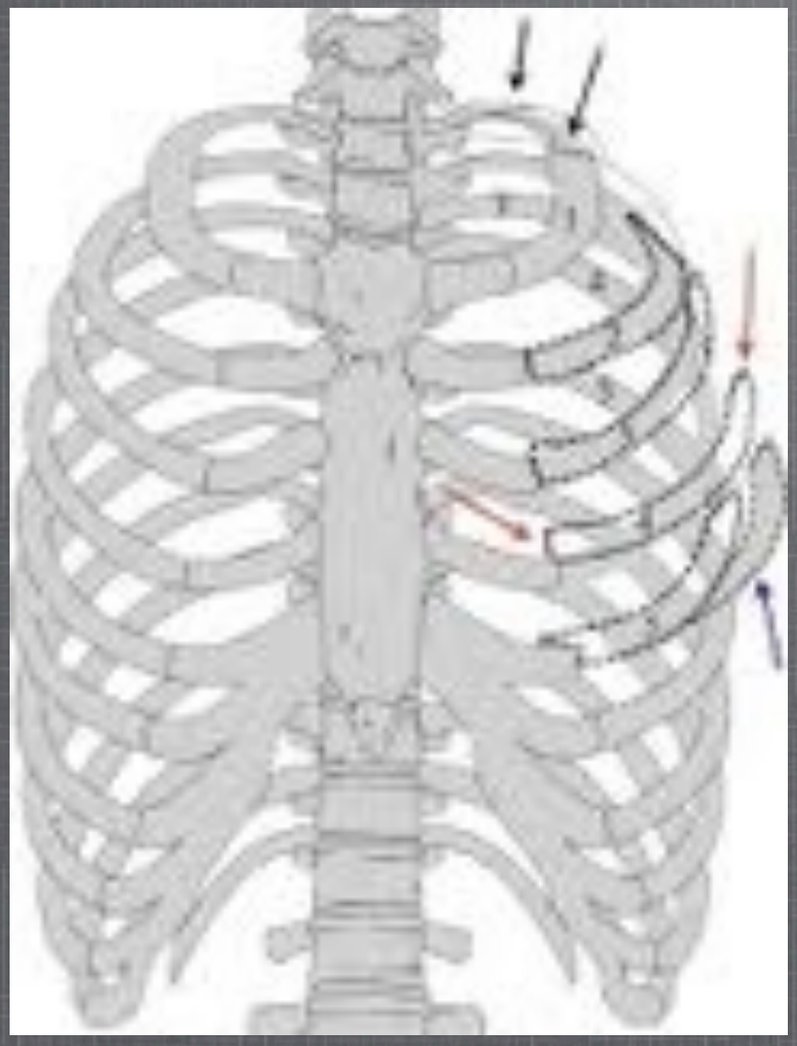
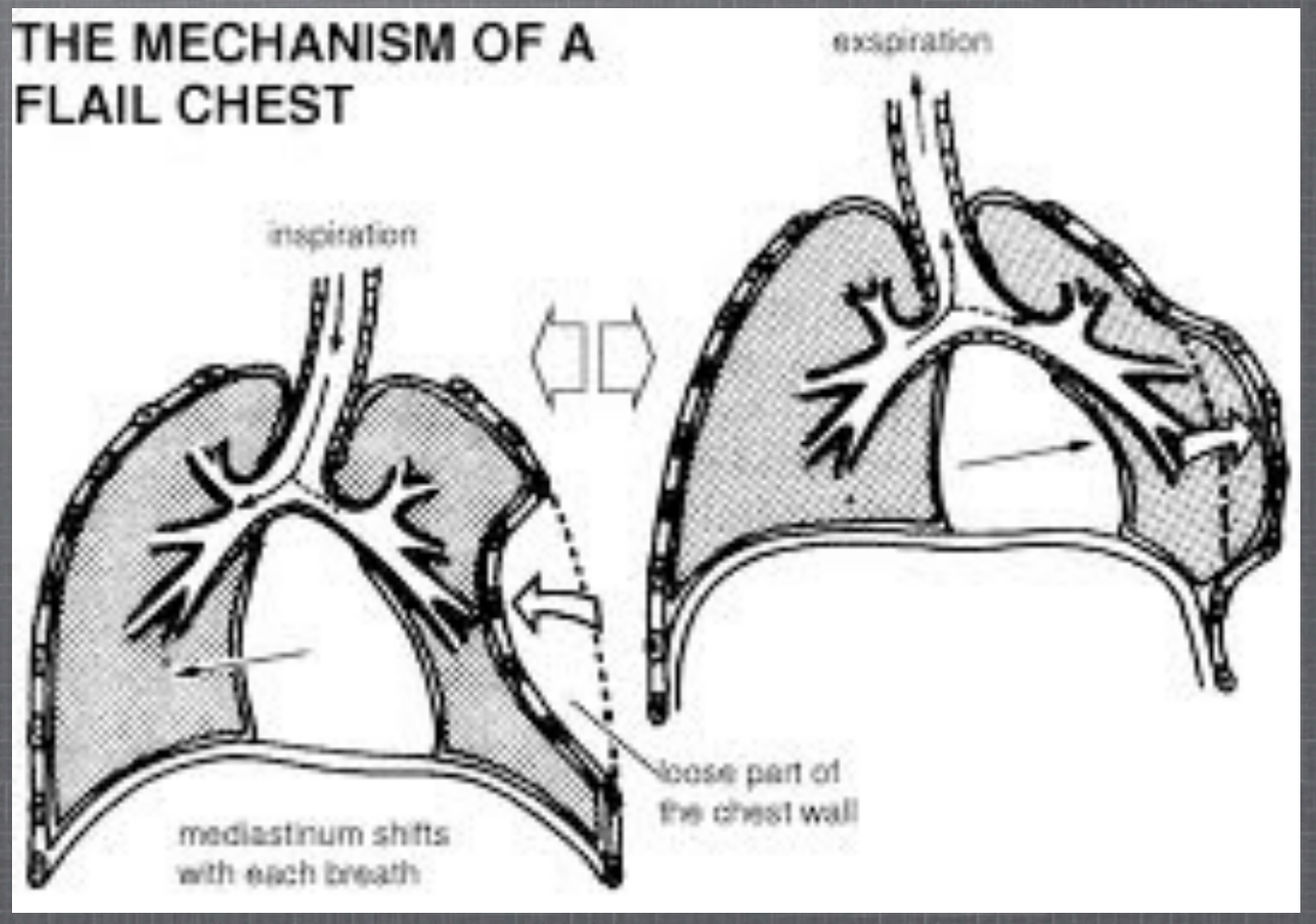
- Requires significant blunt force trauma
  - most common cause is motor vehicle trauma
- Mortality is 20-40% due to associated injuries

PATHOPHYSIOLOGY

- Respiratory failure
  - due to underlying pulmonary contusion
  - associated intra-thoracic injury
  - loss of “bellows” effect of chest wall




THE MECHANISM OF A FLAIL CHEST
inspiration
exspiration
loose part of the chest wall
mediastinum shifts with each breath

ASSESSMENT

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- Chest wall contusion

ASSESSMENT

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- Respiratory distress

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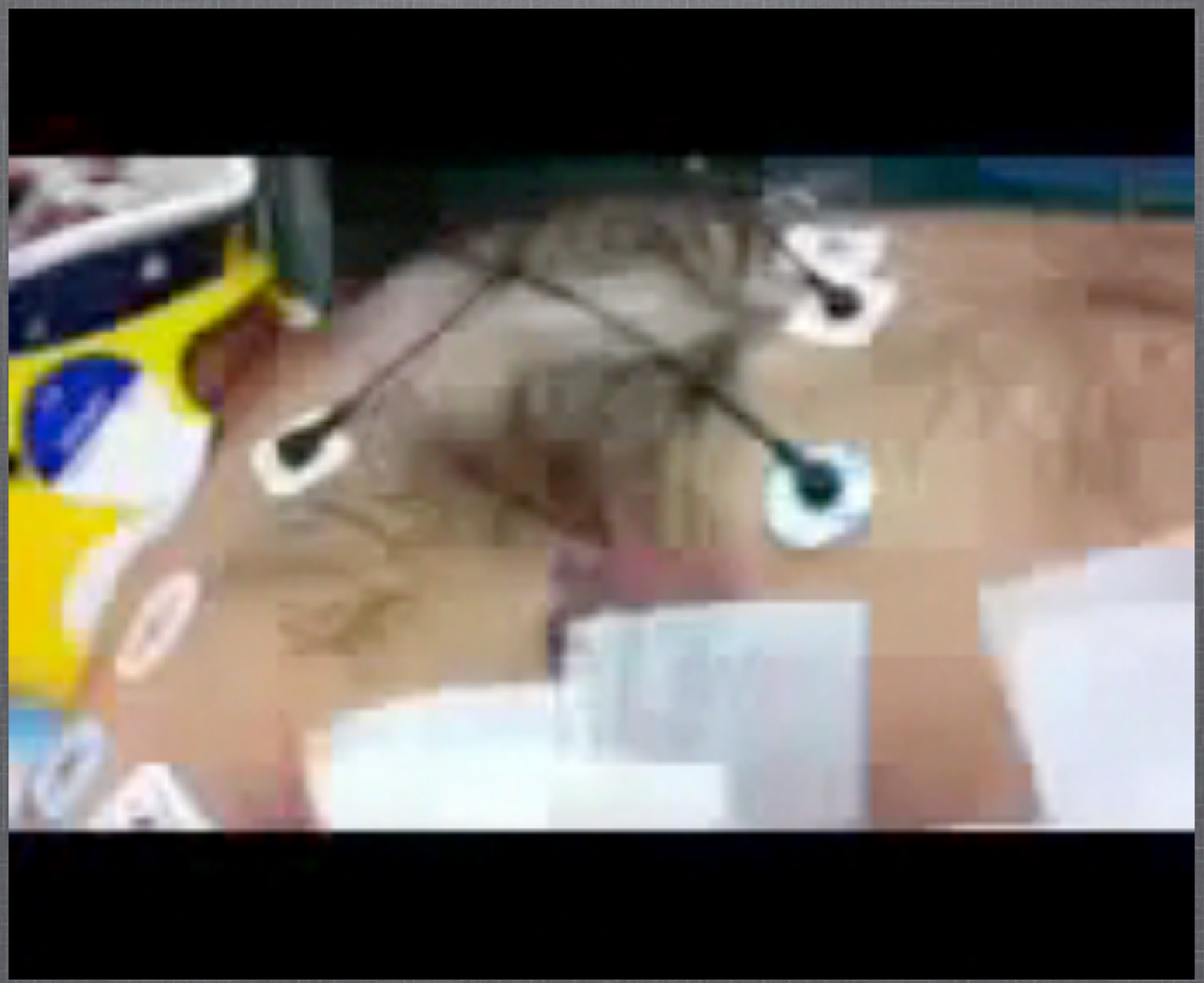
ASSESSMENT

- Chest wall contusion
- Respiratory distress
- Paradoxical chest wall movement
- Pleuritic chest pain
- Crepitus
- Tachypnea and tachycardia

MANAGEMENT

- Airway and ventilation
  - high-concentration oxygen
  - Positive-pressure ventilation
    - how does it help?
    - assess need for intubation
- What about stabilizing the flail segment?



