CHEST TRAUMA
NOT ALL IT’S CRACKED UP TO BE!

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St. Luke’s Roosevelt
Continuum Health Partners, Inc.
Level 1 Trauma Center
190K Visits/Yr.
900 Beds
9th Busiest ED in US
OBJECTIVES

- Review epidemiology of thoracic trauma
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- Review anatomy and physiology as pertains to trauma
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- Review specific thoracic injuries and their management
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- Review general approach to chest 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

- Trauma is the leading cause of death in all people 1-44 years of age, Number 3 overall.
THORACIC TRAUMA

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- Chest Trauma is 2nd leading cause of trauma death after Head
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- Blunt much more common than penetrating (70-80%)
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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
SURFACE LANDMARKS ON CHEST
CHEST WALL

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

- Intercostal Space
  - Below names rib (2nd ICS is below 2nd rib)
  - Neurovascular bundle
- Thoracic inlet
  - superior opening formed by curvature of first rib
CHEST WALL

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

Inspiration:
- Ribs and sternum elevate
- Diaphragm contracts
- External intercostal muscles active
- Diaphragm contracts and moves downward

Expiration:
- Ribs lowered
- Internal intercostal muscles active
- Diaphragm relaxes and moves upward
VENTILATION MECHANICS
WHAT IS THE MOST ANTERIOR CARDIAC STRUCTURE?
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
MAJOR STRUCTURES

- Mediastinum
  - Aorta
  - Heart
  - Pulmonary Artery / Veins
  - Tracheobronchial tree
  - esophagus
THE MEDIASTINUM
WHAT IS THE "BOX"?
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
MECHANISMS OF TRAUMA
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- Blunt
MECHANISMS OF TRAUMA

- Blunt
  - Caused by blast, crush, deceleration
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  - Blast - pressure wave causes injury
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  - Crush - chest is compressed between objects
MECHANISMS OF TRAUMA

- Blunt
  - Caused by blast, crush, deceleration
  - Blast - pressure wave causes injury
  - Crush - chest is compressed between objects
  - Deceleration - “the 3 collisions”
MECHANISMS OF TRAUMA
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- Penetrating
MECHANISMS OF TRAUMA

- Penetrating
  - projectiles (bullet, arrows, shrapnel, etc.)
MECHANISMS OF TRAUMA

- Penetrating
  - projectiles (bullet, arrows, shrapnel, etc.)
  - Stab wounds (Knife, ice pick)
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  - Impaled objects
MECHANISMS OF TRAUMA

- Penetrating
  - projectiles (bullet, arrows, shrapnel, etc.)
  - 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
SKELETAL INJURIES

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  - most commonly fractured bone
SKELETAL INJURIES

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  - rarely a significant injury
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  - complications include subclavian artery or vein injury
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  - Signs and symptoms include pain, swelling, deformity.
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  - complications include subclavian artery or vein injury
  - Signs and symptoms include pain, swelling, deformity.
  - Treatment is sling (+/- swathe)
RIB FRACTURES

- Rare in children, if present must suspect non-accidental trauma
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- More common with increasing age
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- More common with increasing age
- Concern for underlying injury
RIB FRACTURES

- Rare in children, if present must suspect non-accidental trauma
- More common with increasing age
- Concern for underlying injury
- Requires significant force
RIB FRACTURES

- Rare in children, if present must suspect non-accidental trauma
- More common with increasing age
- Concern for underlying injury
- Requires significant force
- Most commonly due to blunt force trauma
RIB FRACTURES

- Fracture usually caused by an anterior-posterior compression force
RIB FRACTURES

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- Rib fractures at weakest point, generally lateral aspect.
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- Ribs 3-8 most commonly fractured
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- Rib fractures at weakest point, generally lateral aspect.

- Ribs 3-8 most commonly fractured

- Fracture of ribs 1-2 highly concerning for associated injury.
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 apparent.
SIGNS AND SYMPTOMS
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- Localized pain
SIGNS AND SYMPTOMS

- Localized pain
- bruising, crepitus, tenderness
SIGNS AND SYMPTOMS

- Localized pain
- bruising, crepitus, tenderness
- decreased chest movement due to pain.
SIGNS AND SYMPTOMS

- Localized pain
- bruising, crepitus, tenderness
- decreased chest movement due to pain.
- Treatment
Localised pain

bruising, crepitus, tenderness

decreased chest movement due to pain.

Treatment

- oxygen, pain management
SIGNS AND SYMPTOMS

- Localized pain
- bruising, crepitus, tenderness
- decreased chest movement due to pain.

Treatment

- oxygen, pain management
- Do NOT splint
SEQELEAE

- Atelectasis
SEQUELAE

- Atelectasis
- Hypoventilation
SEQUELAE

- Atelectasis
- Hypoventilation
- Pneumonia
SEQUELAE

- Atelectasis
- Hypoventilation
- Pneumonia
- Most rib fractures heal without consequence
SEQUELAE

- Atelectasis
- Hypoventilation
- Pneumonia
- 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
Suspicion of multiple rib fractures should prompt transportation to a Trauma Center.
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Positive pressure ventilation may be needed.
TRANSPORT CONSIDERATION

- Suspicion of multiple rib fractures should prompt transportation to a Trauma Center.
- Positive pressure ventilation may be needed
- Consider ALS backup for analgesia if available
FLAIL CHEST

- Definition
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  - 3 or more consecutive ribs fractured in 2 or more places
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  - “free-floating” segment of chest wall
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- most common cause is motor vehicle trauma
FLAIL CHEST

- Definition
  - 3 or more consecutive ribs fractured in 2 or more places
  - “free-floating” segment of chest wall
- 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
- Mediastinum shifts with each breath
-Expiration
- Loose part of the chest wall
ASSESSMENT

