Joint Trauma System

Thoracic Injuries

Joint Trauma System Battlefield Trauma Educational Program
A 21-year-old Marine was shot in the left chest during a raid. He arrests as he arrives to your Role 2 facility. CPR began in the trauma bay.

1. How would you manage this injury?
2. What if he fell 30 feet instead of being shot?
3. What if he was one of 5 patients to arrive simultaneously?
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Objectives

- Recognize and manage specific thoracic and cardiac injuries on the battlefield.
- Describe the indications and technique for performing a resuscitative thoracotomy.
- Describe common thoracic and cardiac exposures and recognize which injuries they address.
Injuries to the chest can profoundly affect breathing and circulation.

Penetrating thoracic injuries below the T4 level/nipple line require evaluation for abdominal injuries due to variable position of the diaphragm.

Injuries requiring urgent intervention include:
- Tension pneumothorax
- Open pneumothorax
- Massive hemothorax
- Cardiac tamponade

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Pneumothorax & Hemothorax

Characteristics
- Air or blood enters potential space between visceral and parietal pleura.

Signs & Symptoms
- Unilateral breath sounds
- Respiratory distress

*Small left pneumothorax*

*Left Hemothorax secondary to penetrating trauma*
Absent or markedly decreased breath sounds with known thoracic trauma indicate need for intervention without additional testing. *Tube thoracostomy (chest tube) is both diagnostic and therapeutic.*

It is reasonable to perform chest x-ray (CXR) or ultrasound prior to chest tube if normal hemodynamics and adequate oxygenation/ventilation.

Tube thoracostomy is indicated in all patients with penetrating chest trauma or suspected hemothorax or pneumothorax.
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Tension Pneumothorax

- Characteristics
  - “One-way” valve traps air
  - Lung collapse
  - Mediastinal shift to contralateral side
  - Decreases venous return to heart (preload)
  - Death

- Signs & Symptoms
  - Respiratory distress
  - Unilateral breath sounds
  - Distended neck veins
  - Tracheal deviation away from the injury
  - Hypotension
  - Tachycardia

- Patient with known chest injury presenting with a patent airway and difficulty breathing has a tension pneumothorax until proven otherwise.

**BEWARE:** Mechanical Ventilation can quickly turn a simple pneumothorax into a tension pneumothorax.
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Tension Pneumothorax

Treatment: Immediate Decompression

- Needle Decompression – 14 gauge/3.25 in/8cm spinal needle
  - **First Choice**: 4\(^{th}\) and 5\(^{th}\) Intercostal Space anterior axillary line
  - **Second Choice**: 2\(^{nd}\) Intercostal space at the mid clavicular line (first choice for children)
  - Short catheters will rarely penetrate the thoracic cavity; using something long like a spinal needle with an angiocath
  - A chest tube should be placed as soon as feasible and safe after needle thoracostomy.
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Tension Pneumothorax

Treatment: Immediate Decompression

- Tube thoracostomy: 5th intercostal space (nipple line/mammary crease), anterior-mid axillary line

  *If chest tube placement delayed, be prepared to repeat needle decompression as needed.*

- Failure to improve after two needle decompressions likely indicates an alternate diagnosis.

*Chest tube being inserted*
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Open Pneumothorax

**Characteristics**
- “Sucking” chest wound
- Defect in the wall large enough to impair effective air exchange
- Generally larger than 2/3 of the tracheal diameter

**Treatment**
- Flutter-valve dressing: Taped on 3-sides
- Tube thoracostomy at remote site
- Operative intervention
- Dressing that is taped on 4 sides results in a tension pneumothorax

*Large, open chest wound to patient’s left posterior chest.*
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Massive Hemothorax

- **Characteristics**
  - Rapid accumulation >1500 mL of blood from chest tube or bleeding continues such that ongoing blood transfusions are required.
  - Injury to:
    - Chest wall vascular injury
    - Hilar pulmonary injury
    - Great vessel/cardiac injury

- **Signs & Symptoms**
  - Hypotension
  - Unilateral breath sounds
  - Dullness to percussion
  - Hypoxia
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Massive Hemothorax

