Crushing Chest Injury

Time is short, the odds great, the margin small, and the stakes infinite.” Churchill

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THINK ENERGY

85% of all chest trauma is fixed with a CT
Background

- Chest trauma responsible for 25% of trauma deaths and contributes to another 50%

- Mechanism
  - Blunt
  - Penetrating
The Fragile Cavity

- Vital Structures
  - Heart, Great Vessels, Esophagus, Tracheobronchial Tree, & Lungs

- 25% of MVC deaths are due to thoracic trauma
  - 12,000 annually in US

- Abdominal injuries are common with chest trauma.
Mechanics of Breathing

- Two pleural membranes – known space
- Opposing forces – “lung recoil vs. ribs”
Negative Intrathoracic Pressure

- This pressure facilitates air movement into alveoli
- Augments venous return
- Loss of negative intrathoracic pressure results in loss of pressure gradient needed for ventilation
- Venous return is hampered
- The pleural space is site of collection of fluid and/or air
Begin With The Basics

- Open the airway!!!
  "NEVER FORGET THE C-SPINE!!!"

- Jaw thrust-distracts the spine by ~4 mm vs chin-lift ~8 mm

- Whenever the collar is off there must be a person assigned to the neck for manual axial in-line stabilization
Airway Obstruction

- Clinical Presentation
  - “Distress” → cyanosis – remember need adequate hemoglobin
  - Stridor / hoarse
  - Let them assume a desired position
Are You In???

- The verification is more important than the intubation itself.
- Direct visualization-- “I saw the cords”
- Auscultation-- ~75% accuracy
- CXR-- time-limiting
- Pulse oximetry—some limitations
- End-tidal CO2
End Tidal CO2 Monitoring

- Place on ETT immediately after intubation
- Deliver ~6 breaths to analyze to eliminate false positives that are seen after long-term BVM or carbonated beverage ingestion
- 100% sensitive with a spontaneous pulse
- ~30% false negative in cardiac arrest
Pulse Oximetry

- Looks at the ratio of saturated hemoglobin molecules and though UV rays depicts them to an analog monitor.

- They require perfusion, normothermia, protection from ambient light, cannot depict the structures of saturation

- Have ~75% prediction of Sa02 Rodicks 2010

- Decreased accuracy with saturations <85%
Airway Obstruction

- *WHEN IN DOUBT INTUBATE*
  - Cricothyroidotomy
Blunt Trauma

- Results from kinetic energy forces
  - Blast
    - 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
- 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 = Absorbs forces
  - Geriatric Thorax: Calcification & osteoporosis = More fractures
Simple Pneumothorax

- Occurs when lung tissue is disrupted and air leaks into the pleural space
- 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
- Typical MOI: “Paper Bag Syndrome”
Tension Pneumothorax
“A Fatal Sequelae”

- **Defined**
  - A pulmonary collapse that results in hemodynamic embarrassment and shock

- **Etiology**
  - Penetrating chest injury
  - Blunt chest injury
  - Iatrogenic barotrauma
Tension Pneumothorax

- Clinical Presentation
  - Severe respiratory distress → hypoxemia
  - Hemodynamic embarrassment
  - Unilateral absence of breath sounds or chest expansion
  - Tracheal (?) and PMI deviation
Tension Pneumothorax

- Management
  - Support – ABC
  - Needle decompression
  - Tube thoracostomy
Massive Hemothorax

- Defined
  - Blood in pleural space
  - Mortality rate of 75%
  - Each side of thorax may hold up to 3,000 mL
  - Blood loss in thorax causes a decrease in tidal volume
  - Ventilation/Perfusion Mismatch & Shock
  - Typically accompanies pneumothorax
    - Hemopneumothorax
Massive Hemothorax

Management

- Support ABC – good venous access -> autotransfusion
- Tube thoracostomy – BIG TUBE
- Indications for thoracotomy
  - Ongoing shock
  - ≥ 1,500 cc initial evacuation
  - ≥ 200 cc for ≥ 3 hours
  - Failure to drain blood
Massive Hemothorax

Clinical Presentation

- Mechanism
- Rib fractures
- Signs of hemorrhagic shock
- Dullness to percussion / absence of breath sounds
- Signs of hypoxemia
Chest Tubes

- Indications: loss of negative inspiratory force!!!
  - air/fluid/blood
  - big tube -- blood/little tube -- air
  - Initial return of 1500cc blood or > 200cc for > 3 hours to OR
  - Call if > 100cc/hr or > 3-5cc/kg for children
- Keep to suction at all times unless there is an order
- Maintain at 20cm H2O unless otherwise noted
- Closely monitor output
  --color
  --volume
- Monitor for airleak
- NEVER CLAMP
- Chest tube ties
- **Indications for removal**
  - <200cc/24 hours
  - Lung fully inflated = no air leak
  - Full inspiration and occlusive dressing when pulled