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  - pulmonary contusion

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  - myocardial contusion / rupture
  - cardiac tamponade
  - pulmonary contusion
- Posterior displacement can cause significant vascular compromise

TREATMENT

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- ABC's

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- Cautious use of fluids

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- Rapid transport to trauma center

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- Do not splint chest wall

PNEUMOTHORAX

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- Air enters the pleural space due to a disruption in the visceral pleura
- Air accumulates around the lung compressing it and it can lead to tension pneumothorax

CLOSED PTX

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CLOSED PTX

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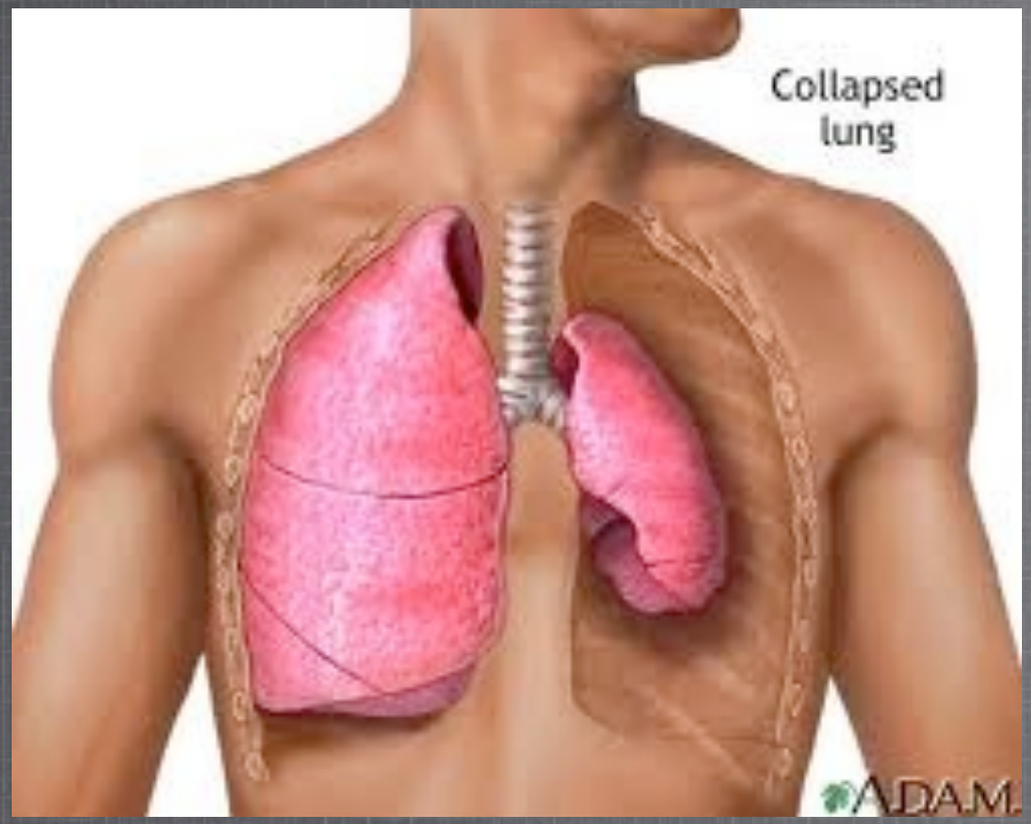
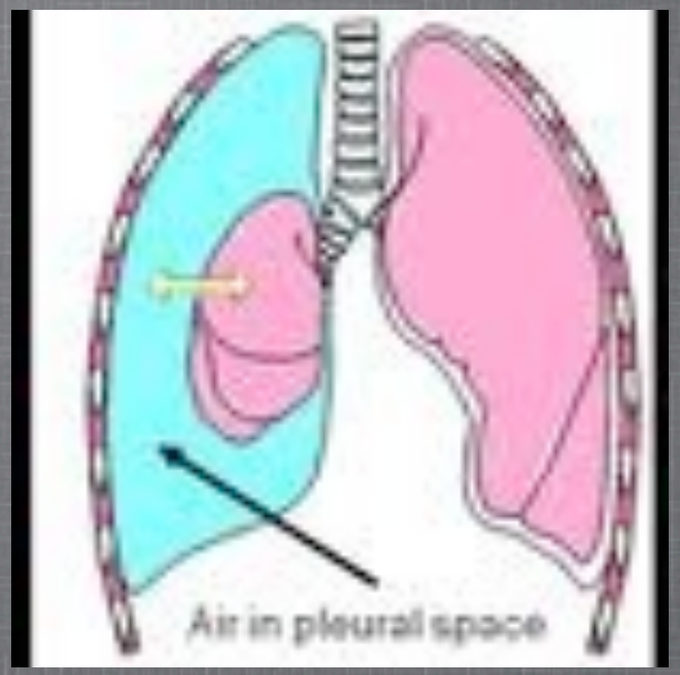
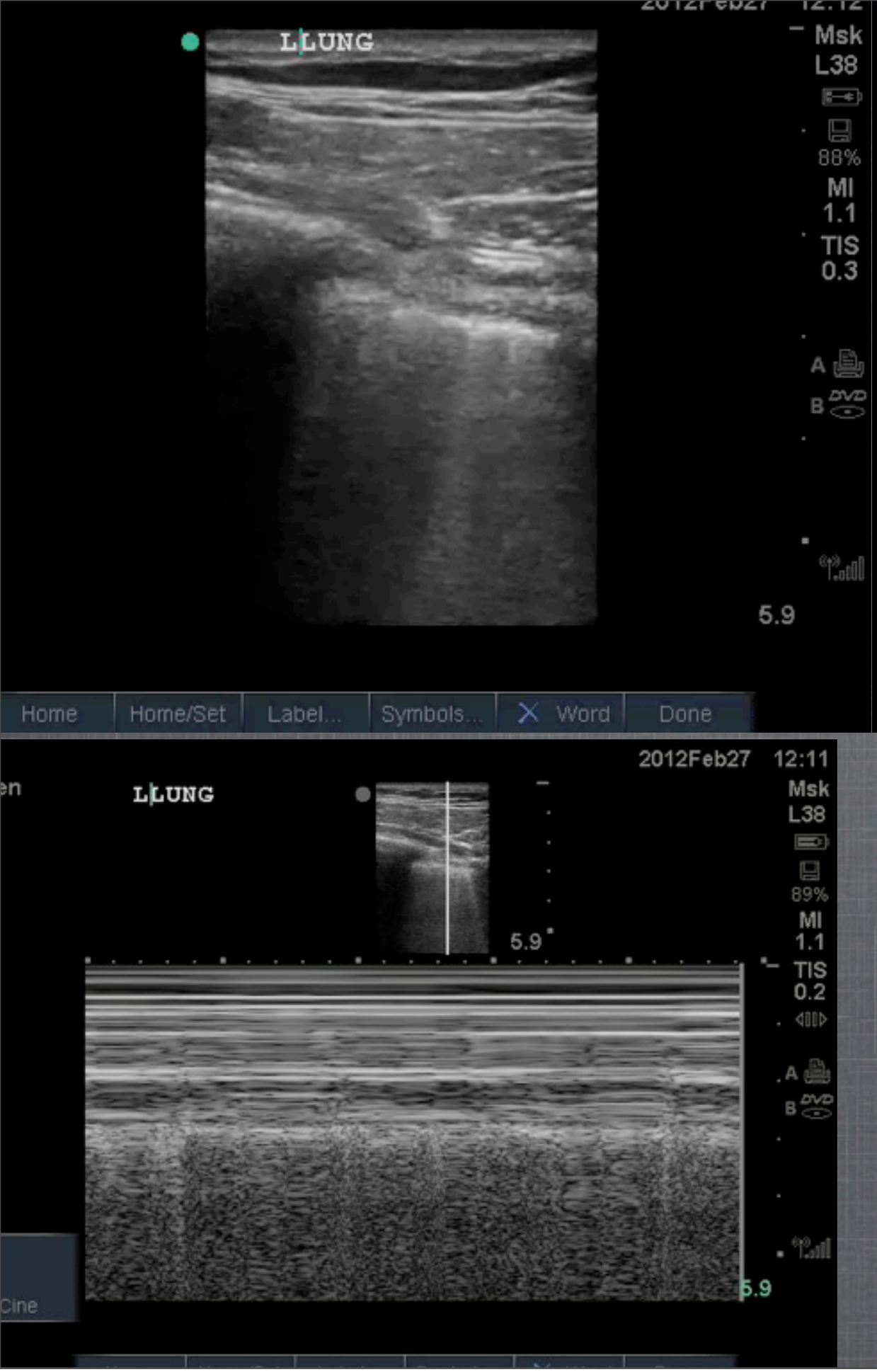
- Can also occur by the “paper-bag effect”
- Small holes usually self seal, large ones may progress
- Leads to a ventilation - perfusion mismatch


Collapsed
lung
A.D.A.M.