- **Diagnosis**
  - CXR
  - US (E-FAST)
  - Tube thoracostomy

- **Treatment**
  - Tube thoracostomy (may need 2)
  - Thoracotomy
    - ≥1500 mL blood out initially
    - > 250 mL / hr of blood
    - Ongoing transfusion requirement
  - Patients will require massive transfusion protocol

*Right Hemothorax secondary to penetrating trauma. Required urgent thoracotomy for hemorrhage control.*
Characteristics
- Penetrating >> blunt trauma
- Pathophysiology
  - Fluid in pericardium
  - Compression of right heart
  - Obstruction of venous return
  - Cardiovascular collapse

Positive FAST. Fluid seen between the pericardium and the ventricles.
Classical Signs & Symptoms

- Beck’s Triad:
  - Distended neck veins
  - Hypotension
  - Muffled heart sounds
- Respiratory distress
- Bilateral breath sounds
  - Unilateral breath sounds with tension pneumothorax
- Midline trachea
  - Tracheal deviation with tension pneumothorax
- Classic physical exam findings are unreliable and do not rule out injury.
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Cardiac Tamponade

■ Diagnosis
  - FAST
  - Pericardial window (best option if unsure and patient stable)

■ Treatment
  - Unstable patient: Left anterolateral thoracotomy -> can convert to clamshell thoracotomy if needed for better exposure
  - Median Sternotomy: In stable patients with positive subxiphoid pericardial window. Best exposure for heart and great vessels.
  - **WARNING:** These patients may arrest upon induction of anesthesia. Be READY.

Source: Combat Casualty Care: Lessons Learned from OEF and OIF, Borden Institute, 2012.
Characteristics

- Gross chest wall instability
- Paradoxical chest wall movement with respirations (section of ribs ‘floating’ with two fractures on each rib).

Signs and Symptoms

- Respiratory distress: Commonly associated with pulmonary contusion
- Visible chest was deformity
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Flail Chest

- **Diagnosis**
  - Clinical presentation
  - CXR or CT scan: Multiple contiguous rib fractures in at least 2 locations

- **Treatment**
  - Resuscitation
  - Adequate oxygenation
  - Improve ventilation
  - Analgesia
  - Pharmacologic (opiates, Tylenol, etc.)
  - Regional nerve blocks (epidural, intercostal blocks)
  - Ipsilateral chest tube placed prior to transport
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Vascular Injuries

■ Initial Control
  - Digital occlusion
  - Sponge stick (venous injury)
  - Fogarty or Foley catheter
  - Side-biting vascular clamp

■ Damage Control Procedures
  - May require temporary proximal and distal control
  - Primary repair
  - Consider shunting
    Aorta shunt = chest tube

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Heart

- Expose and temporarily occlude punctures
  - Digital occlusion
  - Foley catheter
  - Skin stapler

- Damage control procedures
  - 2-0 Prolene, pledgeted sutures
  - Place in horizontal mattress format if near coronary vessel (pictured at top right)

- Maintain high index of suspicion for injury to more than one cardiac structure or hidden, intra-cardiac injury.
  - More complex repairs are impractical without cardiac bypass.

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Lung

- Chest tube adequate for most parenchymal injuries
- Damage control procedures
  - To control immediately life threatening bleeding:
    - Cross-clamp hilum
    - Pulmonary twist

Pulmonary twist

Further Damage Control Procedures

- Tractotomy
  - Divide bleeding tracts with GIA stapler
- Non-anatomic wedge resection (GIA stapler)
- Pneumonectomy last resort
  - Stepwise increase in mortality with more extensive resections when lung injuries are encountered
  - Trauma pneumonectomy mortalities ranging from 50-100%
  - Contact ECMO team

Clinical Findings
- Persistent and/or massive air leak in chest tube chamber
- Frothy hemoptysis
- Pneumomediastinum

Confirmed via bronchoscopy (if available)

If after intubation there is no large air leak and ventilation appears adequate along with no other surgical indications, then further intervention should be deferred to definitive care center.

