PATHOLOGY OF RESPIRATORY SYSTEM

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CONTENT

Upper respiratory tract
- Nose
- Pharynx (Throat)
- Larynx
- Trachea

Lower respiratory tract
- Lung
  - Bronchi
  - Bronchiole
  - Alveoli

Organs of the Respiratory System

- Nasal cavity
- Oral cavity
- Paranasal Sinuses
- Nostril
- Larynx
- Bronchi
- Carina of trachea
- Right main (primary) bronchus
- Left main (primary) bronchus
- Right lung
- Left lung
- Parietal Pleura (and Visceral Pleura covers lung surfaces themselves)
- Diaphragm

- Sinus
- Sinusitis
- Larynx
- Vocal nodule
- Laryngeal malignancy: laryngeal carcinoma
■ Lower respiratory tract
  ■ Pulmonary infections
  ■ Atelectasis
  ■ Pulmonary edema
  ■ Acute respiratory distress syndrome
  ■ Obstructive pulmonary diseases
  ■ Disease of vascular origin: pulmonary embolism
  ■ Tumors

■ SINUSITIS
  ■ Infection of sinuses, associated with acute or chronic rhinitis
  ■ Bacteria or fungus
  ■ s/s: pain at sinus area, post nasal dripping, chronic cough
  ■ Rx: antibiotic

■ UPPER RESPIRATORY TRACT

■ VOCAL NODULES OF LARYNX
  ■ Smoking or singer
  ■ Small nodule at true vocal cord
  ■ Hoarseness
  ■ Benign lesion
VOCAL NODULES OF LARYNX

CARCINOMA OF LARYNX

- Associated with smoking and alcohol
- Squamous cell carcinoma
- Hoarseness or neck mass if metastasis to cervical lymph node
- Treatment by surgery or combined with radiation

LOWER RESPIRATORY TRACT
INFECTION LUNG DISEASE
- Pneumonia
  - Community acquired pneumonia
  - Hospital acquired pneumonia (nosocomial pneumonia)
  - Atypical pneumonia
  - Aspiration pneumonia
- Lung abscess
- Pulmonary tuberculosis

COMMUNITY ACQUIRED PNEUMONIA (CAP)
- Predisposing factors
  - old age
  - chronic disease (COPD, CHF, DM)
  - immune deficiency
  - decreased or absent splenic function
    - eg. sickle cell disease, post splenectomy
    - risk for infection to encapsulated bacteria eg. pneumococcus

CLINICAL COURSE
- Abrupt onset of high fever with chills
- Mucopurulent productive cough
- Dyspnea
- Involve pleura: pleuritic pain
- PE: crepitation, decrease breath sound

CAUSE OF CAP
- Streptococcus pneumoniae (most common)
- Haemophilus influenza: Acute exacerbation of COPD
- Staphylococcus aureus: IVDU
- Klebsiella pneumonia: Chronic alcoholism
- Pseudomonas aeruginosa
GROSS EXAMINATION

- Gross patterns of anatomical distribution
  - Bronchopneumonia: patchy consolidation along bronchi and bronchioles
  - Lobar pneumonia: consolidation involves entire lobe of lung

- Suppurative neutrophils rich exudate in bronchi, bronchioles and alveoli
Bronchopneumonia  Lobar pneumonia

**HOSPITAL ACQUIRED PNEUMONIA**
- Nosocomial pneumonia
- Common patients with any conditions
  - severe underlying disease
  - mechanical ventilator
  - immunosuppression
  - prolonged antibiotic therapy
  - invasive access devices eg. intravascular catheters

**Serious and life-threatening**

**Common organisms**
- Gram negative bacteria
  - Pseudomonas aeruginosa
  - Acinetobacter baumannii
  - Enterobacteriaceae
- Gram positive bacteria
  - Staphylococcus aureus

