### Incidence
- Commonly caused by blunt trauma
- Significant force required
- Commonly adults, usually in elderly

### Flail Chest
- 3 or more ribs fracture in 2 or more places, producing a free floating segment of the chest wall.

### Sternal Fracture
- 5-8% incidence in blunt chest trauma
- Indicates significant energy transfer
- Result from deceleration or compression injuries
- Impact to dashboard or steering wheel
- Direct blow to chest
- Deceleration from frontal impacts:
  - “cheese slice” of aorta
  - “paper bag” syndrome (pneumothorax)
- Abdominal injuries
- Head trauma

### Morbidity/Mortality
- Commonly caused by MVCs
  - Frontal impact
  - Lateral impact
- Falls from heights
- Industrial accidents
- Assault

### Incidence
- Indicates significant energy transfer
- Mortality rates 20-40% due to associated injuries
- Multi-systems trauma
- Pulmonary and cardiac trauma
- Additional factors determining mortality:
  - Advanced age
  - Fracture of 7 or more ribs
  - Presence of 3 or more associated injuries
  - Shock
  - Head injury

### Sites
- Fracture of ribs 4-9 most common (they are thin + poorly protected)
- Fracture of 1st or 2nd rib:
  - Severe force & resultant injuries
  - 50% mortality rate
- Low ribs
- Associated with liver, spleen injury
- Posterior ribs
- Associated with spleen + kidney injury

### Pathophysiology
- Restriction of tidal volume due to pain and splinting
- Ventilation/perfusion mismatch
- Atelectasis from extended restriction of tidal volume:
  - Higher risk in the elderly
  - High likelihood development pneumonia
- Risk of underlying pulmonary + cardiac injury potential:
  - Multiple rib fractures
  - Fracture of 1st or 2nd rib:
    - Severe force & resultant injuries
    - 50% mortality rate
  - Low ribs
  - Associated with liver, spleen injury
  - Posterior ribs
  - Associated with spleen + kidney injury

### Impaired ventilation:
- Pain
- Muscle spasm surrounding the injury
- Paradoxical movement of chest

### Impaired respiration:
- Underlying pulmonary contusion
- Results in:
  - Hypoxia
  - Elevated PaCO₂

### Assessment
- Localized pain
- Provocation pain:
  - Movement
  - Deep inspiration
  - Cough

### Signs:
- Patient self-splinting on respiration
- Chest wall contusion (bruising)
- Palpation:
  - Point tenderness
  - Crepitus or audible crunch
  - Pain on placement of anterior/posterior pressure
  - Tenderness to compression of rib cage

### Signs:
- Localized pain
- Dyspnea
  - Pleuritic chest pain

### Signs:
- Similar as rib fracture
  - Self-splinting
  - ↑HR (tachycardia)
  - ↑RR (tachypnea)
  - Respiratory distress/Shallow resp
  - Lung sounds diminished
  - Unilateral crackles if pulmonary contusion present.
  - Pain and splinting of affected side
  - Chest wall contusion (bruising)
  - Paradoxical chest wall movement

### Palpation:
- Crepitus + point tenderness over sternum
- Other rib fractures may be present

### Management
- High flow O₂ and BMV if needed
- ECG
- Splinting may decrease pain
  - Avoid circumferential splinting
  - Patient self-splinting may be appropriate
- Analgesic for pain
- Psychological support/communication strategies
- Transport considerations:
  - Appropriate mode and facility based on injury

### Signs:
- ↑HR (tachycardia)
- Shallow respiratory effort
- ECG changes associated w/myocardial contusion

### Palpation:
- Crepitus in multiple sites of the affected ribs

### Signs:
- Localized pain
- Tenderness over sternum
- Pleuritic chest pain
  - Ischemic organ pain if a myocardial injury is present

### Signs:
- High flow O₂ and BMV if needed
- ECG
- IV: restrict fluids unless sings of shock
  - Monitor lung sounds
  - Analgesic for pain
  - Psychological support/communication strategies
  - Transport considerations:
    - Appropriate mode and facility based on severity of injury

### Management
- High flow O₂ and BMV if needed
- ECG
- IV: restrict fluids if pulmonary contusion is suspected
  - Fluid challenge may be helpful for a myocardial contusion
- Analgesic for pain
  - Psychological support/communication strategies
  - Transport considerations:
    - Appropriate mode and facility based on severity of injury
# Pulmonary Injuries

