• Chemical Control of Ventilation
  o Central chemoreceptors located near the respiratory centers in the medulla
    ▪ Sensitive to hydrogen ion concentration
    ▪ CO2 crosses the blood brain barrier, combines with H2O and dissociates into H+ ions
    ▪ Signals sent to respiratory center to increase rate and depth of ventilation
  o Peripheral chemoreceptors located in the aortic arch and carotid bodies
    ▪ Sensitive primarily to O2 levels
    ▪ Signals sent to respiratory center to increase ventilation
• Acute Bronchitis
  o Definition: Acute inflammation of the bronchi and or trachea usually caused by irritation (pollen, smoking)
  o Signs and Symptoms:
    ▪ Sore throat, cough, tachypnea, rhonchi that may improve with coughing, prolonged expiratory phase
  o Tx:
    ▪ Bronchodilators, corticosteroids, expectorants, antibiotics for secondary infection
    ▪ Increase PO fluids
    ▪ Remove irritants
• Chronic Bronchitis
  o Defined by a long-term cough with mucus; air trapping and chronic hypoxia and hypercapnia “blue bloater”
  o Smoking is the leading cause
  o Inflammation with fluid accumulation
  o Minimal constriction
  o Symptoms
    ▪ Productive cough
    ▪ Dyspnea
    ▪ SOB
    ▪ Wheezing
    ▪ Rhonchi
    ▪ Polycythemia
  o Tx:
    ▪ Bronchodilators
    ▪ Steroids
    ▪ Remove irritants
• COPD/Emphysema
  o Permanent enlargement of air spaces
  o Alveolar walls destroyed, causing less area for gas exchange
  o SXS
    ▪ Oxygen dependent
    ▪ Dyspnea
      ▪ First upon exertion
      ▪ Eventually at rest
    ▪ Thin but barrel chested
    ▪ Chronic cough
    ▪ Rhonchi, wheezing
    ▪ Pulmonary hypertension
      ▪ (cor pulmonale) “pink puffers”
  o Treatment
    ▪ Oxygen
    ▪ Bronchodilators
    ▪ Steroids
    ▪ Treat pulmonary infections
• Foreign Body Aspiration
  o variety of presentations
  o most often occurs in children and older adults
  o Location
    ▪ Upper Airway
    ▪ Lower Airway

• Asthma
  o Pathophysiology
    ▪ Reversible hyper-reactive airway to an irritant or pathogen which causes
      wide- spread mucous production and bronchial:
      • Inflammation
      • Bronchial spasms
      • Increased mucous production
  o Reactive Airway Disease
    ▪ Spasm of the bronchi, trachea, bronchioles caused by a stimulus
    ▪ Narrowing of bronchi and bronchioles
    ▪ Mucus production in bronchioles
  o Asthma Triggers
    ▪ Allergens
      • Pollen, dust, mold, animal dander, etc
    ▪ Irritants
      • Smoke, chemical fumes, perfume, strong odors from paint or cooking, air pollution
    ▪ Other
      • Emotional stress, cold air, medicines (aspirin or beta-blockers), sulfites in food or wine,
        exercise, and respiratory infections.
      • In some people, even hard laughing or crying can trigger asthma symptoms
  o Asthma Signs and Symptoms
    ▪ Wheezing
    ▪ Unproductive Cough (worse at night)
    ▪ Dyspnea
    ▪ ↑ Respiratory rate
    ▪ Prolonged expiratory phase
    ▪ Cyanosis
    ▪ Tachypnea
    ▪ Tachycardia
    ▪ Silent chest (no BS)
      • Bad sign – no air movement
  o Asthma Treatment
    ▪ Short-acting β₂-agonist
      • Albuterol
      • Epinephrine
      • Racemic Epinephrine
    ▪ Anticholinergics
      • Ipratropium (Atrovent)
    ▪ Corticosteroids (inhaled preferred)
      • Dexamethasone (Decadron)
      • Beclomethasone (Beclomvent)
    ▪ Oral Prednisone
    ▪ Methylprednisone (Solumedrol)
    ▪ Asthma action plan

