Chapter 15

Thoracic Cavity

Chest Trauma

- General chest trauma
  - Incidence
    - Penetrating: rare
    - Blunt: common
  - Compliant chest wall transmits impact forces to intrathoracic structures, often without external evidence of injury to the chest wall (ie, no rib fractures)
  - Types
    - Pulmonary contusion
      - Most common thoracic injury in children
      - Pathology: parenchymal hemorrhage and edema produce intrapulmonary shunting (alveolar ventilation and pulmonary perfusion [V/Q] mismatch) that results in hypoxia, atelectasis, and pneumonia
    - Intrapulmonary hemorrhage
    - Cardiac contusion
  - Diagnosis
    - Physical examination
    - Chest radiograph
    - Computed tomography (CT) scan
  - Treatment
    - Oxygen
    - Fluid restriction
    - Antibiotics
    - Analgesics
    - Assisted ventilation when clinically indicated
- Tension pneumothorax and hemothorax
  - Not well tolerated due to a child's mobile mediastinum
  - Symptoms
    - Breath sounds are decreased
    - Percussion
      - Hyperresonance (pneumothorax)

        - Dullness (hemothorax)
      - Tracheal shift to the contralateral side
      - Tachypnea, tachycardia, pallor, and cyanosis
    - Treatment
      - Immediate needle aspiration
        - Place the needle just over the top of the third rib into the second intercostal space, in the midclavicular line
        - Use a size 16 or smaller gauge over-the-needle catheter in infants and small children to prevent lung laceration
      - Thoracostomy tube
        - Place in the fifth intercostal space, just anterior to the midaxillary line
        - Tunnel subcutaneously over the fifth rib
        - Refer to the table on the inside front cover for age-appropriate thoracostomy tube sizes
      - Indications for thoracotomy
        - Rapid blood drainage of > 20 cc/kg
        - Bleeding continues at > 3 cc/kg/h for 2–4 hours
- Posterior flail
  - Not well tolerated in children
  - May be associated with an underlying pulmonary contusion, hemothorax, or pneumothorax
    - Hypoxia
    - Intrapulmonary shunting (V/Q mismatch)
    - Atelectasis and pneumonia
  - Treatment may require supplemental oxygen; endotracheal intubation; ventilatory support with continuous positive airway pressure (CPAP) or positive end-expiratory pressure (PEEP) on assisted ventilation; or intercostal blocks
- Bronchial injuries and traumatic diaphragmatic hernias
  - More common than great vessel injury
  - Symptoms
    - Respiratory distress
    - Hypoxia
    - Massive air leak from the chest tube
    - Failure of the lung to reexpand after chest tube placement
  - Diagnosis
    - Chest radiograph

        - Bronchoscopy (flexible)
    - Treatment
        - If injury covers > ⅓ of the circumference of the airway, perform an emergent thoracotomy and operative repair with fine, absorbable suture
        - Buttress with a muscle flap
- Aortic injury
    - Rare in children
    - Etiology: rapid deceleration
    - Pathology: the tear is usually at the ligamentum arteriosum or the takeoff of the left subclavian artery
    - On chest radiograph, findings consistent with aortic injuries include:
        - Fractures in the first to third ribs or the scapula
        - Mediastinum widening
        - Pleural or apical cap
        - Deviation of the trachea to the right
        - Deviation of the esophagus (or nasogastric tube) to the right
        - Obliteration of the aortopulmonary window
        - Obliteration of the aortic knob
        - Widened paratracheal stripe
        - Elevation of the right mainstem bronchus
        - Depression of the left mainstem bronchus
        - Left hemothorax
    - Diagnosis: arch aortogram, spiral CT scan
    - Treatment: surgical repair
- Pericardial tamponade
    - Symptoms (Beck triad)
        - Systemic arterial **hypo**tension
        - Central venous **hyper**tension
        - Muffled heart sounds
    - Diagnosis
        - Clinical
        - Ultrasound
    - Treatment
        - Needle pericardiocentesis is a temporizing measure **only**
            - For pneumopericardium: create subxiphoid pericardial window and place a pericardial tube