**Clinical course (similar CAP)**
- Abrupt onset of high fever with chills
- Mucopurulent productive cough
- Dyspnea
- PE: crepitation, decrease breath sound of affected lungs
ATYPICAL PNEUMONIA

- Mycoplasma or Viral pneumonia
- Common in children and young adults
- Most common organisms
  - Mycoplasma pneumonia
  - Virus: influenza virus type A or B, respiratory syncytial virus, adenovirus, rhinovirus, HSV, varicella virus

ATYPICAL PNEUMONIA

- Clinical course
  - fever
  - headache, muscle aches
  - cough +/-
- PE: non-specific

ATYPICAL PNEUMONIA

- Gross
  - patchy or may involve whole lobes
  - affected area: red blue, congested
- Microscopic
  - alveolar septa are wide, edema, mononuclear cell infiltration (lymphocytes, plasma cells, histiocytes)
ASPIRATION PNEUMONIA

- Common in patients with some conditions
  - unconscious patients or during repeated vomiting
  (abnormal gag reflex or swallowing reflex that predispose to aspiration)

- Aspirated food and gastric content (chemical, gastric acid, oral flora bacteria)
  induces to pneumonia

- Clinical course
  - high fever, cough, dyspnea
  - Often more than one organism (mixed aerobes and anaerobes)

ASPIRATION PNEUMONIA

- Gross
  - bronchopneumonia
  - lobar pneumonia
- Microscopic
  - neutrophils rich exudate, often necrosis in alveoli

- Complication
  - lung abscess (common)

NECROTIZING PNEUMONIA AND LUNG ABSCESS

- Local suppurative process in the lung characterized by necrosis of lung tissue
- Organisms (aerobes+anaerobes)
  - aerobes:- streptococci, staphylococci, klebsiella, pseudomonas, E. coli
  - anaerobes:- peptostreptococcus, bacteroides, fusobacterium spp.
NECROTIZING PNEUMONIA AND LUNG ABSCESS

- Clinical course
  - high fever
  - cough with foul smelling purulent sputum
  - chest pain
  - weight loss

PULMONARY TUBERCULOSIS

- Increase risk for TB
  - diabetes mellitus
  - Hodgkin lymphoma
  - chronic lung disease (eg. Silicosis)
  - chronic renal failure
  - malnutrition
  - alcoholism
  - immunocompromised host
**PULMONARY TUBERCULOSIS**

- Caused by M. tuberculosis
- Most infections are acquired by person-to-person transmission of airborne droplets of organisms from active case to a susceptible host
- TB infection leads to development of delayed hypersensitivity to M. tuberculosis antigen, which can be detected by tuberculin skin test (TT)
- Classified as 2 types
  - Primary pulmonary tuberculosis
  - Secondary pulmonary tuberculosis

**PRIMARY PULMONARY TUBERCULOSIS**

- Usually a self-limited infection seen in children and adult
- Most patients are asymptomatic
- May be present with fever, malaise, weight loss, cough, and occasional hemoptysis
- Clinical course
  - Most self-limited and scar with calcification in chest radiography
  - Some patients with progression become have extensive lung damage with cavity
  - May be lymphatic or hematogenous spread to other organs eg, liver, spleen, pancreas \(\rightarrow\) miliary TB

**PRIMARY PULMONARY TUBERCULOSIS**

- Primary infection at lungs composed of “Ghon complex”
  - Lung infection at lower segment of upper lobe or upper segment of lower lobe \(\rightarrow\) Ghon focus
  - Infection of hilar node

Ghon complex
SECONDARY PULMONARY TUBERCULOSIS

- Reactivation or reinfection of primary TB with asymptomatic
- Common infection at high O2 (apex of lung)
- Severe lung damage and produces cavity

SECONDARY PULMONARY TUBERCULOSIS

- Symptom
  - low grade fever, chronic cough, night sweats, anorexia, weight loss
  - may be hemoptysis, pleural effusion
- Clinical course
  - recovery if normal immune or treatment
  - lymphatic or hematogenous spread to other organs eg, liver, spleen, pancreas → miliary TB

cheese like lesion with cavity at apex
PULMONARY TB (reddish bacilli from AFB stain)

