Chapter 42
Chest Trauma

Learning Objectives

• Discuss mechanism of injury associated with chest trauma.
• Describe the mechanism of injury, signs and symptoms, and management of skeletal injuries to the chest.
• Describe the mechanism of injury, signs and symptoms, and prehospital management of pulmonary trauma.
Learning Objectives

• Describe the mechanism of injury, signs and symptoms, and prehospital management of injuries to the heart and great vessels.
• Outline the mechanism of injury, signs and symptoms, and prehospital care of the patient with esophageal and tracheobronchial injury and diaphragmatic rupture.

Skeletal Injury

• May be caused by blunt and/or penetrating trauma
• Thoracic cage protects vital organs within chest
  – Prevents collapse of thorax during respiration

Skeletal Injuries

• Skeletal components of the thoracic cage
  – 12 thoracic vertebrae
  – 12 ribs (with their associated costal cartilages)
  – Sternum
    • Superior 7 ribs (true ribs) are attached by cartilage to sternum
    • Inferior 5 ribs (false ribs) articulate with vertebrae, but do not attach directly to sternum
    • Ribs 8, 9, 10 are joined to common cartilage, which is attached to sternum
    • Ribs 11 and 12 are “floating ribs,” no attachment to sternum
Skeletal Injury

• Sternum has three parts
  – Manubrium
    • Jugular notch is located at superior end
    • Joins body of sternum at sternal angle (angle of Louis)
  – Body
  – Xiphoid process
• Clavicles are part of appendicular skeleton
  – Attach upper limbs to the axial skeleton
  – Made at sternoclavicular joint between clavicles and sternum

Clavicular Fractures

• Clavicle accounts for 5 percent of all fractures and is most frequently fractured bone in children
  – Isolated clavicular fracture is seldom significant injury
  – Common in children who fall on their shoulders or outstretched arms
  – Common in athletes involved in contact sports
  – Treatment usually involves applying clavicle strap or sling and swathe that immobolizes affected shoulder and arm
  – Usually heal well within 4 to 6 weeks
Clavicular Fractures

- Signs and symptoms
  - Pain
  - Point tenderness
  - Evident deformity
- Rare complication is injury to subclavian vein or artery
  - Vascular injury can occur when bony fragments from fracture puncture vessel
    - Results in hematoma or venous thrombosis

Rib Fractures

- Most often occur on lateral aspect of 3rd to 8th ribs, where ribs are least protected by musculature
  - More likely to occur in adults than in children
    - Younger patients have more resilient cartilage that is not fully calcified
    - When blunt forces are applied to ribs of children, energy is transmitted to lung, where pulmonary contusion is more frequent injury than rib fracture
  - Morbidity or mortality from rib fractures depends on patient’s age and number and location of fractures
Why would you expect greater underlying pulmonary injury in a child versus an adult with rib fractures?

Rib Fractures

- Simple rib fractures usually are very painful
  - Rarely are life-threatening
  - Most patients can localize fracture by pointing to area
  - Sometimes movement or grating of bone ends (crepitus) can be felt
- Complications
  - Respiratory or diaphragmatic splinting
    - Occurs when patient uses breath holding or minimizes chest wall movement to lessen pain
  - Can lead to atelectasis (collapse of lung tissue)
  - Ventilation-perfusion mismatch (perfused alveoli that are not ventilated)
Rib Fractures

• Goals of treatment
  – Relieve pain
    • May be relieved by splinting arm against chest wall with sling and swathe
    • Circumferential splinting should not be used as it may not allow complete expansion of chest wall during respiration
    • Administration of analgesics per protocol

Rib Fractures

• Goals of treatment
  – Maintain pulmonary function to prevent atelectasis
    • Encourage patient to cough and to breathe deeply
  – Based on mechanism of injury, consider possibility of more serious trauma
    • Closed pneumothorax
    • Internal bleeding
  – Fractures to lower ribs (8-2) may be associated with injuries to spleen, kidneys, or liver

Rib Fractures

• Great force is required to fracture 1st and 2nd ribs
  – Because of their shape and protection provided by scapulae, clavicles, and upper chest musculature
  – May be associated with
    • Myocardial contusion
    • Bronchial tears
    • Vascular injury
Flail Chest