• Status Asthmaticus
  o A prolonged and severe asthma attack in which asthma symptoms are refractory to initial
    bronchodilator therapy
  o Can lead to respiratory failure and cardiac arrest
    ▪ SXS
    ▪ Silent chest
    ▪ Accessory muscle use
Inability to speak more than 1 – 2 words
- SpO < 90% despite supplemental oxygen
- Fatigue, LOC
- Cyanosis

Treatment
- Oxygen
- Continuous albuterol treatments
- IV rehydration
- Consider BiPAP or intubation
- Consider Heliox

- Pulmonary embolism
  - Pulmonary embolism (PE) refers to the lodging of a thrombus or other embolic material from a distant site in the pulmonary circulation
  - More than 90% of pulmonary emboli originate in the deep venous system of the lower extremities.
  - 8% to 10% of victims of PE die within the first hr.
  - SXS
    - May be asymptomatic
    - Shortness of breath
    - Pleuritic chest pain (often sudden onset)
    - Tachypnea and tachycardia
    - Anxiety, apprehension and restlessness
  - Pre-existing conditions may include
    - Immobility
    - Pregnancy
    - Long bone fracture
    - DVT
  - Virchow’s Triad
    - Hypercoagulability
    - Circulatory stasis
    - Vascular wall injury
  - Diagnostics
    - ABG
    - D-Dimer
      - To rule out not rule in
    - EKG
      - To rule out cardiac
    - Chest Xray
    - VQ scan
    - CT angiography
      - Most definitive
  - Treatment
    - O2
    - Anticoagulation
    - Thrombolytics

- Pleural Effusion
  - Abnormal collection of fluid in the pleural space
  - Resulting from excess fluid production or decreased absorption
  - Most common manifestation of pleural disease
    - cardiopulmonary disorders
    - symptomatic inflammatory or malignant diseases
    - may require urgent evaluation and treatment
• Pneumonia
  o Pneumonia is a common illness that affects millions of people each year in the United States.
  o Causes:
    ▪ Viral
    ▪ Bacterial
    ▪ Fungal
    ▪ Aspiration
  o S&S
    ▪ Dyspnea
    ▪ Productive cough
    ▪ Pleuritic chest pain
    ▪ Rales/Rhonchi
    ▪ Fever/chills
    ▪ Tachycardia
    ▪ Tachypnea
    ▪ Hypotension (Sepsis)
    ▪ Altered LOC with history of cough
  o Treatment
    ▪ Support ABCs
    ▪ Humidified O2
    ▪ Bronchodilators
    ▪ Antipyretics
    ▪ Labs
      • CBC, sputum
    ▪ Initiation of antibiotics
      • After blood cultures
    ▪ Consider BiPAP, intubation
• Pulmonary Edema / ARDS
  Non Cardiac Causes
  o Pulmonary infection (immunocompromised pt)
    ▪ Bacteria – miliary TB, Pneumocystis carinii
    ▪ Virus - Hantavirus (HPS)
    ▪ Fungi- Histoplasmosis, Blastomycosis, Coccidioidomycosis
  o Toxic exposure (common with fires)
  o Aspiration
  o Pulmonary contusion
  o High altitude pulmonary edema (HAPE)
  o SxS
    ▪ Difficulty breathing
    ▪ Coughing up blood
    ▪ Excessive sweating
    ▪ Anxiety, and pale skin
    ▪ Symptoms of fluid overload
  o Treatment
    ▪ Support ABCs
    ▪ May require intubation
    ▪ Treat the cause
    ▪ Rule out cardiac damage
• Non-Traumatic Pneumothorax
  o Primary
    ▪ Without underlying disease or cause
  o Secondary
    ▪ Pts with history of COPD or Pulmonary Fibrosis
  o Higher incidence with tall thin men
• Inhalation Injuries
  o CO poisoning
    ▪ COHb levels of over 10% indicate inhalation
  o Thermal and heat injuries
    ▪ Singed nasal hair, soot, and hoarse voice are clues to airway injury
    ▪ The first 24-48 hours is critical for the airway
  o Smoke poisonings
    ▪ Toxins released in the smoke can cause pulmonary edema
    ▪ Consider high flow O2 or possible hyperbaric chamber