- **After removal**
  - Occlusive dressing for 48-72 hours
  - Date the dressing
  - CXR as ordered
  - Assess the patient
Autotransfusion

- Indication with chest trauma
- Special collection reservoir
- THINK
- May stay extracorporeal for ~4 hours
- Filter, no additives
- Complete paperwork
Heimlich Valves

- May be utilized on airlifted patients
- May be utilized on “pigtails”
- Only used when there is air in the pleural cavity
Chest Catheters

- Utilized for simple pneumothorax
- Usually placed in anterior chest or midaxillary line
- Can be connected to a pleurovac or Heimlich valve
- Less morbidity
Rib Fractures

• >50% of significant chest trauma cases due to blunt trauma
• Compressional forces flex and fracture ribs at weakest points
• Ribs 1-3 requires great force to fracture
  ▪ Possible underlying lung injury
• Ribs 4-9 are 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
• Hypoventilation is COMMON due to PAIN
Facts That Frighten

There is a 27% increase in complications for EVERY rib fractured in the elderly
**Flail Chest**

- Defined
  - Multiple rib fractures occurring in two or more places along the same rib
  - Paradoxical movement
  - ↓ VC, ↑ WOB, ↑ VO2
  - ↓ Venous return, → hypoperfusion
Flail Chest

- **Clinical Presentation**
  - Diagnosis is clinical NOT radiologic
  - Chest bruising, deformity, asymmetry, concavity
  - Hypoxemia
  - Associated sequelae
    - Pulmonary contusion
    - Hemopneumothorax
    - Abdominal injuries (15%)
Flail Chest

- Management
  - Selective use of intubation:
    - Respiratory distress, tachypnea
    - ↑ WOB
    - ↓ P/F ratio, ↑ PaCO2
    - Hemodynamic instability
    - Advanced age
  - “Internal” stabilization – PEEP
  - Breaking the “PAIN-SPLINT-HYPOVENTILATION CYCLE”
  - Aggressive pulmonary toilet
  - Consider surgical fixation in large flails
Sternal Fracture & Dislocation

- Associated with severe blunt anterior trauma
- Typical MOI
  - Direct Blow (i.e. Steering wheel)
- Incidence: 5-8%
- Mortality: 25-45%
  - Myocardial contusion
  - Pericardial tamponade
  - Cardiac rupture
  - Pulmonary contusion
- Dislocation uncommon but same MOI as fracture
  - Tracheal depression if posterior
Pulmonary Contusion

- Defined
  - Parenchymal destruction, interstitial hemorrhage, edema, and capillary leak
  - “Blossoming” – inflammatory cascade
  - Intrapulmonary shunting → hypoxemia
  - Children – “Plastic”
Pulmonary Contusion

- Clinical Presentation
  - Dypnea
  - Hypoxemia / hypercarbia
  - Decreased compliance
  - Diminished breath sounds
  - Hemoptysis
  - Microhemorrhage may account for 1 - 1 ½ L of blood loss in alveolar tissue
  - CXR – findings
Pulmonary Contusion

Management

• “SUPPORT”
• Intensive pulmonary toilet – rotational beds
• Judicious use of fluids – pulmonary artery catheters
• No prophylactic ABX
Pulmonary Contusion

- **MILD**
  - Monitor SpO2
  - Aggressive toilet / mobility
  - Analgesia

- **Moderate → Severe**
  - Intubate with positive pressure ventilation (IDLV)

- **Catastrophic**
  - Non-conventional therapy PC-IRV, HFJ, ECMO
  - Full body support
Pericardial Tamponade

- Defined
  - Perforation of the pericardial sac / chamber / vessel with *rapid* accumulation of blood
  - Blunt injury
  - Non-elastic parietal sac results in compression of structures – hypoperfused tissue beds
  - Primary mechanism – stab wound
Pericardial Tamponade

- Restriction to cardiac filling caused by blood or other fluid within the pericardium
- Occurs in <2% of all serious chest trauma
  - However, 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

- **Clinical Presentation**
  - “Suspect” – low BP, acidosis, BD
  - Beck’s Triad
    - hypotension (↓SV), JVD, muffled heart tones
  - Pulses paradoxus
  - ECG
    - Electrical Alterans
      - P, QRS, & T amplitude changes in every other cardiac cycle
- **PEA**
  - Echo
  - Hemodynamics
**Pericardial Tamponade**