- May occur when three or more adjacent ribs are fractured in two or more places
  - May be difficult to detect in prehospital setting because of muscle spasm that often accompanies injury
  - Within 2 hours after injury, muscle spasm subsides
  - At that point, injured segment of chest wall may begin to move in contrary fashion (paradoxical motion) with inspiration and expiration
  - Interrupts normal mechanics of breathing and decreases effective ventilation

Rib fracture
Flail Chest

• Causes
  – Vehicle crashes
  – Falls
  – Industrial accidents
  – Assault
  – Birth trauma

• Mortality rate is 8 to 35 percent because of underlying, associated injuries
  – Increases with
    • Advanced age
    • Seven or more rib fractures
    • Three or more associated injuries
    • Shock
    • Head injury
Flail Chest

• Diaphragm descends during inspiration
• Lowers intrapleural pressure
  – Unstable chest wall is pushed (“sucked”) inward by negative intrathoracic pressure as rest of chest wall expands
  – During expiration, diaphragm rises, and intrapleural pressure exceeds atmospheric pressure
    • Causes unstable chest wall to move outward

Flail Chest

• Often develop hypoxia
  – Because of lung contusions usually related to this injury
  – Bleeding from alveoli and lung tissue causes contusion
  – Associated with decreased vital capacity and vascular shunting of deoxygenated blood

Flail Chest

• Signs and symptoms
  – Bruising
  – Tenderness
  – Bony crepitus on palpation
  – Paradoxical motion (late sign)
Flail Chest

- Prehospital management
  - Assisting ventilation with high-concentration supplemental O₂
  - Fluid replacement as needed
  - Field stabilization of flail segment is not recommended
  - Many authorities recommend intubation and positive-pressure ventilation (internal splinting) in patients with severe respiratory distress and flail chest

Flail Chest

- Prehospital management
  - Intubation may be indicated if chest injury is associated with
    - Shock
    - Other severe injuries
    - Head injury
    - Pulmonary disease
    - Patient over 65 years of age

Flail Chest

- Most conservative methods for obtaining adequate oxygenation and ventilation should be used to manage patients with flail chest
  - Large percentage of patients with significant chest injury will progress to respiratory failure
    - Requires long-term ventilatory support and hospitalization
Why is positive-pressure ventilation the management of choice for this injury?

Sternal Fractures

- Uncommon but serious injury
  - Usually result from direct blow to chest
  - Usually very painful
  - May be associated with
    - Unstable chest wall
    - Myocardial injury
    - Cardiac tamponade

Sternal Fractures

- Occur in only 5 to 8 percent of patients with blunt chest trauma
  - Mortality rate is 25 to 45 percent
  - Signs and symptoms
    - History of significant anterior chest trauma
    - Tenderness
    - Abnormal motion or crepitation over sternum
Sternal Fractures

• Prehospital management
  – Maintaining high degree of suspicion for associated injuries
  – Airway maintenance
  – Ventilatory support
  – Pulse oximetry
  – ECG monitoring
  – Rapid transport

Sternal Fractures

• Associated injuries that often contribute to serious disability or death
  – Pulmonary and myocardial contusion
  – Flail chest
  – Vascular disruption of thoracic vessels (rare)
  – Intra-abdominal injuries
  – Head injury
Pulmonary Injury

- Classified as
  - Closed pneumothorax
  - Tension pneumothorax
  - Open pneumothorax
  - Hemothorax
  - Pulmonary contusion
  - Traumatic asphyxia

Any of these injuries can result in difficulty in breathing and respiratory insufficiency

Prehospital treatment
- Ensure open airway
- Ventilatory support
- Correct immediately life-threatening ventilatory problems (e.g., tension pneumothorax)
- Rapid transport for definitive care

Closed Pneumothorax

- Simple pneumothorax caused by presence of air in pleural space
  - Causes lung to partially or totally collapse
  - Common causes
    - Fractured rib that penetrates underlying lung
    - May occur without rib fractures
    - Excessive pressure on chest wall against closed glottis (paper bag effect)
    - Rupture or tearing of lung tissue and visceral pleura from no apparent cause (e.g., spontaneous pneumothorax)
  - Occurs in 15 to 50 percent of patients with severe blunt chest trauma
  - 100 percent of patients with penetrating chest trauma
How do you think that high-flow oxygen promotes faster resolution of a closed pneumothorax?