ATELECTASIS

- Incomplete expansion of lungs or collapse of previously inflated lungs, producing areas of relatively airless pulmonary parenchyma
- Acquired atelectasis divided 3 types
  - Resorption (obstruction) atelectasis
  - Compression atelectasis
  - Contraction atelectasis
ATELECTASIS

- Clinical features
  - Reversible disorders, except contraction atelectasis
  - Significant atelectasis reduces oxygenation and predisposes to infection
  - Small area or slowly develop: minor symptom or asymptomatic
  - Large area of rapid lung collapse: sudden onset chest pain, dyspnea, cyanosis, hypotension, tachycardia, shock

PULMONARY CONGESTION AND EDEMA

- Pulmonary congestion
  - Increases intravascular blood
- Pulmonary edema
  - Fluid in alveoli
- Hemodynamic cause
  - Increased hydrostatic pressure
  - Decreased oncotic pressure
  - Lymphatic obstruction
- Edema due to microvascular injury
  - Infection
  - Inhale gas or liquid aspiration
  - Drugs and chemicals
  - Shock, trauma, radiation

Pulmonary Edema in congestive heart failure

Heart failure cells

Pulmonary congestion and edema
ACUTE RESPIRATORY DISTRESS SYNDROME

- Acute lung injury (non-cardiogenic pulmonary edema)
- Abrupt onset of hypoxemia and diffuse infiltrates in the absence of cardiac failure
- Diffuse alveolar damage (DAD): inflammation-associated increase in vascular permeability, epithelial and endothelial cell death

The chest radiographs show a diffuse alveolar infiltration of both lungs.

Gross appearance:
The affected lungs are heavy, firm, red, and boggy.

Microscopic pictures:
Interstitial and intra-alveolar edema, hyaline membranes lining the alveolar walls.
- Direct lung injuries:
  - diffuse pulmonary infections (virus)
  - oxygen toxicity
  - inhalation of toxins and other irritants
  - aspiration of gastric contents

- Systemic conditions:
  - septic shock and shock associated with trauma
  - hemorrhagic pancreatitis
  - burns
  - complicated abdominal surgery
  - narcotic overdose
  - hemodialysis
  - cardiac surgery

- Pulmonary artery obstruction caused by emboli

- The usual cause – thrombosis in the deep vein of the leg

- Clinical cause depend on size of the emboli and circulatory condition of the patient
Large emboli at the bifurcation as a saddle embolus

A wedge shaped hemorrhagic infarct with the apex pointing toward the hilus of the lung

- Hypoxemia
- Chest pain, sudden dyspnea, cough, and shock
- Bed ridden

**OBSTRUCTIVE PULMONARY DISEASE**

**anatomic site lesion**

- Emphysema: Acinus
- Chronic bronchitis: Bronchus
- Asthma: Bronchus
- Bronchiectasis: Bronchus

**OBSTRUCTIVE PULMONARY DISEASE**

- Increase in resistance to airflow owing to partial or complete obstruction at any level from trachea, bronchi, terminal bronchioles and respiratory bronchioles
- Expiratory airflow obstruction result from anatomic airway narrowing in asthma, or from loss of elastic recoil of lung in emphysema
EMPHYSEMA

- Irreversible enlargement of airspaces distal to terminal bronchioles (respiratory bronchioles, alveolar ducts and alveoli)
- Accompanied by destruction of their walls and without obvious fibrosis

Pathogenesis of emphysema
- Protease-antiprotease theory
- Oxidant-antioxidant imbalance