- **Hemodynamically stable**
  - PERICARDIOCENTESIS
- "Primarily diagnostic"
- Left costal margin
- Utilize alligator clamp
- Assessment of fluid / status
- "Problems"
Pericardial Tamponade

- Hemodynamically unstable
  - Subxiphoid window
- Small surgical window
- Open visualization
- "Problems"
Pericardial Tamponade

- **Hemodynamically Unstable** →
  - ED THORACOTOMY
  - Indications
    - Penetrating
    - Recently lost signs
  - Procedure
  - Management of wound
  - Survivability
    - CPR 5 minutes with no airway
    - CPR 15 minutes with airway
Diaphragmatic Tear

- Defined
  - MOI – deceleration injury
  - Left hemidiaphragm injured > right hemidiaphragm
- **Diaphragm**
  - Muscular, dome-like structure
  - Separates abdomen from the thoracic cavity
  - Affixed to the lower border of the rib cage
  - Major muscle of respiration
    - Draws downward during inspiration
    - Moves upward during exhalation
Diaphragmatic Tear

Clinical presentation

- CXR – 25-50% - diagnostic
- Stomach, colon, bowel in chest
- NGT in chest
- Hemidiaphragmatic elevation
- DPL – 35% false negative
- DPL FLUID EXITING CT
- Bowel sounds in chest
- Dyspnea
Diaphragmatic Tear

Management
- Surgical repair
- High mortality due to co-morbidities
Tracheobronchial Injury

- Defined
  - Tear of bronchus
  - MOI – deceleration, compression
  - >80% occur with 2.5 cm of the carina
  - 50% of patients with injury die within 1 hr of injury

- Clinical Presentation
  - Subcutaneous air
  - Dyspnea, pain, dysphagia, cough, hemoptysis
  - Radiologic findings
    - Subcutaneous – posterior soft tissue – mediastinal air
Tracheobronchial Injury

Management

- ABC’s
- Tube thoracostomy
- Bronchoscopy
- OR repair
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 & Symptoms**
  - Head & 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
Blunt Cardiac Injury

**Defined**

- Blunt MOI with subendocardial and interstitial hemorrhage, edema, and inflammatory cascade
- 15% occurrence rate all comers
- Occurs in 76% of patients with severe blunt chest trauma
- Right ventricle primarily injured
- Impairment of conduction and/or contractility 20%
Blunt Cardiac Injury

Clinical presentation (cont’d)

- ECG
  - ST * (PVC’s)
  - Afib
  - RBBB
  - ST, T changes

- ECHO
  - Verify wall motility and valvular function
    - RVEF
• **Enzymes**
  - CKMB – index >5% - significant
  - Troponin I
  - Enzymes weak indicator for BMI

• **Seat belt sign**

• **↓BP, pain, N/V**
Blunt Cardiac Injury

Management

- Monitor for 24 hours for dysrhythmias
- Ventricular hypokinesis → ICU management
  - Fluids
  - Inotropes
  - Optimize DO2/VO2
  - NO VASODIALATORS
- Supplemental O2
- Monitor conduction disturbances
- Pain relief → NSAIDS
Esophageal Injuries

- Defined
  - Penetrating in nature and involve the thoracic esophagus

- Clinical Presentations
  - Subcutaneous air, mediastinal air
  - Fever 24 hours after injury

- Diagnostics
  - Esophagoscopy – 60%
  - Esophagram – 90%
• 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
Esophageal Injuries

- **Management**
  - Injury < 6 hours out $\rightarrow$ primary repair
  - Injury > 12 hours out $\rightarrow$ laceration repair
  - With diversion of proximal surgical feeding tube
  - Injuries 6-12 hours old $\rightarrow$ controversial management
In addition to caring for your 50 patients each nurse will follow these regulations:

1. Daily sweep and mop the floors of the wards, dust patient’s furniture and window sills.

2. Maintain an even temperature in your ward by bringing in a scuttle of coal each day.
• Light is important to observe your patient’s condition, therefore, each day fill the kerosene lamps, clean chimneys, and trim wicks.

Nurses notes are important to add the physician. Make your pens carefully with crisp whittle your nibs.
Each nurse should lay aside from each pay a goodly sum of her earnings for her declining years so that she will not be a burden.

Any nurse who smokes, uses liquor, gets her hair done at a beauty salon, or frequents dance halls give the director good reason to suspect her worth, intentions and integrity.
Each nurse will report everyday at 7 AM and leave at 8 PM except on the Sabbath on which you may be off from 12 noon until 2 PM.

Graduate nurses in good standing with the director of nurses will be given an evening off each week if you go regularly to church.
The nurse who performs her labors, serves her patients and doctors faithfully for 5 years will be given an increase in pay by 5 cents per day providing no hospital debts are outstanding.