Closed Pneumothorax

- Signs and symptoms
  - Dependent on severity of hypoxia, ventilation impairment, percentage of lung that has collapsed
  - Chest pain
  - Dyspnea
  - Tachypnea
  - Diminished/absent breath sounds on affected side
Closed Pneumothorax

- Treatment
  - Ventilatory support with high-concentration O₂
  - Carefully monitor for signs of tension pneumothorax
  - Transport in semisitting position of comfort unless contraindicated by mechanism of injury
  - If patient’s respiratory rate is less than 12 or greater than 28 beats/minute, ventilatory assistance with a bag-valve-mask may be indicated

Closed Pneumothorax

- Most healthy patients have large circulatory and ventilatory reserve capacities
  - Closed pneumothoraces usually do not pose threat to life
  - Life-threatening consequences may develop if
    - Pneumothorax is tension pneumothorax
    - It occupies more than 40 percent of hemithorax
    - Occurs in patient with shock or preexisting pulmonary or cardiovascular

Open Pneumothorax

- Communicating pneumothorax develops when chest injury exposes pleural space to atmospheric pressure
  - Severity of injury is directly proportional to size of wound
  - When chest wound is larger than normal pathway for air through nose and mouth, atmospheric pressure forces air through open wound and into thoracic cavity during inspiration
    - As air accumulates in pleural space, lung on injured side collapses
    - Lung begins to shift toward uninjured side
Open Pneumothorax

- Very little air enters tracheobronchial tree to be exchanged with intrapulmonary air on affected side
  - Results in decreased alveolar ventilation and decreased perfusion
  - Normal side also is adversely affected
    - Expired air may enter lung on collapsed side
    - It then is re-breathed into functioning lung with next ventilation
    - May result in severe ventilatory dysfunction, hypoxemia, and death unless condition is quickly recognized and corrected
Open Pneumothorax

• Signs and symptoms
  – Shortness of breath
  – Pain
  – Sucking or gurgling sound as air moves in and out of pleural space through open chest wound

Open Pneumothorax

• Prehospital treatment
  – Close chest wound by first applying direct pressure with gloved hand
    • Chest wound can then be sealed by applying occlusive dressing of petroleum gauze or dressing of foil or plastic, securing it with tape
    • Medical direction may advise that only three sides of dressing be taped
    • Provides venting mechanism (or one-way valve)
    • May allow spontaneous decompression of developing tension pneumothorax
    • Closely monitor for development of tension pneumothorax if patient’s dressing does not provide venting mechanism
Open Pneumothorax

- Prehospital treatment
  - Provide ventilatory support with high-concentration $\text{O}_2$ and monitor $\text{O}_2$ saturation
  - Airway management includes assisting ventilations with bag-mask device and intubation
  - Treat patient for shock by administering crystalloid per protocol
  - Rapidly transport

Tension Pneumothorax

- When air in thoracic cavity cannot exit pleural space, a tension pneumothorax may develop
  - True emergency
  - Results in profound hypoventilation and impaired perfusion
  - May result in death if not immediately recognized and managed
Tension Pneumothorax

- When air is allowed to leak into pleural space during inspiration and becomes trapped during expiration, pleural pressure increases
  - Produces shift in mediastinum
  - Further compresses lung on uninjured side
  - Compression of vena cava reduces venous return to heart
    - Results in decrease in cardiac output
Tension Pneumothorax

- Signs and symptoms
  - Anxiety
  - Cyanosis
  - Increasing dyspnea
  - Tracheal deviation (late sign)
  - Tachycardia
  - Hypotension or unexplained signs of shock
  - Diminished or absent breath sounds on injured side
  - Distended neck veins (unless patient is hypovolemic)
  - Unequal expansion of chest (tension does not fall with respiration)
  - Subcutaneous emphysema

Why may the neck veins be distended in a patient with tension pneumothorax?

