8. Respiratory pathology

Respiratory system
Structure and function [Figs. 8-1, 8-3]

- Upper respiratory tract
  - structure
    - nasal cavity, sinuses, nasopharynx,
    - oral cavity, oropharynx
  - function
    - filter, warm, humidify air

- Lower respiratory tract
  - structure
    - larynx, trachea
    - lungs (right and left)
  - function
    - air exchange
    - speech

- Branching of airways into smaller ducts
  - bronchi → bronchioles → alveolar ducts → alveoli
- Air exchange occurs in most distal spaces (alveoli)
  - diffusion barrier [Fig. 8-3]
    - alveolar pneumocyte, common basement membrane, endothelial cell

- Respiratory defense mechanisms
  - mucus, mucocilliary escalator
  - alveolar macrophages
  - cough/sneeze reflexes

- Pulmonary circulation
  - dual blood supply

Respiratory pathology
Overview

- Infections
- Obstructive airway diseases
- Restrictive airway diseases
- Miscellaneous disorders
- Neoplasms

Infections of the upper respiratory tract

- Common cold, sore throat, “Flu”
  - viral infection of upper respiratory tract with classic symptoms
  - rhinovirus, parainfluenza viruses
  - self limited, symptomatic relief
- Strep throat
  - a bacterial infection caused by streptococcus A
  - diagnosed by identifying the bacteria, antibiotic therapy
- Mononucleosis
  - a viral infection caused by EBV with enlarged nodes, sore throat
- Diphtheria
  - a bacterial infection of the throat with formation of a membrane
Respiratory pathology
Infections, middle respiratory tract [Fig. 8-5]

- **Croup (3mo -3yo)**
  - acute viral infection of the larynx in children younger than 3 yo
  - barking cough
  - due to parainfluenza virus
- **Acute epiglottitis (3yo-7yo)**
  - acute bacterial infection of the epiglottis due to H. influenzae B
  - may be life threatening due to swelling and closure of airway
  - immunization
- **Bronchiolitis (< 2yo)**
  - inflammation of bronchi and bronchioles due to viral infection
  - usually due to Respiratory Syncitial Virus

**Pneumonia** [Fig. 8-7]

- Inflammation/ infection of the lungs
- **Typical pneumonia**
  - infection affecting the air spaces characterized by a cough that produces sputum (productive cough)
  - Lobar pneumonia is widespread involvement (lobe of lung)
  - Bronchopneumonia is more limited involvement
- **Atypical (interstitial) pneumonia**
  - infection affecting the interstitial lung tissue characterized by a non-productive cough

**Typical pneumonias**

- Causative agents depend on where infection acquired
  - community acquired
    - usual bacteria are streptococcus, hemophilus, staphylococcus
  - hospital acquired
    - usual bacteria are gram negatives
  - fungi, parasites and viruses may also cause pneumonia
    - travel history is important re possible exposure
    - immuno compromised individuals susceptible to unusual organisms

- Routes of infection
  - inhalational
  - hematogenous

**Atypical pneumonias**

- **Mycoplasma pneumoniae**
  - commonest atypical pneumonia
  - common in young adults
  - may develop extra-pulmonary features
- **Legionella pneumophilia**
  - cause of Legionnaire’s disease
  - prominent non-respiratory symptoms
  - uncommon, source is standing water

**Complications of pneumonia** [Fig. 8-9]

- Pleuritis: inflammation of the pleural lining
- Pyothorax: pus in the pleural cavity
- Empyema: loculated areas of pus in the pleural cavity
- Abscess
- Bronchiectasis
- Chronic lung disease
Respiratory pathology

Pneumonia [Fig. 8-7]

Diagnosis
- symptoms
  - fever, chills, rigors
  - dyspnea, cough
  - mucopurulent discharge
- chest x-ray, bacterial cultures of sputum, CBC & differential, arterial blood gas

Treatment
- antibiotics

Tuberculosis [Figs. 8-10, 8-11]
- Chronic respiratory infection due to bacterium called Mycobacteria tuberculosis (Mtb)
- Mtb causes granulomatous reaction with caseous necrosis
- Initial primary infection
  - Ghon complex consists of lung lesion and enlarged hilar nodes
    - M. tb bacteria isolated within the granulomas preventing spread
  - uncommonly primary infection may progress
- Secondary tuberculosis
  - reactivation or reinfection
  - tissue destruction, extrapulmonary spread

Diagnosis
- non-specific symptoms
- demonstrate presence of bacteria in sputum
  - acid fast stain (Ziehl-Nielsen)
  - DNA probes
- important because if present must isolate patient

Treatment
- multi-drug regimen
- treatment continues for many months
- drug resistant strains arising

Obstructive airway diseases

- Group of respiratory diseases characterized by symptoms of obstructed airways (↓ flow rate, air trapping)
- Major diseases:
  - Asthma
  - Chronic obstructive pulmonary disease
    - emphysema
    - chronic bronchitis
  - Bronchiectasis
  - Cystic fibrosis
Respiratory pathology

Chronic obstructive pulmonary disease

• Chronic bronchitis
  • disease diagnosed clinically as production of excessive sputum for at least 3 months during 2 consecutive years
  • smoking is most common cause
  • obstruction is due to narrowing of airways caused by thickened mucosal lining and increased mucus

• Emphysema
  • destruction and dilation of distal air spaces
  • centrilobular emphysema (widening of air spaces in center of a lobule)
    • most common form of emphysema, usually secondary to smoking
  • panlobular emphysema (widening of all air spaces in a lobule)
    • secondary to deficiency of α-1 anti-trypsin (inactivates proteases)