Air in pleural space


L LUNG
Msk
L38
88%
MI
1.1
TIS
0.3
A
B
DVD
5.9
Home
Home/Set
Label...
Symbols...
Word
Done


Gen
S MB
R LUNG
5.9
Home
Home/Set
Label...
Symbols...
Word
Done

2012Feb27 12:11
L LUNG
Msk
L38
89%
MI
1.1
TIS
0.2
5.9
A
B
DVD
5.9
Cine

Gen
2012Feb27 12:10
R LUNG
Msk
L38
89%
MI
1.1
TIS
0.2
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A
B
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Cine

MANAGEMENT

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- Transport considerations

OPEN PNEUMOTHORAX

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  - GSW, knife, impaled object, MVC

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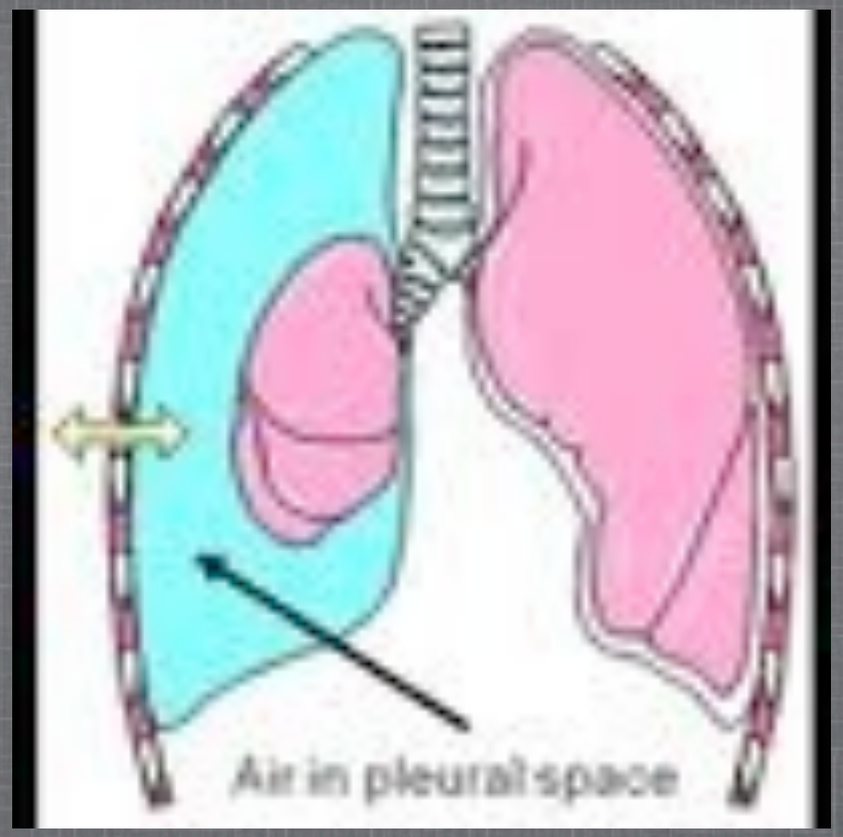
  - GSW, knife, impaled object, MVC
- Severity is directly proportional to size of wound
- Delayed management often leads to death

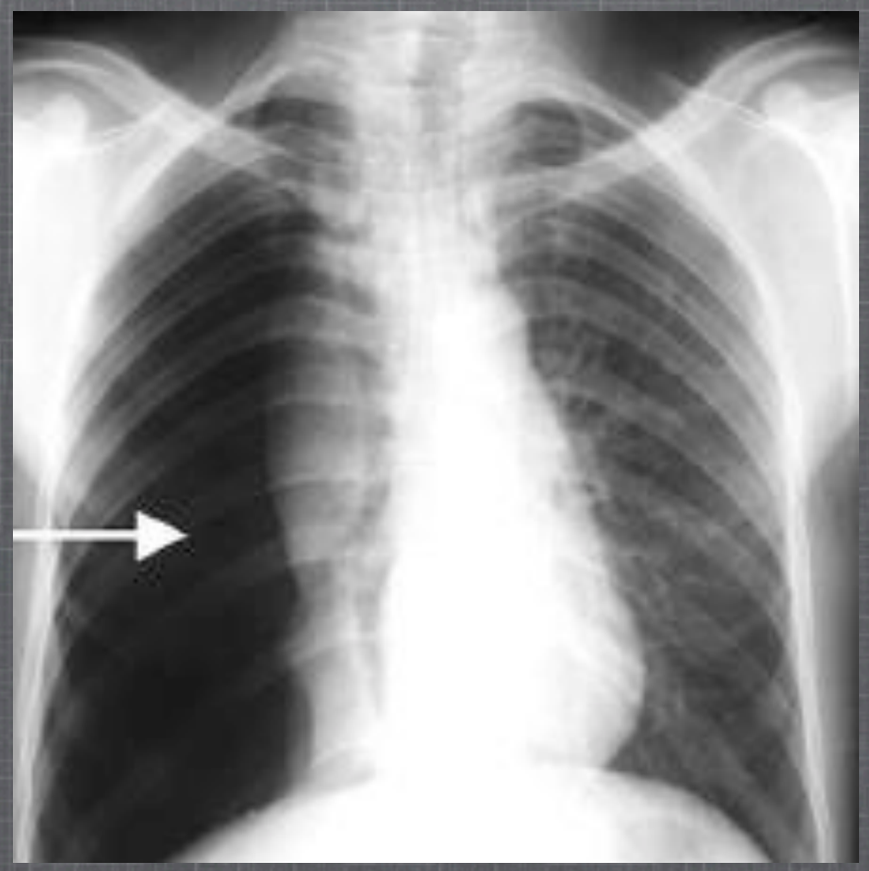
PATHOPHYSIOLOGY

- Open defect in chest wall
  - If chest wall opening is greater than two-thirds the diameter of the trachea, air follows path of least resistance and flows through chest wall with each inspiration.
  - As the air accumulates in chest cavity, lung is compressed and begins to shift to unaffected side

PATHOPHYSIOLOGY

- Very little air enters trachea for gas exchange leading to V/Q mismatch
- Uninjured side sees less ventilation as well
- Leads to severe ventilatory dysfunction, hypoxemia and death if not rapidly recognized and treated


Air in pleural space



ASSESSMENT

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- To and fro air movement from wound (Sucking)

ASSESSMENT

- To and fro air movement from wound (Sucking)
- Hole in chest

ASSESSMENT

- To and fro air movement from wound (Sucking)
- Hole in chest
- Tachycardia

ASSESSMENT

- To and fro air movement from wound (Sucking)
- Hole in chest
- Tachycardia
- Tachypnea

ASSESSMENT

- To and fro air movement from wound (Sucking)
- Hole in chest
- Tachycardia
- Tachypnea
- Subcutaneous emphysema

ASSESSMENT

- To and fro air movement from wound (Sucking)
- Hole in chest
- Tachycardia
- Tachypnea
- Subcutaneous emphysema
- Decreased breath sounds on affected side

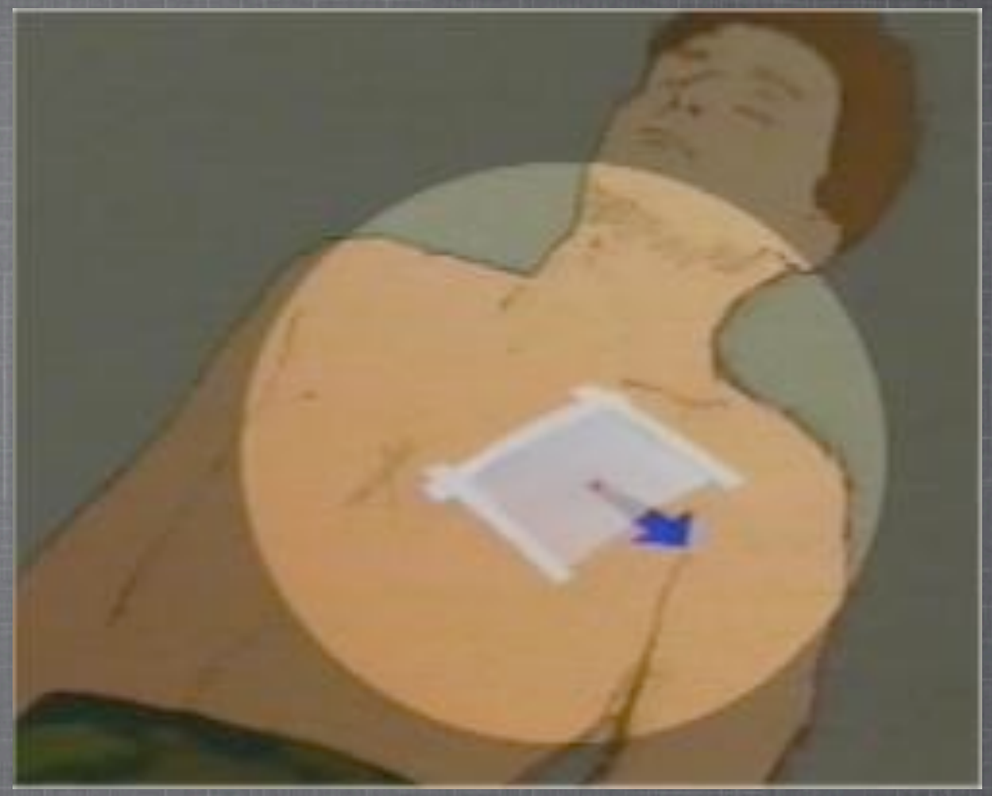
TREATMENT

TREATMENT

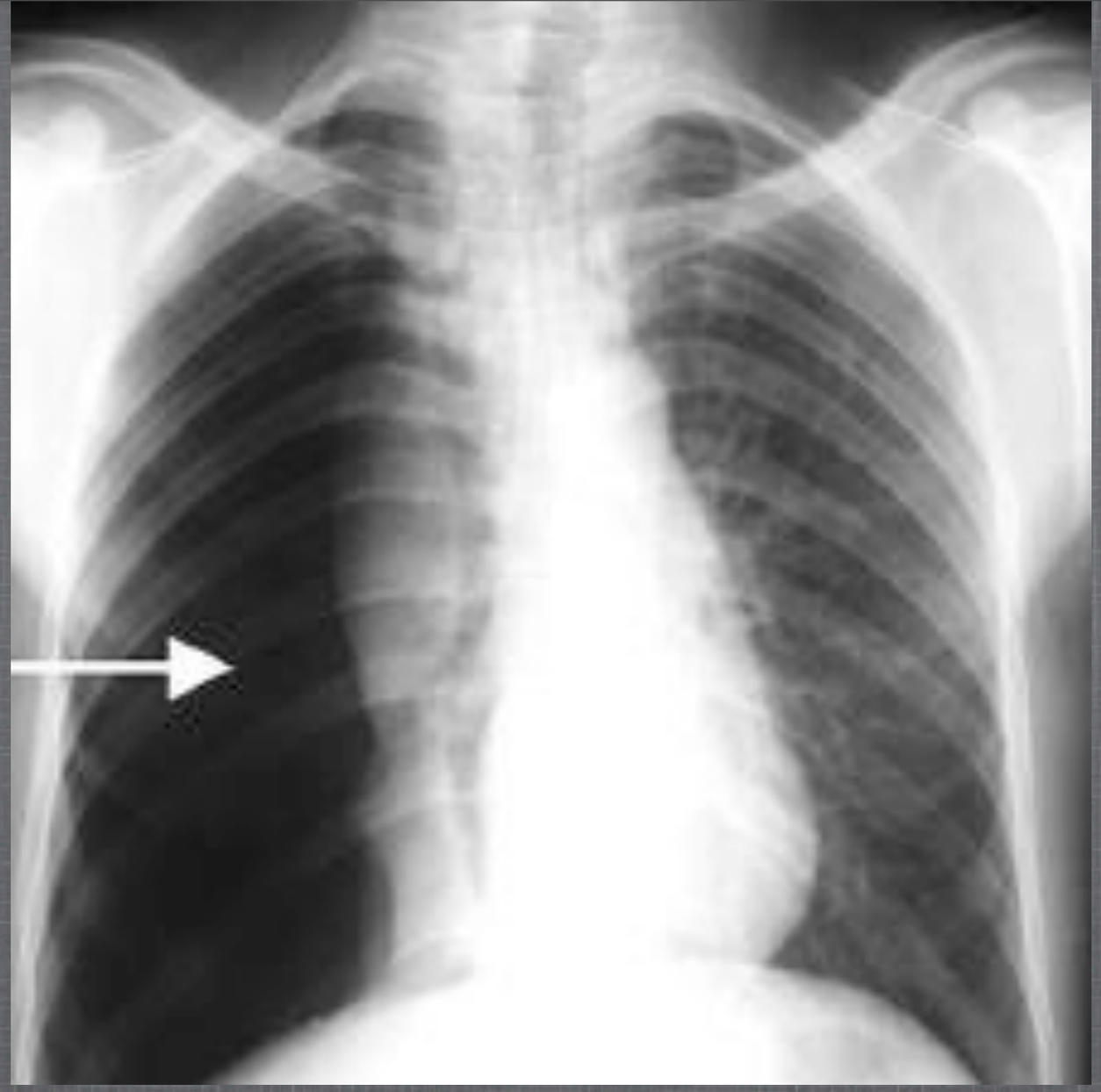
- Airway and ventilation
  - High concentration oxygen
  - PPV if needed, intubate if needed
  - Monitor for development of tension pneumothorax
  - Seal the wound