Tension Pneumothorax

- Should be managed aggressively
  - Evidenced by
    - Increasing dyspnea
    - Compromised ventilation
    - Tachycardia
    - Tachypnea
    - Unilateral decreased or absent breath sounds
    - Hyper-resonance on percussion
  - Emergency care
    - Directed at reducing pressure in pleural space
    - Returning intrapleural pressure to atmospheric or subatmospheric levels
Tension Pneumothorax Associated with Penetrating Trauma

• Sealing open pneumothorax with occlusive dressing may produce tension pneumothorax
  – In such cases, increased pleural pressure can be relieved by momentarily removing dressing
  – When dressing is lifted from wound, audible release of air from thoracic cavity should be noted
  – If this does not occur and patient’s condition remains unchanged, wound should be gently spread open with gloved fingers
    • May allow trapped air to escape

• Sealing open pneumothorax with occlusive dressing may produce tension pneumothorax
  – After pressure has been released, wound should again be sealed
    • Dressing may need to be removed more than once to relieve pleural pressure during transport
    • If tension is not relieved with this procedure, needle decompression of thorax (needle thoracentesis; needle thoracostomy) should be performed

• Needle decompression should be performed when three findings are present
  – Worsening respiratory distress or increasing difficulty ventilating with BVM device
  – Unilateral decreased or absent breath sounds
  – Decompensated shock (systolic BP less than 90 mm Hg)
Tension Pneumothorax Associated with Closed Trauma

- Tension pneumothorax that develops in patient with closed chest trauma
  - Must be relieved through thoracic decompression
  - Can be done with large-bore needle or commercially available thoracic decompression kit

Tension Pneumothorax Associated with Closed Trauma

- For needle decompression, large-bore, 10- or 14-gauge hollow catheter-over-needle is inserted into affected pleural space
  - Needle can be inserted anteriorly in 2nd intercostal space in midclavicular line
  - May be placed in 4th or 5th intercostal space laterally on involved side
  - Needle should be inserted just above rib
  - After insertion of needle, audible rush of air should be noted

Tension Pneumothorax Associated with Closed Trauma

- Audible rush of air
  - Pressure escaping from pleural space (confirming tension pneumothorax)
  - At this point, patient should show signs of improvement
    - Patient will be easier to ventilate
    - Person's breathing will be less labored
  - Needle should be withdrawn and catheter secured in place with tape
  - Needle decompression may need to be repeated if catheter becomes occluded blood clot and tension pneumothorax reoccurs
Put your finger on the correct location on your chest to place a needle for decompression of a tension pneumothorax.
Hemothorax

- Accumulation of blood in pleural space
  - Caused by bleeding from lung parenchyma or damaged vessels
  - If associated with pneumothorax, called hemopneumothorax

Hemothorax

- Accumulation of blood in pleural space
  - Blood loss may be massive in these patients
  - Each side of thorax can hold 30 to 40 percent (2000 to 3000 mL) of patient’s blood volume
  - Severed intercostal artery can easily bleed 50 mL per minute
  - Patients with hemothorax often have hypovolemia and hypoxemia
  - Commonly associated with pneumothorax (25 percent) and extrathoracic injuries (73 percent)
Hemothorax

- As blood continues to fill pleural space, lung on affected side may collapse
  - In rare cases, mediastinum may even shift away from hemothorax
    - Would compress unaffected lung

Hemothorax

- As blood continues to fill pleural space, lung on affected side may collapse
  - Resultant effects of respiratory and circulatory compromise are responsible for the following signs and symptoms
    - Tachypnea
    - Dyspnea
    - Cyanosis (often not evident in hemorrhagic shock)
    - Diminished or decreased breath sounds (dullness on percussion)
    - Hypovolemic shock
    - Narrow pulse pressure
    - Tracheal deviation to the unaffected side (rare)

Hemothorax

- Prehospital care
  - Directed at correcting ventilatory and circulatory problems
    - High-concentration O₂
    - Ventilatory support with bag-mask device, intubation, or both
    - Administration of volume-expanding fluids to correct hypovolemia
    - Rapid transport
  - Hemothorax associated with great vessel or cardiac injury has a high mortality rate
    - 50 percent die within 1 hour of injury
Why is hemothorax associated with a higher mortality rate than simple, closed pneumothorax?

Pulmonary Contusion

• Most often caused by rapid deceleration forces
  – Push lung against chest wall
    • Results in rupture of alveoli, with hemorrhage and swelling of lung tissue
    – More than 50 percent of patients with blunt chest trauma have pulmonary contusion

• During sudden inertial deceleration and direct impact, fixed and mobile parts of lung move at varying speeds
  – Result is stretching and shearing of alveoli and intravascular structures (inertial effect)
    • This kinetic wave of energy is partly reflected at alveolar membrane surface
    • Remainder causes localized release of energy (spalding effect)
    • Overexpansion of air in lungs occurs after primary energy wave has passed (implosion effect)
Pulmonary Contusion