## Epidemiology
- **Incident**:
  - Nearly 100% in penetrating chest trauma
  - 10-30% blunt chest trauma
- **Morbidity/mortality**:
  - Dependent upon extent of involvement
  - Dependent upon presence + severity of associated injuries
- **Impact**:
  - Penetrating trauma
  - Common cause by blunt thoracic trauma
  - Associated with great vessel/cardiac injury
  - Blast injuries
  - Penetrating trauma
- **Morbidity/mortality**:
  - Death due to profound hypovolemia
  - Death related to delayed management
  - 50% will die immediately
  - 25% will live 5 to 10 minutes
  - 25% may live 30 min or longer
  - Nearly 100% in penetrating trauma
  - Commonly associated with rib fractures
  - High association with pneumothorax

## Pathophysiology
- Disruption of pleural space:
- Air accumulation in pleural space:
  - Compression of lung tissue
  - Ventilation/perfusion mismatch
  - Air accumulation change with position
- Deep, open defect in the chest wall:
  - Air will enter pleural space during inspiration
  - Air may or may not exit during expiration
  - Breath sounds on affected side
- Pleuritic chest pain:
  - Collapse/compression of affected area
  - Potential development of pressure within pleural space
  - Hypoventilation
  - Hypoxia
- Similar to pneumothorax:
  - Large volume of air trapped in pleural space with increased pressure in the thoracic cavity:
  - Severe compression lung tissue
  - Hypoxia
  - Elevated levels of PaCO2
  - Lung collapses on affected area:
  - Impairment to ventilation
  - Heart output:
  - Preload due to kinking of the vena cava
  - Profound shock may occur fast
- Blood accumulation into the pleural space:
  - Chest cavity can hold up to 2-3 liters
  - Massive hemothorax indicates a great vessel or cardiac injury
- Sources of bleeding:
  - Pulmonary contusion
  - Disruption of pulmonary vessels
  - Disruption of chest wall vessels
  - Disruption of intercostal vessels
  - Myocardial rupture
- Bruised lung — lung impacts chest wall in blunt trauma
- Alveoli and capillary rupture:
  - Bleeding into alveoli and interstitial space
- Edema
- Disruption of respiration:
  - Damaged capillaries and alveolar walls are unavailable for gas exchange:
  - Hypoxia
  - CO2 retention

## Assessment findings
- **s/s**:
  - Dyspnea
  - Chest pain referred to shoulder or arm on affected site
  - Respiratory distress
  - Subcutaneous emphysema
  - Decreased or absent breath sounds on affected site
  - Rapid onset respiratory distress
  - Extreme anxiety or rapidly deteriorating mental status
  - Cyanosis
  - Bulging of intercostal muscles
  - Unilateral absent breath sounds
  - Subcutaneous emphysema
  - Late signs:
    - JVD
    - Tracheal deviation
    - Decompensated shock
  - Vital signs:
    - Tachycardia
    - Tachypnea
    - Hypoxia
    - Narrowing pulse pressures
- **Vital signs**:
  - High flow O₂ / BVM
  - Monitor for development of tension pneumothorax
  - IV
  - ECG
  - Psychological support/communication strategies:
    - Transport considerations:
      - Appropriate mode and facility based on severity of injury
      - Needle decompression
      - Rapid transport
      - Consider ALS intercept for advance airway procedures
      - Transport considerations:
        - Appropriate mode and facility based on severity of injury
        - Appropriate mode and facility
        - Transport considerations:
          - Appropriate mode and facility
  - High flow O₂ / BVM
  - IV fluid admin if signs of shock
  - Treatment for respiratory compromise and shock
  - ECG
  - Psychological support/communication strategies:
    - Transport considerations:
      - Appropriate mode and facility based on severity of injury
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        - Appropriate mode and facility
        - Transport considerations:
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## Vital signs:
- HR (tachycardia)
- RR (tachypnea)
- Normal or slightly lowered pulse oximetry readings
- JVD
- Tracheal deviation
- Decompensated shock
- Narrowing pulse pressures
- Cough, hemoptysis (coughing blood)
- Evidence of blunt chest trauma
- Apprehension
- Changes in skin color
- Dull to percussion
- Signs of hypoxia dependent upon size of injury
- Respiratory distress
- Lung sounds:
  - Crackles in affected lung
  - Sounds w/ reduced tidal volume
  - Rapid transport
  - Consider ALS intercept for advance airway procedures