TREATMENT

- Airway and ventilation
  - High concentration oxygen
  - PPV if needed, intubate if needed
    - Monitor for development of tension pneumothorax
    - Seal the wound
- Circulation
  - Treat for shock, control hemorrhage. Fluids?




B&A Products
ACS




R
SUP
ORTABLE
Scapula
edge

TENSION PNEUMOTHORAX

TENSION PNEUMOTHORAX

- Results from the buildup of air in the pleural cavity which cannot escape to the outside

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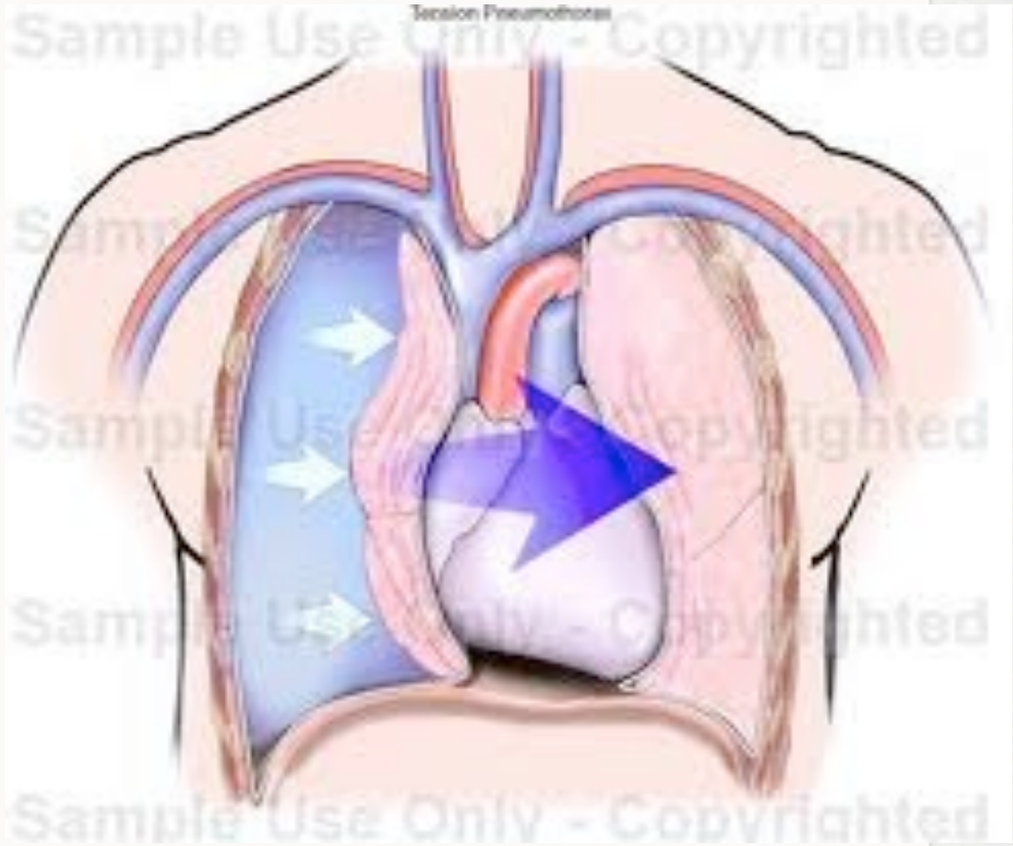
TENSION PNEUMOTHORAX

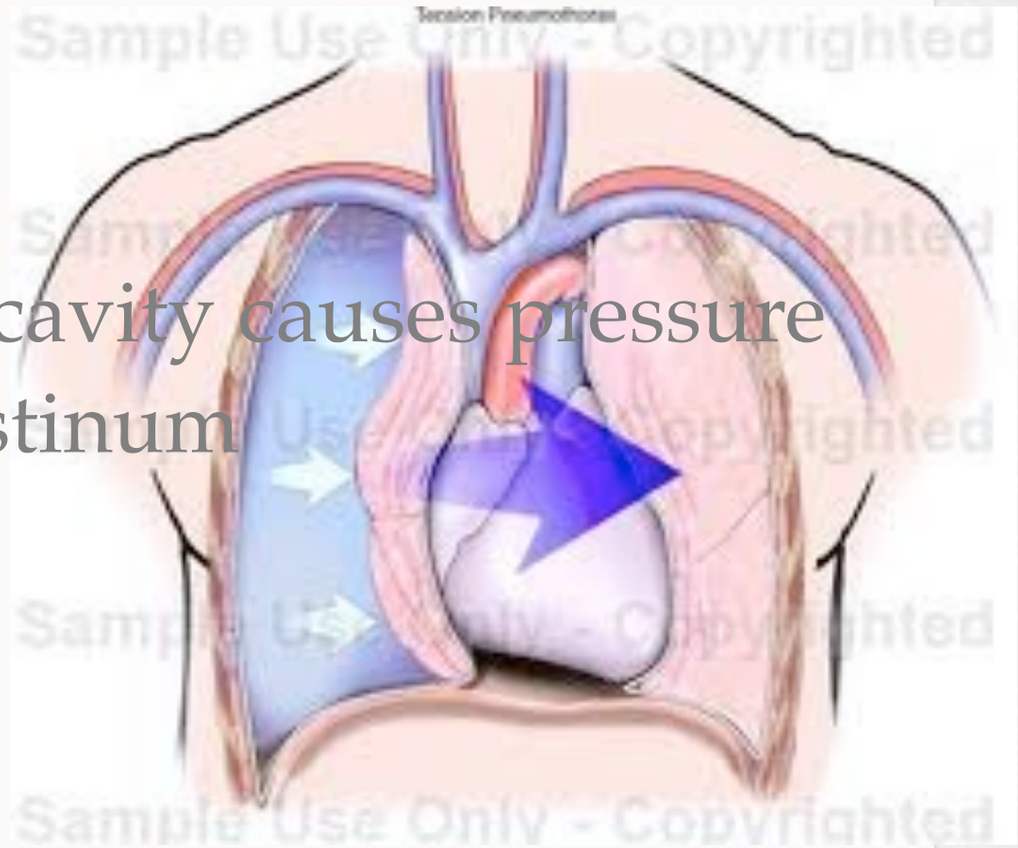
- Results from the buildup of air in the pleural cavity which cannot escape to the outside
- Can develop from both closed and open ptx
- Leads to cardiovascular collapse
- Fatal if not treated
- Immediate life threatening condition that must be corrected in primary survey

PATHOPHYSIOLOGY



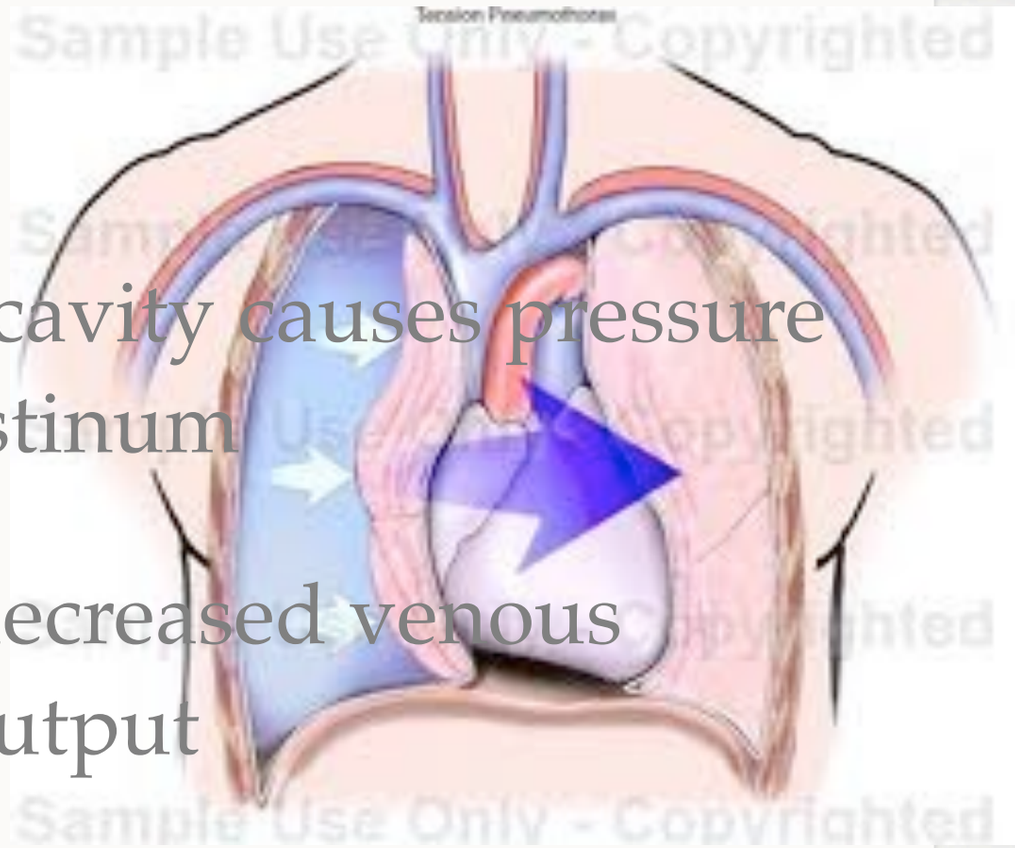
PATHOPHYSIOLOGY

- Buildup of pressure in pleural cavity causes pressure to be applied across the mediastinum