• Low-pressure rebound shock waves cause overstretching and damage to lung tissue
  – Combination of these events results in alveolar and capillary damage with bleeding into lung tissue and alveoli
  – Contused area of lung is unable to function properly after injury
    • Profound hypoxemia may develop
    • Degree of respiratory complication is directly related to size of contused area

Pulmonary Contusion

• Signs and symptoms are subtle at first
  – Should be suspected based on kinematics of event and presence of associated injuries
    – Tachypnea
    – Tachycardia
    – Cough
    – Hemothysis
    – Apprehension
    – Respiratory distress
    – Dyspnea
    – Evidence of blunt chest trauma
    – Cyanosis

Will you always be able to distinguish between simple pneumothorax and pulmonary contusion in the prehospital setting? Why?
Pulmonary Contusion

• Emergency care
  – Ventilatory support and administration of high-concentration O₂
  – Patients with associated injuries or preexisting pulmonary or cardiovascular disease
    • Should be closely monitored in case ventilations need to be assisted with a bag-valve device, intubation, or both
  – May be associated with major chest injury
  – Generally heal spontaneously over several weeks

Traumatic Asphyxia

• Severe crushing injury to chest and abdomen
  – Results from increase in intrathoracic pressure
    • Pressure increase forces blood from right side of heart into veins of upper thorax, neck, and face
    • Forces involved may cause lethal injury, but traumatic asphyxia alone is not life-threatening
    • Brain hemorrhages, seizures, coma, and death have been documented to occasionally occur
Traumatic Asphyxia

- Signs and symptoms
  - Reddish purple discoloration of face and neck
  - Skin below area remains pink
  - Jugular vein distention
  - Swelling or hemorrhage of conjunctiva
    (subconjunctival petechiae may appear)

Traumatic Asphyxia

- Emergency care
  - Ensure open airway
  - Provide adequate ventilation
  - Care for associated injuries
  - Be ready to manage hypovolemia and shock when compressive force is released

Heart and Great Vessel Injury

- Trauma to heart and great vessels may result from blunt or penetrating trauma and associated
- Potentially fatal complications of these injuries
  - Life-threatening dysrhythmias
  - Conduction abnormalities
  - Congestive heart failure
  - Cardiogenic shock
  - Cardiac tamponade
  - Cardiac rupture
  - Coronary artery occlusion
Myocardial Contusion

• Usually caused by vehicle collision
  – Chest wall strikes dashboard or steering column
  – Deformed dashboard or steering column should alert paramedic to possibility of cardiac injury
  – Blunt myocardial injury occurs in as many as 55 percent of patients who suffer blunt trauma to chest

How would you manage a cardiac rhythm disturbance resulting from a myocardial contusion?

Myocardial Contusion

• Extent of injury may vary
  – May be only localized bruise
  – May be full-thickness injury to wall of heart with hemorrhage and edema
  – Blood may accumulate in pericardium (hemopericardium) as result of tear in epicardium or endocardium
    • May result in cardiac rupture or traumatic MI
    • Fibrinous reaction at contusion site may lead to delayed rupture or ventricular aneurysm

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Myocardial Contusion

• Patients may have no symptoms, or they may complain of chest pain similar to that seen with MI
  – Other signs and symptoms
    • ECG abnormalities
    • New cardiac murmur
    • Pericardial friction rub (late)
    • Persistent tachycardia (sinus tachycardia occurs in 70 percent of patients)
    • Palpitations

Myocardial Contusion

• Emergency care
  – Similar to that for MI
  – O₂ administration
  – ECG monitoring
  – Pharmacological therapy for dysrhythmias and hypotension
  – Any intervention that increases myocardial O₂ demand should be avoided

Pericardial Tamponade

• Penetrating trauma may cause tears in heart chamber walls
  – Allows blood to leak from heart
  – If pericardium has been torn sufficiently, blood can leak into thoracic cavity and patient rapidly dies from hemorrhage
  – Often, pericardium remains intact
    • In such cases, blood enters pericardial space
    • Causes increase in pericardial pressure and volume (pericardial tamponade)
Pericardial Tamponade

- Increased pressure prevents heart from expanding and refilling with blood
  - 60 to 100 mL of blood and clots in pericardial sac can cause tamponade
  - Results in decrease in stroke volume and cardiac output
  - Myocardial perfusion decreases because of pressure effects on walls of heart and decreased diastolic pressures