• Trauma

• Rib Fractures
  o Cause:
    ▪ Direct trauma to the chest
    ▪ Most common blunt chest injury
    ▪ 50% missed on initial Xray
      ▪ 1st and 2nd rib fx assoc with severe trauma and high mortality
  o SxS:
    ▪ Sharp, point pain to ribs that is worse w/ breathing and/or palpation
    ▪ Slight SOB
    ▪ Normal or slightly elevated vital Signs
    ▪ Suspect visceral injury
  o Tx:
    ▪ Hospitalized for 3 or more rib fx
    ▪ Intercostal nerve blocks
    ▪ Pneumonia prevention
  o Associated Injuries with Rib Fxs
    ▪ 1st rib fx associated with subclavian artery, lung apices, vertebral column or aortic injury
    ▪ Mid rib fx associated with pneumo/ hemothorax
    ▪ Left lower rib fx associated with splenic injury
    ▪ Right lower rib fx associated with hepatic injury
    ▪ Sternal fx associated with cardiac contusion
    ▪ Rib fractures less common in children

• Flail Chest
  o A free floating section of rib cage – 2 or more consecutive ribs fractured in 2 or more places
  o Blunt trauma to the chest
  o SxS:
    ▪ Chest pain
    ▪ Visible Flail Segment
    ▪ Paradoxical Chest Rise
  o Tx
    ▪ respiratory support (PEEP)
    ▪ surgical fixation

• Pneumothorax
  o Causes:
    ▪ Opening from the lung into the plural space
    ▪ Frequently caused by trauma (high/low energy)
    ▪ Can spontaneously occur
      ▪ Can get worse, but not normally a life threat
  o Tx:
    ▪ Chest tube for 20% or greater or if transporting at high altitude
  o SxS:
    ▪ SOB
- Chest pain
- Tachycardia
- Decreased breath sounds on one side
- Hyperresonance on injured side
- Sub Q emphysema
- Wound (hole) in chest (open pneumothorax)

**Tension Pneumothorax**
- Life-threatening progression of a pneumothorax
- *Air enters plural space but cannot escape.*
- Collapses the lung on the injured side
- *Pressure in the chest increases over pressure in the lungs and heart causing mediastinal shift*
- Signs and Symptoms
  - SOB
  - Increased Pulse
  - Hypotension
  - Decreased Lung Sounds
  - Low BVM compliance
  - JVD
  - Tracheal deviation (late sign)
  - Cyanosis (late sign)
  - Mediastinal shift on CXR
- Treatment
  - Needle decompression – large bore needle into 2 ICS, mid-clavicular line
  - Chest tube
  - Hemodynamic support

**Hemothorax**
- Cause:
  - Blood fills the pleural space
  - Decreased lung volume
- SxS:
  - SOB
  - Shock
  - Decreased Breath Sounds
    - *Rales + Rhonchi*
  - Dullness to percussion on the injured side
- Tx:
  - Chest tube (large bore)
  - Autotransfusion
  - Emergency thoracotomy