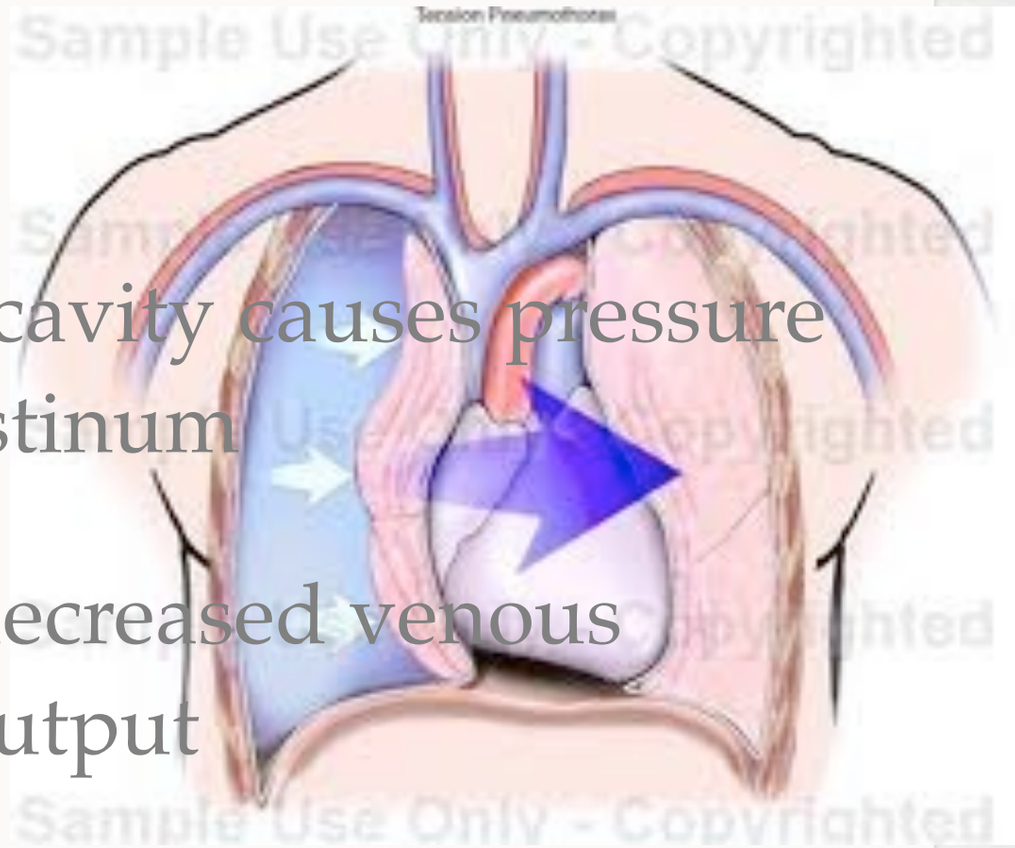
PATHOPHYSIOLOGY

- Buildup of pressure in pleural cavity causes pressure to be applied across the mediastinum
- mediastinal pressure leads to decreased venous return and decreased cardiac output



PATHOPHYSIOLOGY

- Buildup of pressure in pleural cavity causes pressure to be applied across the mediastinum
  - mediastinal pressure leads to decreased venous return and decreased cardiac output
- If not rapidly corrected will progress to PEA arrest



ASSESSMENT

- Increasing dyspnea
- Cyanosis
- JVD
- Hypotension
- Tachycardia
- Absent breath sounds on affected side
- Tracheal deviation (in dead people)

ASSESSMENT

- Unequal chest expansion
- Subcutaneous emphysema
- Hyper-resonance to percussion

MANAGEMENT

MANAGEMENT

- Airway and ventilation as needed

MANAGEMENT

- Airway and ventilation as needed
- Must relieve the tension ptx

MANAGEMENT

- Airway and ventilation as needed
- Must relieve the tension ptx
- needle decompression

MANAGEMENT

- Airway and ventilation as needed
- Must relieve the tension ptx
  - needle decompression
  - release occlusive dressing

MANAGEMENT

- Airway and ventilation as needed
- Must relieve the tension ptx
  - needle decompression
  - release occlusive dressing
  - Tube thoracostomy (hospital)


Needle thoracocentesis
Emergency decompression of
clinical tension pneumothorax


chest wall
needle
portion
of glove

HEMOTHORAX

HEMOTHORAX

- May be associated with pneunothorax

HEMOTHORAX

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- Commonly caused by rib fx and laceration of intercostal vessel

HEMOTHORAX

- May be associated with pneunothorax
- Commonly caused by rib fx and laceration of intercostal vessel
- Can be associated with great vessel injury
  - 50% die immediately
  - 25% in 5-10 minutes
  - 25% can live 30 minutes or longer

PATHOPHYSIOLOGY

- Accumulation of blood in the pleural space
- Results in hypovolemia
- Each hemithorax can hold 2 liters of blood
- Often due to bleeding intercostal vessel

FINDINGS

- Tachypnea
- Dyspnea
- Cyanosis
- Diminished breath sounds
- Dullness to percussion
- Hypotension

MANAGEMENT

MANAGEMENT

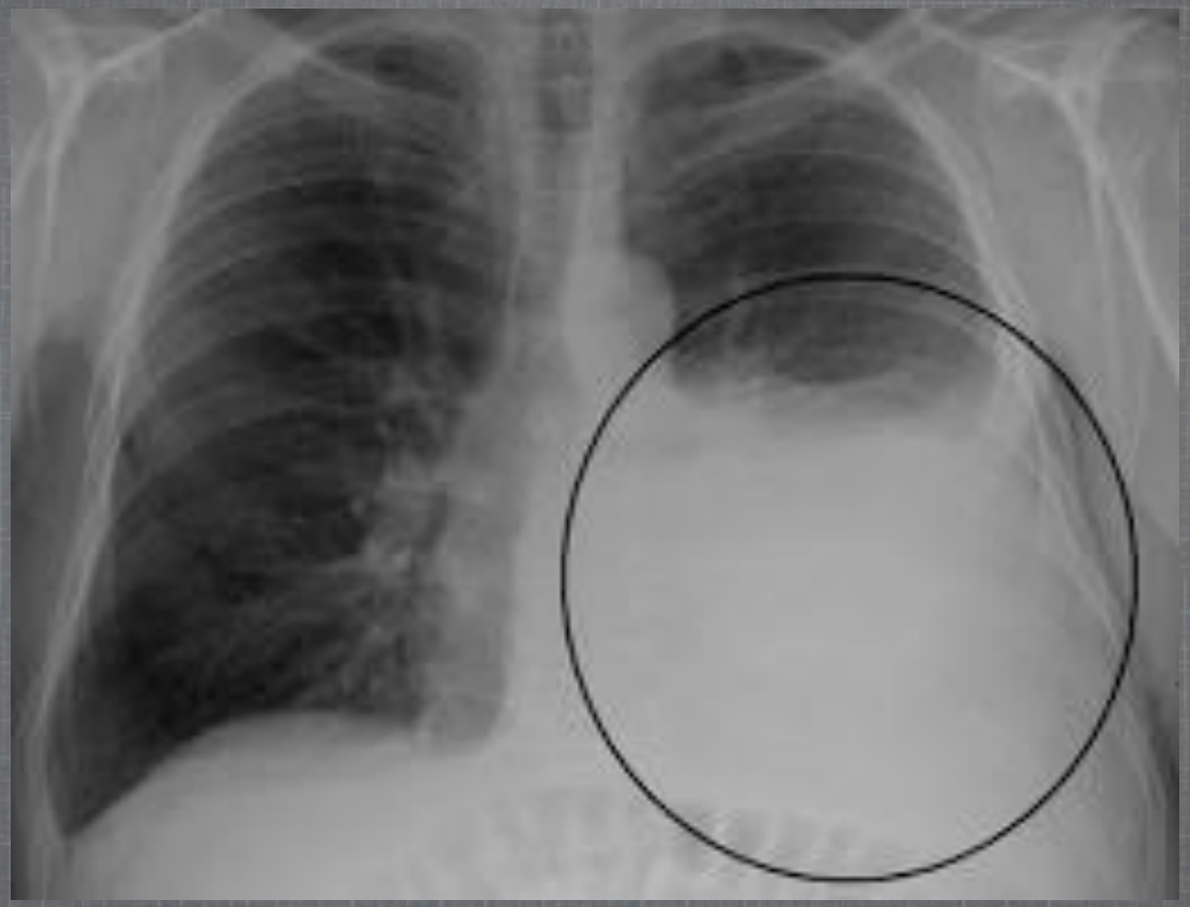
- Airway and Ventilation
  - High concentration oxygen
  - PPV as needed

MANAGEMENT

- Airway and Ventilation
  - High concentration oxygen
  - PPV as needed
- Circulation
  - Treat hypotension and shock

MANAGEMENT

- Airway and Ventilation
  - High concentration oxygen
  - PPV as needed
- Circulation
  - Treat hypotension and shock
- HIGHEST PRIORITY IS RAPID TRANSPORT

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PULMONARY CONTUSION

PULMONARY CONTUSION

- Most common potentially lethal chest injury

PULMONARY CONTUSION

- Most common potentially lethal chest injury
- Incidence
  - MC injury from blunt thoracic trauma
  - 30-75% of patients with blunt thoracic trauma