        - For hemopericardium:
            - Traumatic: perform thoracotomy
            - Nontraumatic: place drainage catheter
- Myocardial contusion
    - Diagnosis
        - Electrocardiogram (ECG) will show nonspecific ST-T wave changes (most helpful)
        - Creatine phosphokinase, muscle band (CPK-MB); troponin (most accurate)
        - Echocardiogram will show traumatic ventricular septal defect and ruptured chordae
    - Treatment
        - Continuous cardiac rate and rhythm monitoring
        - Serial ECGs
        - Assess serial cardiac enzymes (especially troponin)
- Diaphragmatic rupture
    - 80% are on the left
    - Associated with injury to the spleen or kidney
    - Symptoms: respiratory distress (may be delayed)
    - Diagnosis: chest radiograph (nasogastric tube in the chest)
    - Treatment
        - Immediate diagnosis: midline abdominal incision
        - Delayed diagnosis: thoracotomy instead of laparotomy
- Penetrating chest wound with tracheal and esophageal injury
    - Treatment: primary repair with interposition of cervical strap muscle between the repair suture lines

Infections of the Lung and Pleura

- Bacterial pneumonias (see Chapter 29, Infectious Diseases)
- Complications of pneumonia
    - Pneumatocele
        - Usually seen in young children with *Staphylococcus aureus* pneumonia
        - Etiology: necrosis and liquefaction of the lung parenchyma
        - Diagnosis: chest radiograph or CT scan will show intrapulmonary air pockets without air–fluid levels
        - Differential diagnosis: congenital lung cysts
        - Treatment: pneumatocele usually regresses in response

to antibiotics

- Lung abscess
  - Etiology
    - The most common cause is pulmonary aspiration
    - Operations on upper respiratory tract (eg, tonsillectomy, tooth extractions)
    - Most common sites are the superior segment right lower lobe (supine position), posterior segment of the right upper lobe (lying on right side), basilar segments of lower lobes (upright position)
    - Typical organism causes are anaerobes (most common), *S aureus*, *Pseudomonas*
  - Symptoms include fever, malaise, and cough
  - Diagnosis: chest radiograph and CT scan show an intrapulmonary cavity with an air–fluid level
  - Treatment
    - Antibiotics for 6–8 weeks
    - Bronchoscopy with direct aspiration of fluid
    - Chest physical therapy
    - Indications for surgical resection (usually a segmental resection)
      - Chronic (> 3 mo), thick-walled (> 4–6 cm) abscess
      - Progression to empyema
      - Massive hemoptysis
- Empyema
  - Pathogenesis
    - Stages
      - Exudative or acute: thin pleural fluid, pH < 7.2, low cell count
      - Fibropurulent: many polymorphonuclear leukocytes, pH < 7.2, decreased glucose, deposition of fibrin, fluid loculations
      - Organizing: thick exudates, fibrous peel
    - Organisms: *Streptococcus pneumoniae* (most common), *S aureus*, *Haemophilus influenzae*
    - Early treatment with intravenous antibiotics may prevent the effusion from becoming infected and forming an empyema

        - Anaerobic empyemas are associated with the highest mortality rate
    - History
        - Tachypnea
        - Fever
        - Cough
    - Diagnosis
        - Physical examination
        - Chest radiograph
        - Thoracentesis (differential diagnosis of transudate)
            - pH < 7
            - Appearance: fibropurulent
            - Glucose < 40
            - Lactate dehydrogenase > 1,000 units/mL
            - Cell count: large numbers of polymorphonuclear leukocytes
            - Gram stain showing organisms
    - Treatment: intravenous antibiotics and either of the following:
        - Nonloculated fluid: thoracostomy tube drainage
        - Loculated fluid: video-assisted thoracoscopic surgery (VATS)
- Mediastinal masses
    - Anterior mediastinum
        - Ectopic thyroid
        - Lymphoma
        - Sarcoma
        - Teratoma
        - Thymus (cyst, thymoma, normal thymus)
    - Middle mediastinum
        - Bronchogenic cyst
        - Cardiac tumor
        - Cystic hygroma
        - Lymphadenopathy
        - Lymphoma
        - Pericardial cyst
        - Vascular abnormalities
    - Posterior mediastinum
        - Esophageal duplication
        - Meningomyelocele

- Neurenteric abnormalities
- Neurogenic tumors (eg, neuroblastoma)