**Pulmonary Contusion**
- Cause
  - Occurs as a result of direct impact
  - Capillary Blood leaks into lung prohibiting gas exchange
  - Respiratory insufficiency develops gradually over time (24-48 hrs)
- SxS
  - Dyspnea
  - Ineffective cough
  - Hemoptysis
  - Hypoxia
  - Chest pain
  - Chest wall contusion or abrasions
- Tx:
  - Supportive with observation for ARDS
• Additional conditions to review
  o Ruptured bronchus and trachea: usually results from severe blunt trauma; requires surgical intervention.
  o Ruptured esophagus: clothes-line injury; surgical intervention
  o Ruptured diaphragm: herniation of abdominal contents into chest; surgical intervention

• Blood gas evaluation
  o “Normal”:
    ▪ pH 7.35 - 7.45
    ▪ PaCO2 35-45 mmHg
    ▪ HCO3 22- 26 meq/l
    ▪ Base Excess -2 - +2
    ▪ PaO2 80 - 100
    ▪ SaO2 95% or greater
  o ROME mnemonic
    ▪ Respiratory Opposite
      • pH ↑ PCO2 ↓ = Alkalosis
      • pH ↓ PCO2 ↑ = Acidosis
    ▪ Metabolic Equal
      • pH ↑ HCO3 ↑ = Alkalosis
      • pH ↓ HCO3 ↓ = Acidosis

• Assisted ventilation
  o C-PAP – used for sleep apnea
  o BiPAP – used for COPD, CHF, pneumonia (noninvasive preferred)
  o Ventilators
    • Settings: mode, rate, FiO2, PEEP
    • Alarms – high and low causes; think “DOPE”
    • Complications: VAP(protocol), barotrauma, hemodynamic instability, GI bleed, oxygen toxicity
    • ETCO2 monitoring – provides early detecting of hypercapnia; normal 35%-45%; report 10% inc/dec

• Chest tubes
  o Insertion - pleural space at 4 th ICS anterior axillary line
  o Chambers
    ▪ Negative pressure suction pulls air out
    ▪ Underwater seal prevents air going back in
    ▪ Collection chamber for pleural fluid
  o Clamping
    ▪ Never > 1 min
    ▪ Never to transport
    ▪ To change drainage system
Review questions

1. An obese 36 yr old female presents to the ED with sudden onset left-sided chest pain and shortness of breath. She is diaphoretic and pain. She denies trauma, fever, N/V. Past medical history is unremarkable except that she was placed on oral contraceptives 6 mo ago. Initial V/S are BP 100/60, HR 120, RR 36/min and O2 sat 90%. Based on your assessment, you suspect the patient has:
   a. Pericarditis
   b. Acute coronary syndrome
   c. Pulmonary embolus
   d. Viral pneumonia

2. A patient with a history of COPD is admitted to the ED with moderate dyspnea. The patient has diminished breath sounds bilaterally, use of accessory muscles, and appears anxious. ABGs on 2L/min via NC are drawn and reveal pH of 7.31, PaO2 of 45, PCO2 of 55, and HCO3 of 26. The nurse anticipates the MD to order:
   a) IV aminophylline
   b) Albuterol/Ipratropium (Combivent) nebulized treatment
   c) Epinephrine
   d) Lorazepam 0.5 mg PO

3. A 80 year old male is brought to the ED with complaints of fever, tachycardia, and tachypnea. His ABGs reveal: pH 7.01, PO2 125 mm/Hg, PCO2 42 mm/Hg, HCO3 10mEq/L. The correct interpretation of these ABGs is:
   a) metabolic acidosis
   b) metabolic alkalosis
   c) respiratory acidosis
   d) respiratory alkalosis

4. You are caring for an unrestrained driver of a MVC. He is severely dyspneic and cyanotic, has labored respirations, absent breath sounds on the right, unilateral chest rise and fall and JVD. You suspect:
   a) aspiration
   b) flail chest
   c) tension pneumothorax
   d) cardiac tamponade

5. Interpret the following ABGs: pH – 7.60, PO2 – 140, PCO2 – 16, HCO3 – 22
   a) metabolic acidosis
   b) metabolic alkalosis
   c) respiratory acidosis
   d) respiratory alkalosis