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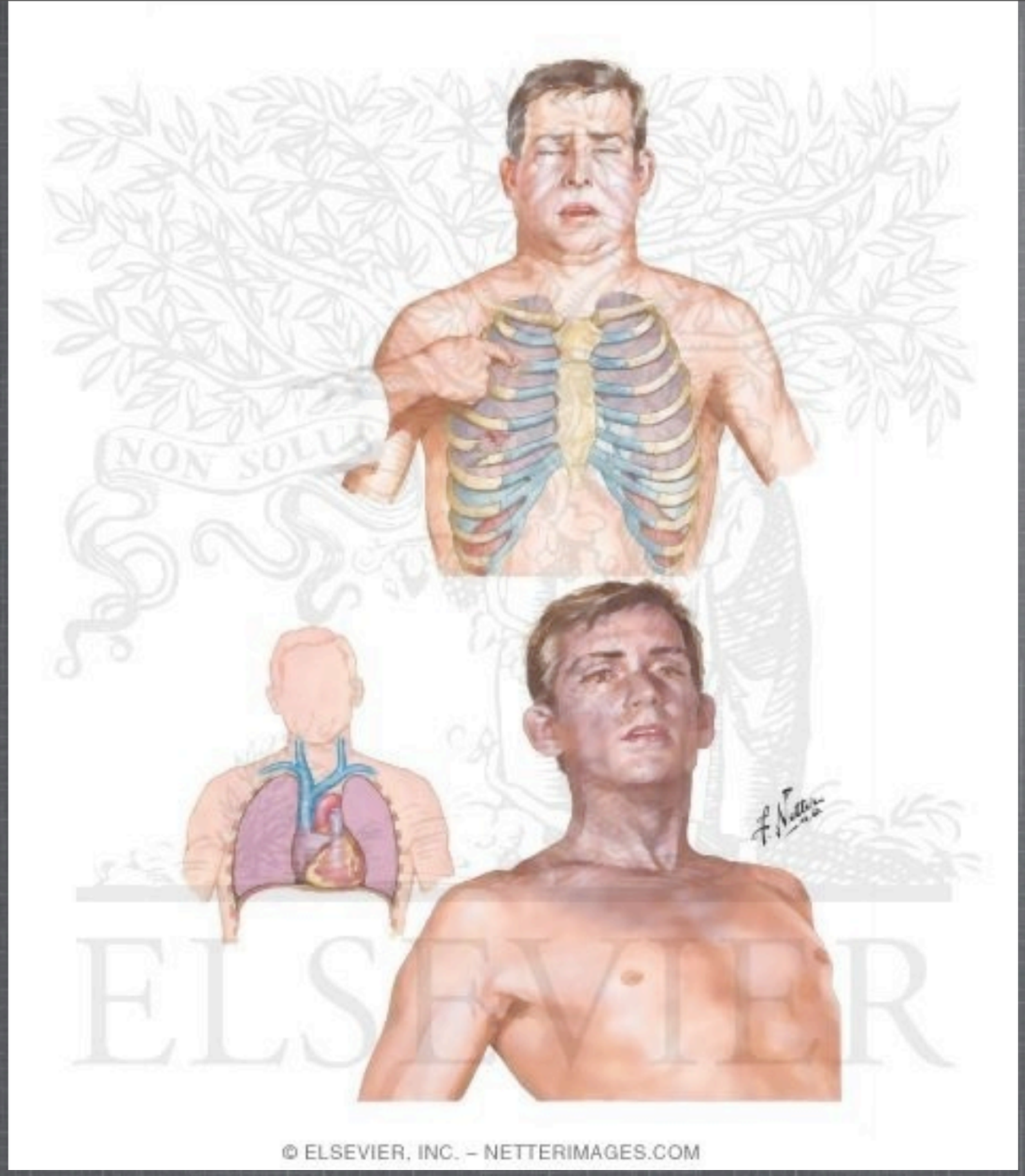
PULMONARY CONTUSION

- Most common potentially lethal chest injury
- Incidence
  - MC injury from blunt thoracic trauma
  - 30-75% of patients with blunt thoracic trauma
- Commonly associated with rib fracture
- Blast trauma, rapid deceleration

FINDINGS

- Tachypnea, tachycardia
- Cough
- Hemoptysis
- Respiratory distress
- Evidence of blunt trauma
- Cyanosis

B



TRAUMATIC ASPHYXIA

severe crushing mechanism

DON'T TRY THIS AT HOME

PERICARDIAL TAMPONADE

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- Most commonly result of penetrating trauma

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- GSW has much higher mortality than stab wounds

PERICARDIAL TAMPONADE

- Most commonly result of penetrating trauma
- Occurs in less that 2% of all chest trauma
- GSW has much higher mortality than stab wounds
- Lower mortality rates if isolated tamponade

PATHOPHYSIOLOGY

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- Pericardium

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- Pericardium
  - tough fibrous sac enclosing heart

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- Injury causes tear in a heart chamber wall allowing blood to leak into pericardium or chest

PATHOPHYSIOLOGY

- Pericardium
  - tough fibrous sac enclosing heart
  - attached to great vessels at base of heart
- Injury causes tear in a heart chamber wall allowing blood to leak into pericardium or chest
- Development of tamponade can occur with as little as 150mL of blood acutely

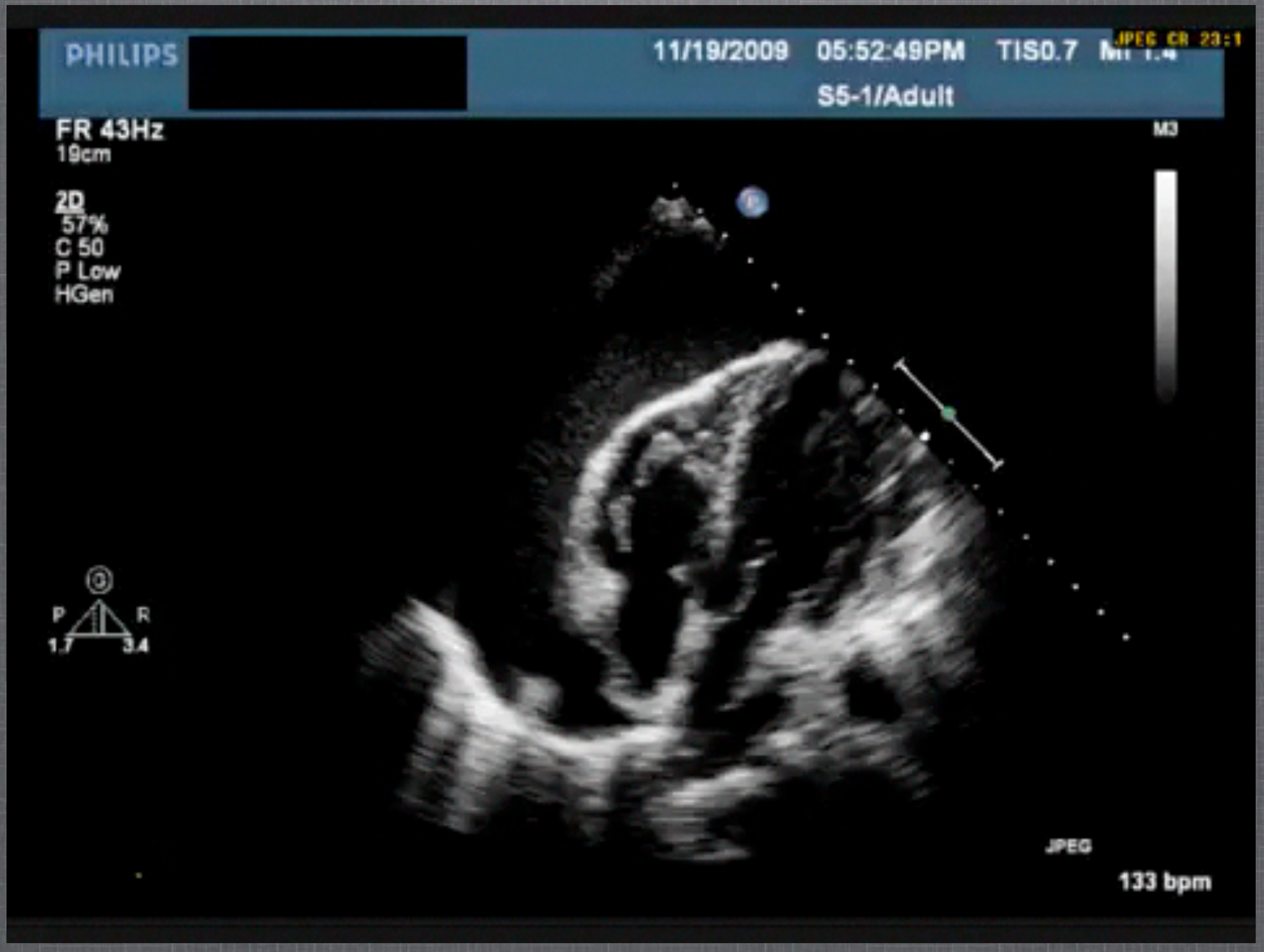
PATHOPHYSIOLOGY

PATHOPHYSIOLOGY

- Intrapericardial pressure increases
  - does not allow heart to expand and fill
  - results in decreased stroke volume and cardiac output
  - myocardial perfusion decreases

PATHOPHYSIOLOGY

- Intrapericardial pressure increases
  - does not allow heart to expand and fill
  - results in decreased stroke volume and cardiac output
  - myocardial perfusion decreases
- REMOVAL OF AS LITTLE AS 20mL CAN HAVE DRAMATIC IMPROVEMENT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C 50
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M3
P
R
1.7
3.4
JPEG
133 bpm

ELECTRICAL ALTERNANS

ASSESSMENT

ASSESSMENT

- Tachycardia

ASSESSMENT

- Tachycardia
- Respiratory distress

ASSESSMENT

- Tachycardia
- Respiratory distress
- Shock

ASSESSMENT

- Tachycardia
- Respiratory distress
- Shock
- Beck's triad
  - Narrow pulse pressure
  - JVD
  - Muffled heart sounds