Pericardial Tamponade

- Associated ischemic dysfunction may result in MI
- Pericardial tamponade occurs in fewer than 2 percent of patients who suffer blunt chest trauma
- 60 to 80 percent of patients with stab wounds involving heart develop tamponade

Pericardial Tamponade

- At first, most patients with pericardial tamponade have peripheral vasoconstriction
  - Diastolic BP rises > systolic BP
  - Causes decrease in pulse pressure
  - These patients are also tachycardic
  - Increase in heart rate compensates for decrease in cardiac output
Pericardial Tamponade

- At first, most patients with pericardial tamponade have peripheral vasoconstriction
  - Up to this point, pericardial tamponade and hemorrhagic shock have similar signs
    - Key clinical finding often allows differentiation of two forms of shock
    - First described by Beck in 1935
    - It and two other clinical clues make up Beck triad

Pericardial Tamponade

- Beck triad
  - Consists of
    - Elevated central venous pressure (evidenced by jugular vein distention)
    - Muffled heart sounds
    - Hypotension
  - 1st element: elevated central venous pressure, is single best way to distinguish pericardial tamponade from hemorrhagic shock

Pericardial Tamponade

- Beck triad
  - Other signs and symptoms
    - Tachycardia
    - Respiratory distress
    - Narrow pulse pressure
    - Cyanosis of head, neck, upper extremities
**Pericardial Tamponade**

- Two other findings in pericardial tamponade
  - Pulsus paradoxus
    - Systolic BP that drops more than 10-15 mm Hg during inspiration compared with expiration
    - Excessive decline in systolic pressure occurs in cardiac tamponade when pleural pressure is reduced during inspiration
    - Reduction of pleural pressure provides some relief from tamponade and causes inspiratory fall in arterial flow and systolic pressure

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**Pericardial Tamponade**

- Two other findings in pericardial tamponade
  - Electrical alternans
    - Refers to change in amplitude of patient’s ECG waveforms that decrease with every other cardiac cycle
    - Rare finding in cardiac tamponade

- Electrical alternans
  - Refers to change in amplitude of patient’s ECG waveforms that decrease with every other cardiac cycle

- Rare finding in cardiac tamponade
Pericardial Tamponade

- True emergency
  - Pericardial blood must be removed
  - Bleeding must be stopped if patient is to survive injury
- Prehospital management
  - Careful monitoring
  - O₂ administration
  - Aggressive fluid replacement to maintain adequate preload (if transport time is short)
  - Rapid transport

Pericardial Tamponade

- Definitive care
  - Needle pericardiocentesis to remove blood from pericardial sac
  - Removal of as little as 20 mL may drastically improve cardiac output

Myocardial Rupture

- Occurs when blood-filled chambers of ventricles are compressed with enough force to rupture chamber wall, septum, or valve
  - Nearly always immediately fatal
  - About 20 percent of patients will survive 30 minutes or longer, allowing time for surgical repair
  - May allow time for rapid transport and surgical repair
  - Motor vehicle crashes are responsible for most cases of myocardial rupture, accounting for 15 percent of fatal thoracic injuries
Myocardial Rupture

- Other proposed mechanisms
  - Deceleration or shearing forces that disrupt the inferior and superior vena cavae
  - Upward displacement of blood (causing increase in intracardiac pressure) after abdominal trauma
  - Direct compression of heart between sternum and vertebrae
  - Laceration from rib or sternal fracture
  - Complications of myocardial contusion

Myocardial Rupture

- Patients often present with significant mechanism of injury
  - Signs and symptoms of congestive heart failure and cardiac tamponade may be present
    - Monitor closely for signs of pericardial tamponade

Myocardial Rupture

- Prehospital care
  - Mainly supportive
  - Airway and ventilatory support
  - Rapid transport
  - Consider possibility of tension pneumothorax
    - Mimic those of myocardial rupture with tamponade
Traumatic Aortic Rupture

- Thought to be result of shearing forces
  - Develop between tissues that decelerate at different rates
  - Common mechanisms of injury
    - Rapid deceleration in high-speed motor vehicle crashes
    - Falls from great heights
    - Crushing injuries
  - Estimated that 1 in 6 people who die in motor vehicle crashes has rupture of aorta
    - Of these patients, 80 to 90 percent die at scene as result of massive hemorrhage