- Miscellaneous conditions
  - Spontaneous pneumothorax
    - Etiology: ruptured subpleural apical bleb
    - Typical patient is a thin, lean, adolescent male, often a smoker
    - Physical
      - Diminished breath sounds on the ipsilateral chest
      - Tympany to percussion
      - Shift of the mediastinum to the contralateral side (if under tension)
      - Shift of mediastinal structures may decrease the venous return, resulting in hypotension and tachycardia
    - Diagnosis
      - Obtain posteroanterior and lateral chest radiographs
      - Perform chest CT scan to assess for the presence of apical blebs
    - Treatment
      - If under tension: emergent needle decompression through the second intercostal space, midclavicular line
      - If < 15%: observation and oxygen by mask
      - If > 15%: small intrathoracic catheter and Heimlich valve
    - Treatment for recurrence or persistent air leak: VATS for apical pleurectomy (endostapler) and pleurodesis (mechanical and/or chemical)
  - Pneumomediastinum
    - Etiology: esophageal or tracheal perforation
    - Symptoms: chest pain (possible)
    - Diagnosis: chest radiograph, chest CT scan, esophagram
    - Treatment: treat the inciting condition
  - Pneumopericardium
    - Etiology: usually associated with dissection of air from a tension pneumothorax in infants on assisted ventilation with high mean airway pressures
    - Treatment: if cardiac output is impaired, perform needle aspiration, place a pericardial tube, and decrease the mean airway pressures, if possible

- Hemothorax
  - Etiology
    - Trauma (blunt or penetrating)
    - Injury to subclavian vessels or the heart during insertion of a central venous catheter
  - Sources of bleeding
    - Intercostal artery
    - Internal mammary artery
    - Lung parenchyma
    - Mediastinal vessel
    - Great vessels
    - Heart
  - Physical: dullness to percussion, tachycardia, pleuritic pain, tachypnea
  - Diagnosis: chest radiograph, CT scan, thoracentesis
  - Treatment (initial): thoracostomy tube in the fifth intercostal space, just anterior to the axillary line
- Chylothorax
  - Etiology
    - Congenital anomalies of the thoracic duct
    - Blunt, penetrating, or birth trauma
    - Neoplasms (lymphomas, lymphangioma, neuroblastoma)
    - Operative injury during a thoracotomy, especially on the left (eg, patent ductus arteriosus, coarctation of the aorta, Blalock shunt)
    - Thoracic duct enters the left internal jugular vein posteriorly at the junction with the left subclavian vein
  - Symptoms
    - Acute respiratory distress (dyspnea, tachypnea, cyanosis)
    - Decreased breath sounds, dullness to percussion
    - Effects of a prolonged loss of chyle
      - Malnutrition (loss of fat)
      - Immunodeficiency (lymphopenia), which predisposes patient to opportunistic fungal infections
      - Hypoproteinemia
      - Fluid and electrolyte abnormalities
  - Diagnosis
    - Chest radiograph shows pleural effusion

- Thoracentesis of chyle (high fat, high protein, 80%–90% T lymphocytes)
  - Clear, straw-colored in a fasting patient
  - White, milky after feedings containing fat
- Treatment
  - Nonoperative
    - Thoracostomy tube drainage
    - Nothing by mouth; peripheral or central total parenteral nutrition, medium chain triglycerides
    - Octreotide (decreases gastric, pancreatic, and intestinal secretions)
  - Operative indications
    - Persistence > 2–3 weeks
    - Daily chyle loss > 100 cc/year of age for 5 days
    - Nutritional complications
  - Operative treatment
    - Technetium-99m lymphangiography to identify the site of leakage preoperatively
    - Preoperative administration of cream into the gastrointestinal tract
    - Ipsilateral thoractomy
    - Identification and ligation of leaking ducts, proximally and distally
    - When the site of leakage cannot be identified, ligate all tissues surrounding the aorta at the hiatus
    - Fibrin glue
    - Pleurodesis
    - A Denver pleuroperitoneal shunt (Denver Biomaterials, Surgimed Inc, Golden, Colo) is sometimes (but rarely) used

- Hemoptysis
  - Etiology
    - Pulmonary hypertension
    - Bronchiectasis
    - Foreign body
    - Congenital pulmonary malformations
    - Pneumonia
  - Treatment of massive hemoptysis
    - Usually stops spontaneously

- Bronchoscopic localization and selective bronchial artery embolization
- Perform lobectomy if the above measures are unsuccessful