## Management
- High flow O₂ / BVM
- Cover open wounds with occlusive dressing
- Monitor for development of tension pneumothorax
- IV
- ECG
- Psychological support/communication strategies:
  - Transport considerations:
    - Appropriate mode and facility based on severity of injury
    - Needle decompression
    - Rapid transport
    - Consider ALS intercept for advance airway procedures
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## PULMONARY INJURIES

<table>
<thead>
<tr>
<th>Simple pneumothorax</th>
<th>Open pneumothorax</th>
<th>Tension pneumothorax</th>
<th>Hemorrhax</th>
<th>Pneumonothorax</th>
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<tbody>
<tr>
<td>Incident:</td>
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<td>Penetrating trauma</td>
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## Vital signs:
- Tachycardia
- Tachypnea
- Hypoxia
- Narrowing pulse pressures

## Finding:
- Dyspnea
- Chest pain referred to shoulder or arm on affected site
- Respiratory distress
- Subcutaneous emphysema
- Decreased or absent breath sounds on affected site
## Epidemiology

**Incidence:**
- 16-76% of blunt trauma
- Major deceleration injury
- Common in frontal impacts:
  - Bent steering wheel and chest tenderness
  - Direct blows to the chest
- High association with sternal fractures
- Right ventricle most likely to be contused (right heart usually injured)
- Result of injury: conduction system damage
- Bruising of myocardium (all or some)

**Morbidity/Mortality:**
Significant cause of morbidity + mortality in blunt trauma patient.

## Pathophysiology

- Rapid deceleration of right atrium and/or ventricle against the sternum
- Vascular damage
  - bleeding into the myocardium or pericardium
- Injury to contractile and conduction fibers
  - ↓ stroke volume
- Complications
  - ↓ cardiac output
  - conduction disturbances
  - myocardial ischemia

## Assessment

**Findings**
- Chest discomfort
- Palpitations
- Dyspnea
- Signs of chest wall trauma:
  - Multiple rib fractures
  - Sternal fracture
  - signs of hypoperfusion
  - adventitious lung sounds if lung injuries

**Vital signs:**
- ↑HR (tachycardia)
- irregular heart rhythm

**Clues of a Contusion**
- Bent steering wheel
- Chest discomfort
- Palpitations
- Bruising of chest wall
- Persistent tachycardia
- ECG changes
- ↓ cardiac output

## Management

- High flow O₂ / BVM
- IV therapy (fluid boluses in hypoperfusion, tachycardia)
- ECG (monitor changes after treatments)
- Antidysrhythmic therapy i.e. lidocaine for malignant PVC
- Psychological support/communication strategies
- Transport considerations:
  - appropriate mode, consider air medical transport
  - appropriate facility

## Incidence:
- Occurs in less than 2% of chest trauma
- Rare in blunt trauma
- More common occurs in penetrating trauma
- Myocardial rupture

## Rapid fluid accumulation in the pericardial sac (rapid trauma)
- compression of myocardium + chambers of the heart:
  - restricting diastolic expansion and
  - reduces chamber filling
- restricts venous return to the right atrium
- Results:
  - ↓ stroke volume => ↓cardiac output
  - ↓myocardial perfusion
  - myocardial infarction may develop
  - development of shock

## Vital signs:
- ↑HR (tachycardia)
- Narrow pulse pressure (systolic and diastolic get closer and closer to each other)
- pulsus paradoxus (pulse becomes weaker as one inhales and stronger as one exhales)
- ECG changes

30% of tamponades:
- Muffled heart tones
- Neck vein distension (JVD)
- Hypotension
- Shows a progressive worsening of the condition

## s/s:
- Respiratory distress
- Chest discomfort
- Open wounds to the chest
- Cyanosis
- Head
- Neck
- Upper extremities
- signs of shock

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<th><strong>Epidemiology</strong></th>
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<th><strong>Assessment Findings</strong></th>
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</tr>
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<td>- Crush injuries, major blunt trauma</td>
<td>- 15% of all blunt trauma deaths</td>
<td>- Chest discomfort</td>
<td>- IV - Titrate fluid admin to signs of adequate perfusion</td>
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<td>- Caused by significant, rapid deceleration</td>
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<td>- LOC</td>
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<td>- Motor vehicle collisions</td>
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<td>- Systolic BP of 90mm Hg</td>
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<td>- Frontal impacts</td>
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<td>- ECG (monitor changes after treatments)</td>
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<td>- Drugs (narcotic analgesics are contraindicated)</td>
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<td>- 85%-95% die instantaneously</td>
<td><strong>Vital signs:</strong></td>
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