- About 10 to 20 percent survive first hour
  - Bleeding is tamponaded by surrounding adventitia of aorta and intact visceral pleura
  - Of these individuals, 30 percent have ruptures within 6 hours
    - For these reasons, rapid and pertinent evaluation and transport to appropriate medical facility are critical
  - Aortic rupture is responsible for 15 percent of all deaths from blunt trauma

- Usual site of damage to aorta is in distal arch
  - Just beyond takeoff of left subclavian artery and proximal to ligamentum arteriosum
  - Ligamentum arteriosum and descending thoracic arch are somewhat fixed
    - Transverse portion of arch is somewhat mobile
    - If shearing forces exceed tensile strength of arch, junction of mobile and fixed points of attachment may be partly torn
    - If outer layer of tissue around aorta remains intact, patient may survive long enough for surgical repair
Traumatic Aortic Rupture

- Aortic rupture is severe injury
  - About 85 percent of patients die before reaching hospital
  - Any trauma patient who has unexplained shock and appropriate mechanism of injury (rapid deceleration) should be suspected of having ruptured aorta
  - BP may be normal or elevated, with significant difference between two arms
  - Upper extremity hypertension with absent or weak femoral pulses can occur in these patients
    * Thought to result from compression of aorta by expanding hematoma

- Other patients have hypertension because of increased activity of sympathetic nervous system
  - About 25 percent have harsh systolic murmur that can be heard over pericardium or between scapulae
  - In rare cases, may have paraplegia without cervical or thoracic spine injury
    * Occurs as consequence of decreased blood flow through anterior spinal artery
  - Anterior spinal artery is in thoracic region
    * Composed of branches from posterior intercostal arteries
    * Are branches of thoracic aorta
Traumatic Aortic Rupture

• Prehospital management
  – Advising medical direction of suspected rupture
  – Administration of high-concentration O₂
  – Ventilatory support with spinal precautions
  – Judicious fluid replacement (avoiding overhydration)
  – Rapid transport for surgical repair

Penetrating Wounds of the Great Vessels

• Usually involve injury to chest, abdomen, or neck
  – Often accompanied by
    • Massive hemothorax
    • Hypovolemic shock
    • Cardiac tamponade
    • Enlarging hematomas that may cause compression of vena cava, trachea, esophagus, great vessels, and heart

Penetrating Wounds of the Great Vessels

• Prehospital care
  – Provide airway and ventilatory support
  – Managing hypovolemia with judicious fluid therapy (guided by medical direction)
  – Rapid transport for definitive care
Other Thoracic Injuries

- Other injuries that may be associated with blunt or penetrating trauma to thorax
  - Esophageal and tracheobronchial injuries
  - Diaphragmatic rupture

Esophageal and Tracheobronchial Injuries

- Esophageal injuries most often are caused by penetrating trauma
  - Can result from
    - Spontaneous perforation caused by cancer
    - Anatomic distortions caused by diverticula or gastric reflux, both of which can lead to violent vomiting

Esophageal and Tracheobronchial Injuries

- Assessment findings
  - Pain
  - Fever
  - Hoarseness
  - Dysphagia
  - Respiratory distress
  - Shock
Esophageal and Tracheobronchial Injuries

• If esophageal perforation occurs in cervical region
  – Local tenderness
  – Subcutaneous emphysema
  – Resistance to neck movement
• Esophageal perforation that occurs lower in thoracic region may result in
  – Mediastinal and subcutaneous emphysema
  – Inflammation of mediastinum
  – Splinting of chest wall

Esophageal and Tracheobronchial Injuries

• Tracheobronchial injuries (tracheobronchial disruptions) are rare
  – Occur in fewer than 3 percent of victims of blunt or penetrating chest trauma
  – Mortality rate for these injuries is about 10 percent, depending on associated injuries, early diagnosis, and surgical repair
  – Most injuries occur within 3 cm (about 1½ inches) of carina
    • Can occur anywhere along tracheobronchial tree

Esophageal and Tracheobronchial Injuries

• Tracheobronchial injuries (tracheobronchial disruptions) are rare
  – Signs and symptoms
    • Severe hypoxia
    • Tachypnea
    • Tachycardia
    • Massive subcutaneous emphysema
    • Dyspnea
    • Respiratory distress
    • Hemoptysis
Esophageal and Tracheobronchial Injuries