TREATMENT

TREATMENT

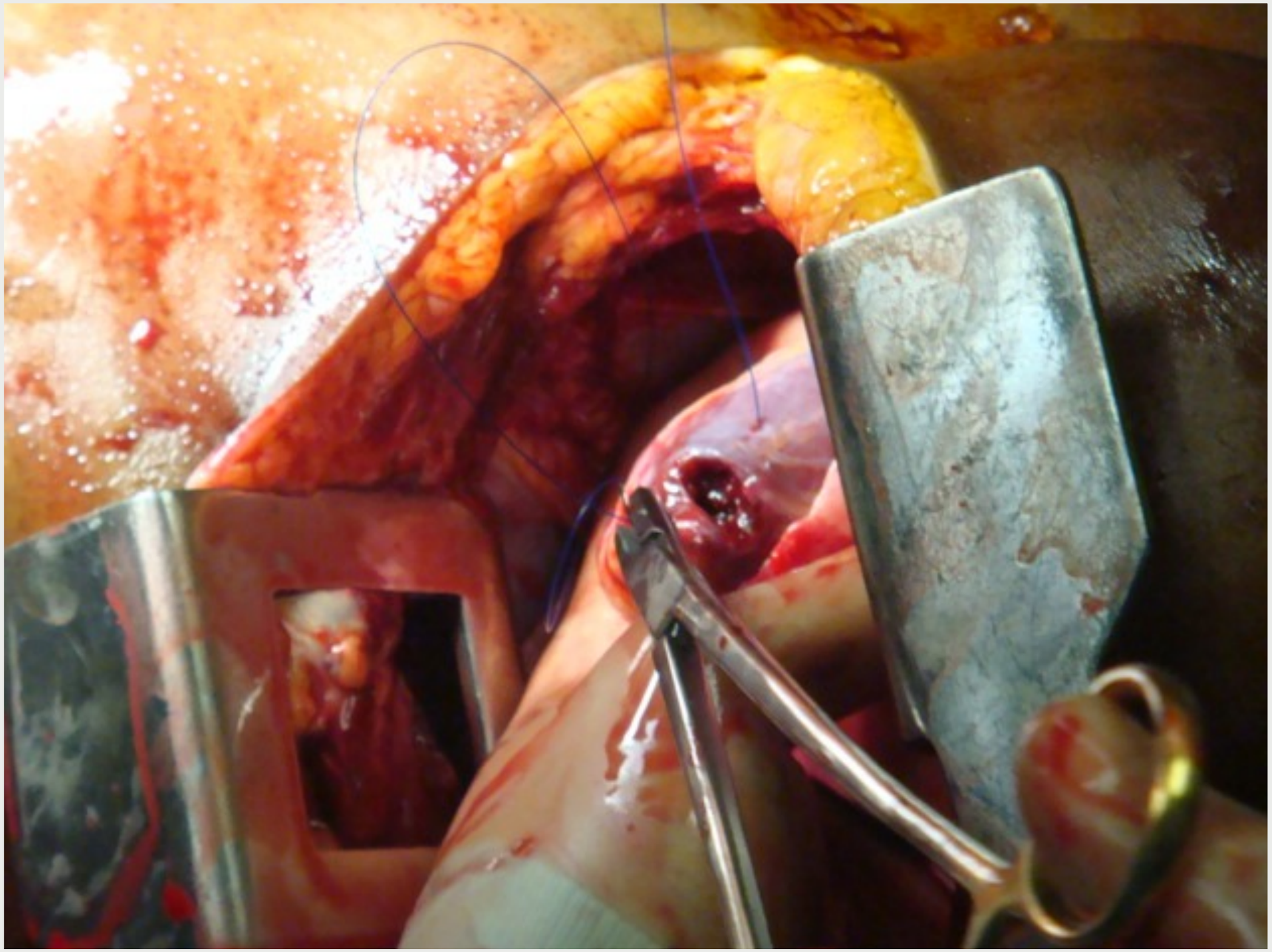
- Bright lights and cold steel

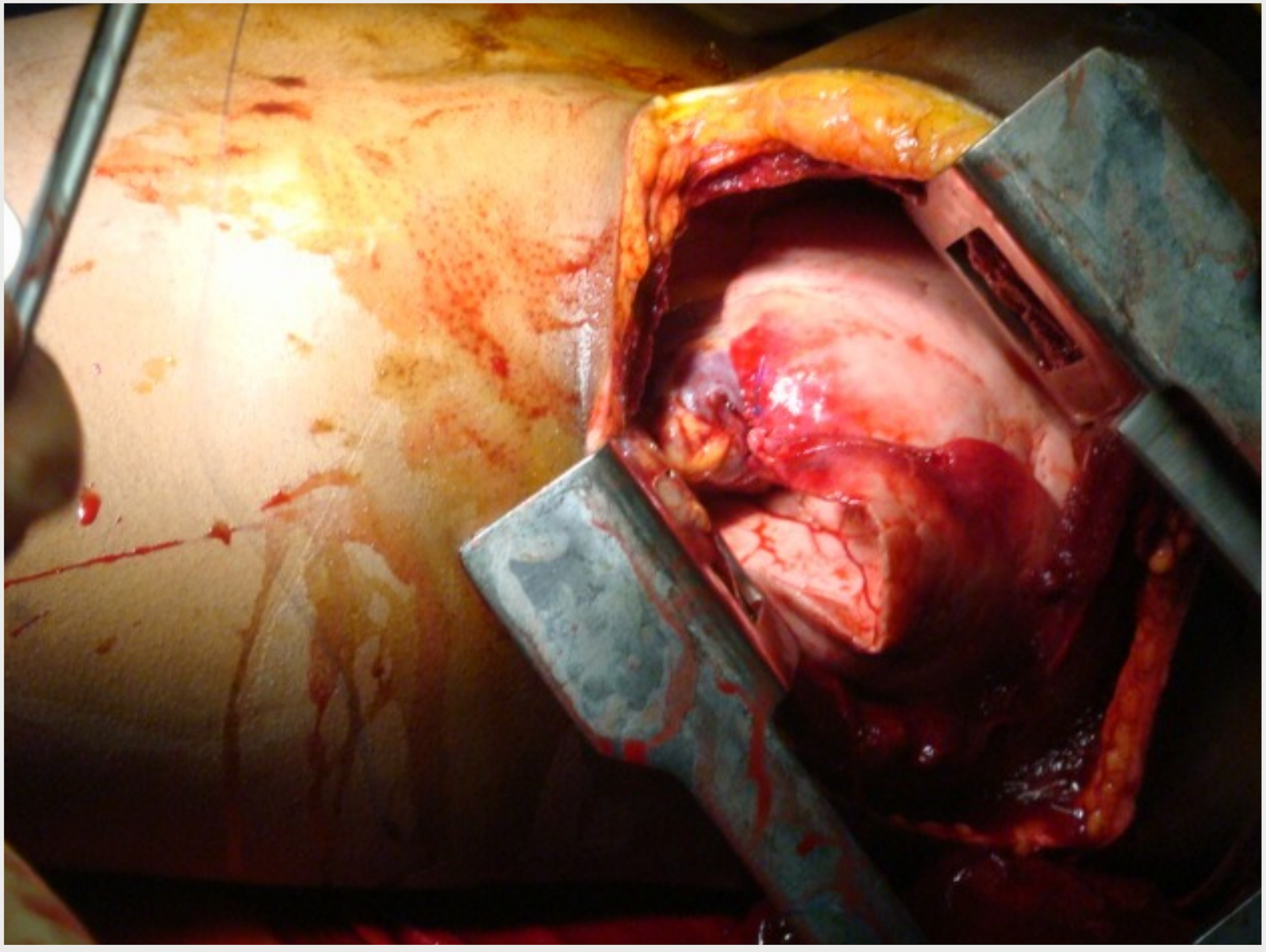
TREATMENT

- Bright lights and cold steel
- Rapid transport to Trauma Center

TREATMENT

- Bright lights and cold steel
- Rapid transport to Trauma Center
- Pericardiocentesis
  - temporizing measure





AORTIC RUPTURE

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- Blunt trauma
  - rapid deceleration

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- 80-90% of these patients die at the scene from massive hemorrhage

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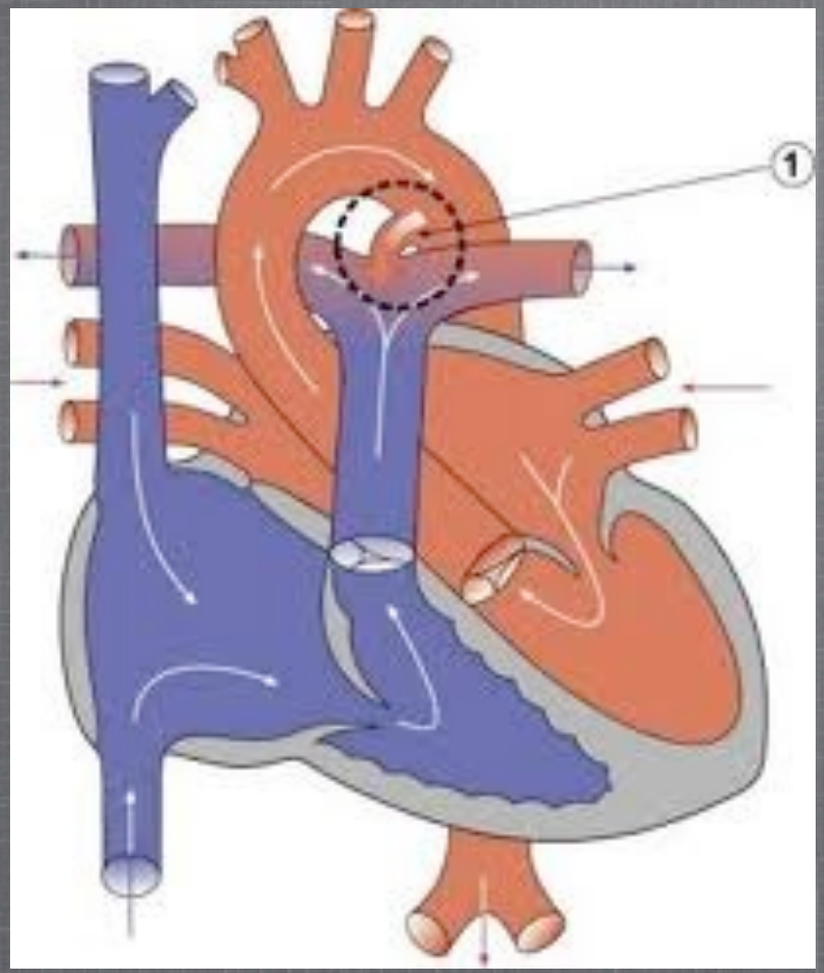
- Blunt trauma
  - rapid deceleration
- 80-90% of these patients die at the scene from massive hemorrhage
- Of the ones who initially survive, 1/3 will die in first 6 hours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ASSESSMENT

ASSESSMENT

- Pulse disparities

ASSESSMENT

- Pulse disparities
- Neurological findings (stroke)

ASSESSMENT

- Pulse disparities
- Neurological findings (stroke)
- Chest / back pain

ASSESSMENT

- Pulse disparities
- Neurological findings (stroke)
- Chest / back pain
- SOB

TREATMENT

TREATMENT

- Rapid transport to trauma center

TREATMENT

- Rapid transport to trauma center
- Hypotension is your friend

TREATMENT

- Rapid transport to trauma center
- Hypotension is your friend
- Airway and ventilation as needed