Subcutaneous emphysema and pneumothorax requiring multiple chest tubes on the right.
Surgical exposure
- Mid-distal trachea – *median sternotomy*
- Distal trachea and carina – *right thoracotomy*
- Left mainstem bronchus – *left thoracotomy*

Damage control procedures
- Repair over ET tube with absorbable suture.
- Bolster with pleural or intercostal muscle flap, especially between trachea and esophagus.

Temporization with bronchial blockers or double lumen ET tubes is possible.
Diagnosis

- Rarely isolated injury – will be identified with other injuries.
- Clues include pain, fever, leukocytosis, cervical emphysema.
- Chest tube may have gastric content.
- Chest X-ray: pneumothorax, mediastinal air, pleural effusion.
- CT and endoscopy for isolated injuries if available.
Damage control procedures
- Broad spectrum antibiotics
- Drainage via tube thoracostomy and careful placement of nasogastric tube above the level of injury
- Repair if < 24 hours: Single or double-layer closure with absorbable suture
  - Bolster with pleura or intercostal muscle flap
  - >24 hours: wide drainage only
- Resection should only be utilized in the setting of extensive tissue devitalization.

Access if isolated injury in stable patient
- Upper to mid thoracic esophagus: *right posterolateral thoracotomy*
- Lower thoracic esophagus: *left posterolateral thoracotomy*
Diagnosis

- CXR: Gastric bubble or colon outline
- CT scan: Only available at some treatment facilities
- Direct visualization: Usually found directly when exploring for penetrating trauma

Pneumothorax (green arrow), but also note outline of bowel in right chest (red arrow)
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Diaphragm

■ Access
  - If identified during thoracic procedure, the abdomen must be evaluated for intra-abdominal injury.

■ Repair
  - Use running or simple interrupted 0 or 2-0 non-absorbable suture.
  - If significant contamination of pleural space by enteric contents, copious irrigation with drainage of chest.

Small diaphragmatic injury (arrow)
Source: Borden Institute: War Surgery in Afghanistan and Iraq
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Surgical Exposures

- Positioned to maximize necessary interventions
  - Supine with arms out
  - Prepped from chin to knees and chest to elbows
  - Large bore IV access

- Anesthesia concerns
  - Induction can cause cardiovascular collapse, especially with cardiac tamponade.
  - Consider having patient prepped and draped prior to inducing anesthesia.
  - If clinical pattern allows, suspected great vessel injury should receive short-acting beta blocker with goal SBP 100-120.
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Surgical Exposures

- Median Sternotomy
  - Suspected cardiac injury
  - Positive subxiphoid window
  - Suspect injury to great vessels of chest
  - **Weaknesses**: Poor exposure to left subclavian or thoracic aorta

- Extensions
  - Subclavicular: Mid-to-distal subclavian artery injury (preferred)
  - Trap Door: Proximal left subclavian artery injury
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Median Sternotomy

Median sternotomy with subclavicular extension for subclavian injury

Median Sternotomy with left anterolateral thoracotomy with temporary packing
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Surgical Exposures

- Left anterolateral thoracotomy
  - Ideal for the patient in extremis or is profoundly unstable.
  - Should be combined with right tube thoracostomy.
  - Same incision used for emergency resuscitative thoracotomy.

- Extensions
  - Transverse sternotomy with right anterolateral thoracotomy ("clamshell").
    Suspected intra-pericardial injury or right pleural space bleeding.

Trans-mediastinal gunshot wound with active cardiac massage
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Surgical Exposures

- Right anterolateral thoracotomy
  - Used for injuries known to be to right chest

- Posterolateral thoracotomy
  - *Rarely appropriate in the acute trauma setting.*
  - May be indicated for definitive repair of posterior mediastinal or lung injuries in well resuscitated patients.
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References


- Savistky, Eric MD and Brian Eastridge MD COL MC USAR. Combat Casualty Care: Lessons Learned from OEF and OIF. Fort Sam Houston, TX: Borden Institute, 2012.)

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