• Clinical features
  • pink puffer
    • patients with predominant emphysema
    • destruction of lung tissue results in overinflation (barrel chest)
    • use of accessory muscles of respiration
    • hyperventilate to keep blood oxygenated (“puffer”)
  • blue bloater
    • patients with predominant chronic bronchitis
    • hypoxemia results in cyanosis “blue”
    • frequently obese (“bloater”)
    • pulmonary hypertension with resulting right ventricular hypertrophy
    • usually a combination

Bronchiectasis

• Permanent dilatation of a bronchus due to destruction of the wall
• Increased susceptibility to infections
• Causes of bronchiectasis include
  • obstruction (foreign body, tumor)
  • infection (TB, measles, pneumonia)
  • impaired defense mechanisms (cystic fibrosis)

Asthma

• Asthma is a respiratory disease characterized by increased reactivity of smooth muscle in airways (reactive airway disease)

• Extrinsic asthma
  • attacks precipitated by exposure to triggering allergens
    • Type I Hypersensitivity reaction
    • associated with other atopic diseases (eczema, hay fever, allergies)

• Intrinsic asthma
  • attacks precipitated by non-immune mechanisms
    • exercise, stress, infections, temperature, aspirin

• Pathogenesis
  • stimuli trigger inflammation with release of mediators
    • smooth muscle contraction (bronchi constriction)
    • leaky vessels
    • mucus plugs

• Status asthmaticus
  • severe unremitting asthma attack not responsive to bronchodilators

• Treatment
  • treat acute attacks with bronchodilators, prevent chronic inflammation with steroids
Respiratory pathology

Restrictive lung diseases
- Group of respiratory diseases characterized by symptoms of restrictive lung function (↓ lung volume, ↓ compliance)
- Major diseases
  - hypersensitivity pneumonitis
  - pneumoconioses
  - sarcoidosis
- Inflammatory process in alveolar walls with fibrosis
- Honeycomb lung is common end stage appearance

Hypersensitivity pneumonitis
- Respiratory disease due to disordered immune reaction to various inhaled antigens [Fig. 8-18]
- Exposure is usually work or hobby related
- Allergens include moldy hay, pigeon droppings, etc.
  - farmer’s lung
  - pigeon fancier’s lung
- Acute form (Type III reaction)
- Chronic form (Type IV reaction)
- Treatment is avoidance of the allergen

Pneumoconioses
- Respiratory disease due to inhalation of inorganic dusts
- Exposure often occurs at work
- Severity depends on amount, duration and type of dust
- Examples
  - Coal-worker’s lung
    - inhalation of coal and silica particles in miners
  - Silicosis
    - inhalation of silica particles by sand blasters, miners, stone cutters
  - Asbestosis
    - inhalation of asbestos particles by shipyard workers, insulation
    - nb. also develop pleural plaques, lung cancer, mesothelioma
- Treatment is avoidance of the dust

Sarcoidosis [Fig. 8-17]
- Multisystemic disease of unknown etiology characterized by non-caseating granulomas in various organs
- May involve any organ
  - typically lungs, lymph nodes, liver
- Diagnosis
  - biopsy of affected tissue
- Treatment
  - no specific treatment
  - steroids
Respiratory pathology

Drowning

- Third leading cause of accidental deaths
- Types of drowning
  - wet drowning (90%)
    - aspirated water enters the respiratory tract with resulting anoxia
    - sea water results in more pronounced pulmonary edema
  - dry drowning (10%)
    - reflex laryngospasm with closure of glottis resulting in anoxia
    - no water in the lungs
- Outcome depends on speed of rescue/ resuscitation

Adult respiratory distress syndrome (ARDS)

- Clinical condition characterized by acute respiratory failure that does not respond to oxygen
- Various causes
  - aspiration, drowning, sepsis, shock, etc.
- Injury to lung causes leaky capillaries
  - fluid enters the air spaces and interstitial space from the capillaries
- High mortality (50%)

Miscellaneous terms

- Atelectasis [Fig. 8-22]
  - term used to describe incomplete expansion of alveoli
  - causes
    - deficiency of surfactant
    - compression of alveoli by external mass
    - resorption of air distal to obstruction
  - usually reversible
- Dyspnea
  - term used to describe subjective feeling of shortness of breath

Neoplasms

- Laryngeal carcinoma
  - linked to smoking, alcohol
  - squamous cell carcinomas
  - symptoms include hoarseness, loss of voice
Respiratory pathology

Lung cancer [Fig. 8-26]
- Statistics
  - number one cause of deaths due to cancer (male and female)
  - second most common malignancy (male and female)
- Risk factors
  - cigarette smoking
  - asbestos exposure
  - radiation
  - arsenic, chromium
  - genetic factors
- Lung is also a common site for metastatic tumors
- Adenocarcinoma
  - most common primary lung malignancy (>35%)
  - equal frequency in smokers and non-smokers
  - usually peripheral, solitary nodule
- Squamous cell carcinoma (30%)
  - usually smokers
  - typically more centrally located
- Small cell carcinoma (20%)
  - usually smokers
  - often early spread
  - paraneoplastic syndromes common

Pleural disease
- Review of terms
  - pneumothorax [Fig. 8-28]
    - entry of air into the pleural cavity with collapse of the lung
  - pleural effusion
    - accumulation of fluid in the pleural cavity
  - pleuritis
    - inflammation of the pleura typically secondary to pneumonia
- Pleural tumors
  - mesothelioma is a malignant neoplasm of mesothelial cells
  - associated with asbestos exposure