CONTROVERSIES

- Fluid management
- Temperature regulation

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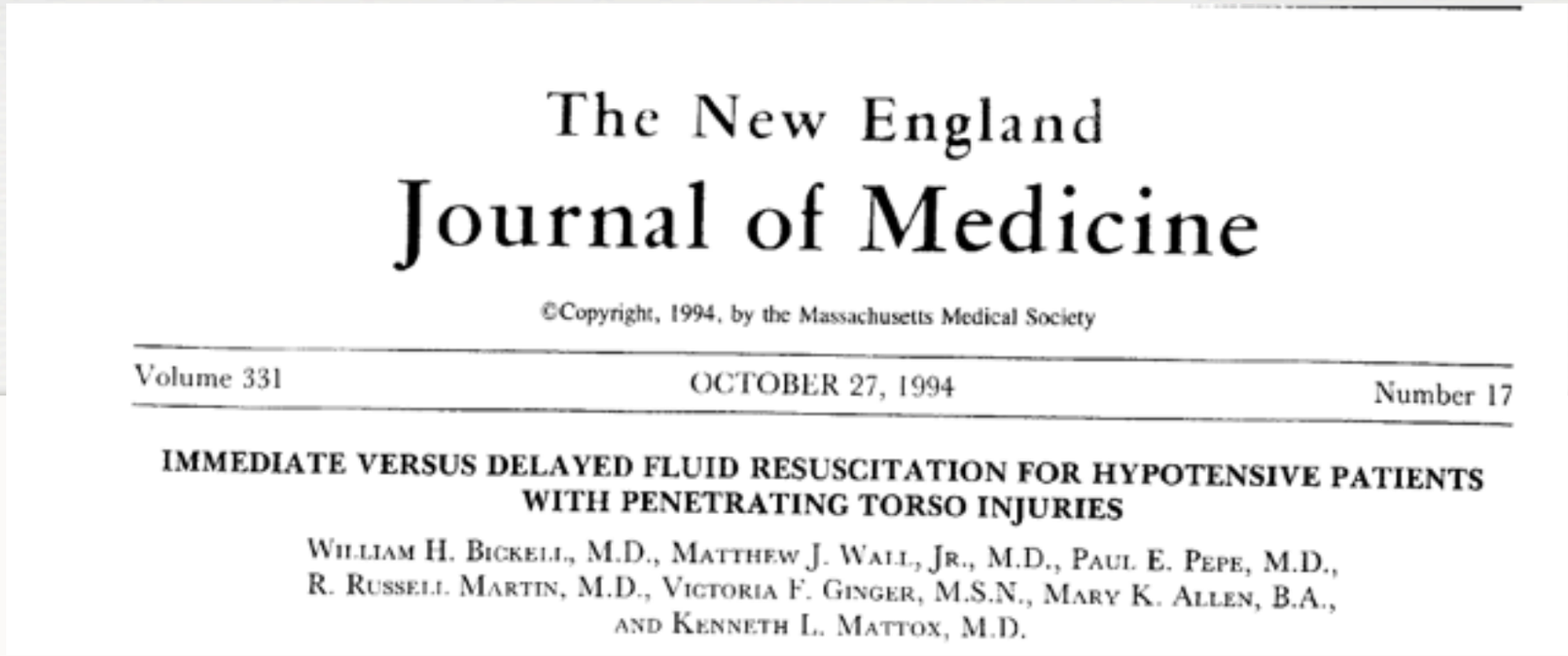

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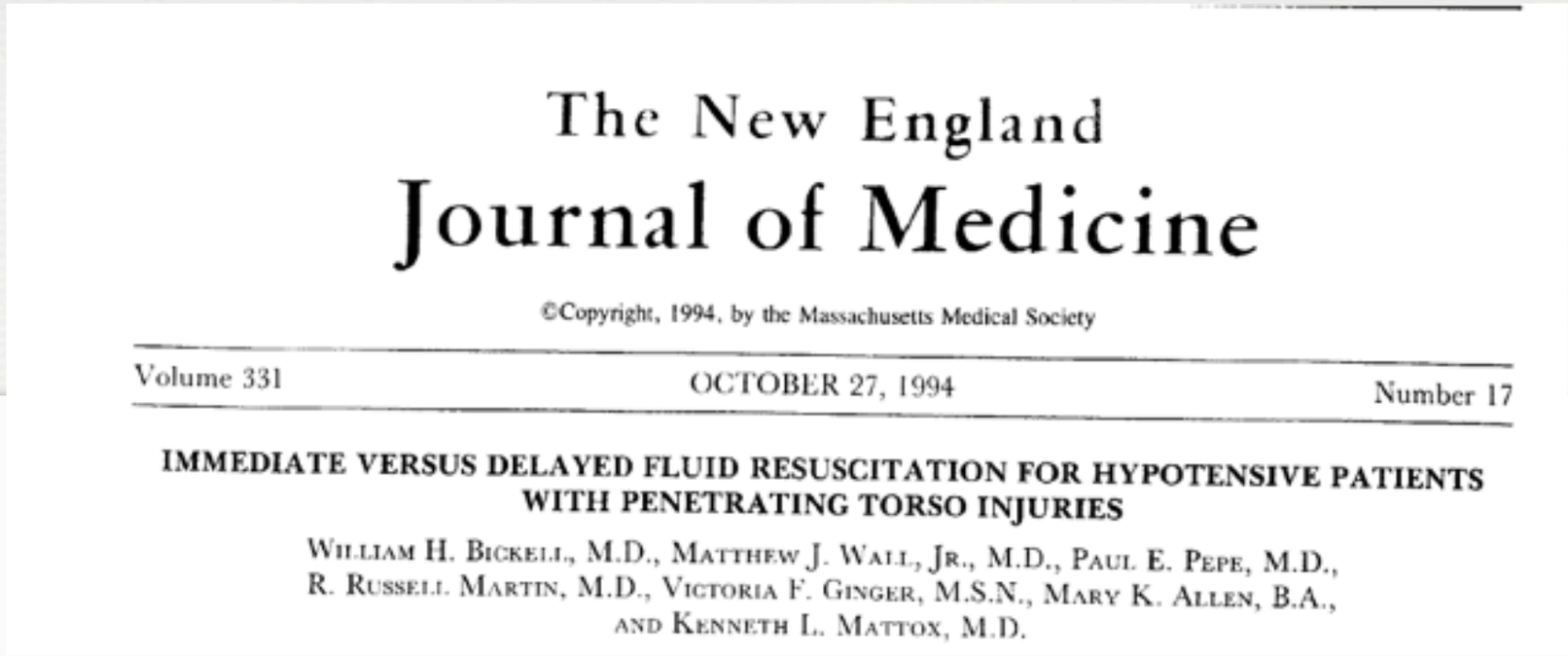
- Odd vs. even
- Fluids by standard protocol vs. heplock only



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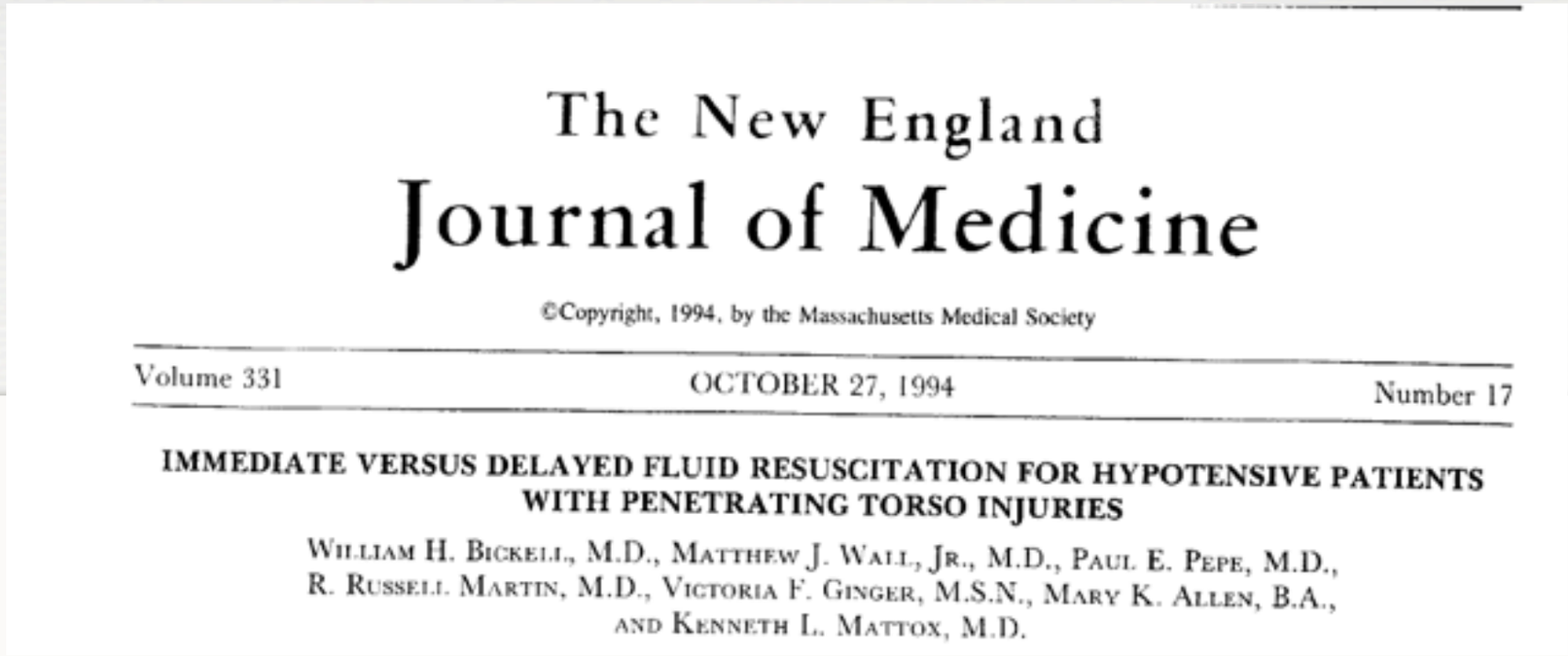

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- Odd vs. even
- Fluids by standard protocol vs. heplock only
- No fluid group did better
- Why haven't EMS protocols changed?

FLUIDS

FLUIDS

- US Military experience

FLUIDS

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  - tolerate SBP as low as 70

FLUIDS

- US Military experience
  - tolerate SBP as low as 70
  - based on mental status

FLUIDS

- US Military experience
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  - based on mental status
  - rapid transport to damage control surgery

FLUIDS

- US Military experience
  - tolerate SBP as low as 70
  - based on mental status
  - rapid transport to damage control surgery
  - fluids after mechanical control

TEMPERATURE

TEMPERATURE

- Highly overlooked

TEMPERATURE

- Highly overlooked
- Most trauma patients arrive hypothermic

TEMPERATURE

- Highly overlooked
- Most trauma patients arrive hypothermic
- coagulopathy develops when cold

TEMPERATURE

- Highly overlooked
- Most trauma patients arrive hypothermic
- coagulopathy develops when cold
- warm blankets once assessed

THANK YOU