- Emergency care
  - Provide airway, ventilatory, and circulatory support
  - Rapid transport for definitive care

Diaphragmatic Rupture

- Diaphragm is sheet of dome-shaped muscle
  - Separates abdominal cavity from thoracic cavity
  - Sudden compression of abdomen (such as with blunt trauma to trunk) results in sharp increase in intra-abdominal pressure
  - When this occurs, pressure differences may cause abdominal contents to rupture through thin diaphragmatic wall and enter chest cavity

Diaphragmatic Rupture

- Detected more often on left side than on right side
  - Rupture on either side may allow intra-abdominal organs to enter thoracic cavity
  - They may compress lung, resulting in
    - Reduced ventilation
    - Decreased venous return
    - Decreased cardiac output
    - Shock
  - Because of mechanical forces involved, patients with diaphragmatic rupture often have multiple injuries
Diaphragmatic Rupture

• Signs and symptoms
  – Abdominal pain
  – Shortness of breath
  – Decreased breath sounds
  – If most of abdominal contents are forced into chest, abdomen may have hollow or empty appearance
    • Bowel sounds may be heard in chest

Diaphragmatic Rupture

• Prehospital management
  – O₂ administration
  – Ventilatory support as needed (positive pressure ventilation may worsen injury)
  – Volume-expanding fluids
  – Rapid transport with patient in supine position to appropriate medical facility for surgical repair
  – Some medical direction agencies also may recommend that nasogastric tube be placed to empty stomach and reduce abdominal pressure
### Summary

- **Chest injuries** are caused by blunt or penetrating trauma
  - Often results from motor vehicle crashes, falls from heights, blast injuries, blows to the chest, chest compression, gunshot wounds, and stab wounds
- **Fractures of clavicle, ribs, or sternum**, as well as flail chest, may be caused by blunt or penetrating trauma
  - Complications of skeletal trauma of chest may include cardiac, vascular, or pulmonary injuries

### Summary

- **Closed pneumothorax** may be life-threatening if (1) it is a tension pneumothorax, (2) it occupies more than 40 percent of the hemithorax, or (3) it occurs in a patient in shock or with a preexisting pulmonary or cardiovascular disease
- **Open pneumothorax** may result in severe ventilatory dysfunction, hypoxemia, and death unless it is quickly recognized and corrected

### Summary

- **Tension pneumothorax** is a true emergency
  - Results in profound hypoventilation
  - May result in death if it is not quickly recognized and managed
- **Hemothorax** may result in massive blood loss
  - These patients often have hypovolemia and hypoxemia
Summary

• Pulmonary contusion results when trauma to lung causes alveolar and capillary damage
  – Severe hypoxemia may develop
    • Degree is directly related to size of contused area
• Traumatic asphyxia results from forces that cause increase in intrathoracic pressure
  – When it occurs alone, it is often not lethal
    • Brain hemorrhages, seizures, coma, and death have been reported after these injuries

Summary

• Extent of injury from myocardial contusion may vary
  – Injury may be only localized bruise
    • Also may be full-thickness injury to wall of heart
  – Full-thickness injury may result in cardiac rupture, ventricular aneurysm, or traumatic myocardial infarction

Summary

• Pericardial tamponade occurs if 150 to 200 mL of blood enters the pericardial space suddenly
  – Results in decrease in stroke volume and cardiac output
  – Myocardial rupture refers to acute traumatic perforation of ventricles or atria
  – Nearly always immediately fatal
    • Death may be delayed for several weeks after blunt trauma
Summary

• Aortic rupture is severe injury
  – There is an 80 to 90 percent mortality rate in first hour
  – Paramedic should consider possibility of aortic rupture in any trauma patient who has unexplained shock after rapid deceleration injury

Summary

• Esophageal injuries most frequently are caused by penetrating trauma (e.g., missile projectile and knife wounds)
  – Tracheobronchial injuries are rare
    • Occur in fewer than 3 percent of victims of blunt or penetrating chest trauma, but mortality rate is over 30 percent
  – Tension pneumothorax that does not improve following needle decompression or absence of continuous flow of air from needle following decompression should alert paramedic to possibility of tracheobronchial injury

Summary

• Diaphragmatic ruptures may allow abdominal organs to enter thoracic cavity
  – There they may cause compression of the lung, resulting in reduction in ventilation, decrease in venous return, decrease in cardiac output, and shock
Questions?