- Chest wall contusion
ASSESSMENT

- Chest wall contusion
- Respiratory distress
ASSESSMENT

- Chest wall contusion
- Respiratory distress
- Paradoxical chest wall movement
ASSESSMENT

- Chest wall contusion
- Respiratory distress
- Paradoxical chest wall movement
- Pleuritic chest pain
ASSESSMENT

- Chest wall contusion
- Respiratory distress
- Paradoxical chest wall movement
- Pleuritic chest pain
- Crepitus
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?
STERNAL FRACTURE
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- 25-45% mortality rate due to association with other injuries
STERNAL FRACTURE

- 25-45% mortality rate due to association with other injuries
  - myocardial contusion / rupture
STERNAL FRACTURE

- 25-45% mortality rate due to association with other injuries
  - myocardial contusion / rupture
  - cardiac tamponade
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- 25-45% mortality rate due to association with other injuries
  - myocardial contusion / rupture
  - cardiac tamponade
  - pulmonary contusion
STERNAL FRACTURE

- 25-45% mortality rate due to association with other injuries
  - myocardial contusion / rupture
  - cardiac tamponade
  - pulmonary contusion
- Posterior displacement can cause significant vascular compromise
TREATMENT

- ABC’s
TREATMENT

- ABC’s
- High-concentration oxygen
TREATMENT

- ABC’s
- High-concentration oxygen
- Cautious use of fluids
TREATMENT

- ABC’s
- High-concentration oxygen
- Cautious use of fluids
- Rapid transport to trauma center
TREATMENT

- ABC’s
- High-concentration oxygen
- Cautious use of fluids
- Rapid transport to trauma center
- Do not splint chest wall
PNEUMOMOTHORAX

- Incidence
  - 10-30% in blunt trauma, almost 100% in penetrating
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  - Various subtypes including: closed, open, spontaneous, tension.
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- Air enters the pleural space due to a disruption in the visceral pleura
PNEUMOTHORAX

- Incidence
  - 10-30% in blunt trauma, almost 100% in penetrating
  - Various subtypes including: closed, open, spontaneous, tension.

- 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

- Most common cause is rib fracture puncturing the pleura and lung
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- Can also occur by the “paper-bag effect”
CLOSED PTX

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- Small holes usually self seal, large ones may progress
CLOSED PTX

- Most common cause is rib fracture puncturing the pleura and lung
- Can also occur by the “paper-bag effect”
- Small holes usually self seal, large ones may progress
- Leads to a ventilation - perfusion mismatch
High - concentration oxygen
MANAGEMENT

- High - concentration oxygen
- PPV as needed. Must use caution with BVM or intubation
MANAGEMENT

- High - concentration oxygen
- PPV as needed. Must use caution with BVM or intubation
- Needle thoracostomy if tension ptx develops
MANAGEMENT

- High - concentration oxygen
- PPV as needed. Must use caution with BVM or intubation
- Needle thoracostomy if tension ptx develops
- Transport considerations
OPEN PNEUMOTHORAX
OPEN PNEUMOTHORAX

- Usually the result of penetrating trauma
OPEN PNEUMOTHORAX

- Usually the result of penetrating trauma
  - GSW, knife, impaled object, MVC
OPEN PNEUMOTHORAX

- Usually the result of penetrating trauma
  - GSW, knife, impaled object, MVC
- Severity is directly proportional to size of wound
OPEN PNEUMOTHORAX

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

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

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- Can develop from both closed and open ptx
- Leads to cardiovascular collapse
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
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
Buildup of pressure in pleural cavity causes pressure to be applied across the mediastinum.
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.
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

- 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
HEMOTHORAX

- May be associated with pneumothorax
HEMOTHORAX

- May be associated with pneumothorax
- Commonly caused by rib fx and laceration of intercostal vessel
HEMOTHORAX

- May be associated with pneumothorax
- 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
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

- 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
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
PULMONARY CONTUSION

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- Commonly associated with rib fracture
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
TRAUMATIC ASPHYXIA

severe crushing mechanism
DON'T TRY THIS AT HOME
PERICARDIAL TAMponade

- Most commonly result of penetrating trauma
PERICARDIAL TAMPONADE

- Most commonly result of penetrating trauma
- Occurs in less than 2% of all chest trauma
PERICARDIAL TAMПONADE

- Most commonly result of penetrating trauma
- Occurs in less than 2% of all chest trauma
- GSW has much higher mortality than stab wounds
PERICARDIAL TAMPOONADE

- 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

- Pericardium
Pericardium

tough fibrous sac enclosing heart
PATHOPHYSIOLOGY

- Pericardium
  - tough fibrous sac enclosing heart
  - attached to great vessels at base of heart
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
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
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
ELECTRICAL ALTERNANS
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

- 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

- Blunt trauma
  - rapid deceleration
AORTIC RUPTURE

- Blunt trauma
  - rapid deceleration
- 80-90% of these patients die at the scene from massive hemorrhage
AORTIC RUPTURE

- 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
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
IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS WITH PENETRATING TORSO INJURIES

William H. Bickell, M.D., Matthew J. Wall, Jr., M.D., Paul E. Pepe, M.D.,
R. Russell Martin, M.D., Victoria F. Ginger, M.S.N., Mary K. Allen, B.A.,
and Kenneth L. Mattox, M.D.
Odd vs. even
- Odd vs. even
- Fluids by standard protocol vs. heplock only
- Odd vs. even
- Fluids by standard protocol vs. heplock only
- No fluid group did better
- Odd vs. even
- Fluids by standard protocol vs. heplock only
- No fluid group did better
- Why haven’t EMS protocols changed?
FLUIDS

- US Military experience
FLUIDS

- US Military experience
  - tolerate SBP as low as 70
FLUIDS

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

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