Protease-antiprotease theory
PATHOGENESIS OF EMPHYSEMA

- Oxidant-antioxidant imbalance
  - Normal lung contains a healthy antioxidants (superoxide, dismutase, glutathione) that keep oxidative damage to minimum
  - Tobacco smoke contains abundant reactive $O_2$ species (free radicals), which deplete antioxidant mechanisms, thereby inciting tissue damage
  - Activated neutrophils in alveoli pool of free radicals result alveolar wall damage

BULLOUS EMPHYSEMA

- Large subpleural blebs or bullae and near apex (>1 cm in diameter)
- Can occur in any form of emphysema
- Sometime in relation to old tuberculous scarring
- Rupture of bullae may give rise to pneumothorax
- Hyperinflation lung
- Long narrow heart shadow
- Flat diaphragm

EMPHYSEMA

- Clinical course
  - at least 1/3 of functioning lung parenchyma damage result clinical presentation
  - insidious onset of dyspnea, cough, wheezing, weight loss
  - barrel chest, prolonged expiration, sits forward in a hunched-over position, breathes through pursed lips
  - cor pulmonale is late complication

EMPHYSEMA

- Cause of death:
  - respiratory acidosis and coma
  - right sided heart failure
  - massive lung collapse secondary to pneumothorax

- Diagnosis
  - History, physical examination, clinical presentation and spirometry
**CHRONIC BRONCHITIS**

- Persistent cough with sputum production for at least 3 months in at least 2 consecutive years, in absence of any other identifiable cause
- Long term inflammation of bronchi by chronic irritation from agents
- Common among habitual smokers and inhabitants of smog-laden city

**CHRONIC BRONCHITIS**

- Earliest feature is hypersecretion of mucus in large airways associated with hypertrophy of submucosal gland in trachea and bronchi
- Chronic bronchitis persist: marked increase in goblet cells of small airway (bronchi, some bronchioles) leading to excessive mucus production
- Cigarette smoke predisposes to infection, that interferes ciliary action of respiratory epithelium or direct damage to epithelium, and inhibits ability of bronchial and alveolar leukocytes to clear bacteria or virus

**Clinical feature**
- persistent cough productive of sputum
- continued smoking → hypoxia, cyanosis
- long standing severe chronic bronchitic leads to cor pulmonale with cardiac failure

*Increase in size and numbers of submucosal mucus glands of bronchi*
**ASTHMA**

- Chronic inflammatory disorder of airways
- Inflammation causes an increase in airway responsiveness (bronchospasm) to a variety of stimuli eg. exercise, cold, allergen, fever

<table>
<thead>
<tr>
<th>Predominant Bronchitis</th>
<th>Predominant Emphysema</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>40-45</td>
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<tr>
<td></td>
<td>50-75</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Mild; late</td>
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<td></td>
<td>Severe; early</td>
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<tr>
<td>Cough</td>
<td>Early; copious sputum</td>
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<tr>
<td></td>
<td>Late; scanty sputum</td>
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<tr>
<td>Infections</td>
<td>Common</td>
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<tr>
<td></td>
<td>Occasional</td>
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<tr>
<td>Respiratory insufficiency</td>
<td>Repeated</td>
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<tr>
<td></td>
<td>Terminal</td>
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<tr>
<td>Cor pulmonale</td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td>Rare; terminal</td>
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<tr>
<td>Airway resistance</td>
<td>Increased</td>
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<td></td>
<td>Normal or slightly increased</td>
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<tr>
<td>Elastic recoil</td>
<td>Normal</td>
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<td></td>
<td>Low</td>
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<tr>
<td>Chest radiograph</td>
<td>Prominent vessels;</td>
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<td></td>
<td>Large heart</td>
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<td></td>
<td>Hyperinflation; small heart</td>
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<tr>
<td>Appearance</td>
<td><em>Blue bloater</em></td>
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<td><em>Pink puffer</em></td>
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ASTHMA

- Sign and symptom
  - reversible acute symptomatic attacks
to severe dyspnea, cough and wheezing triggered by sudden episodes of bronchospasm

BRONCHIECTASIS

- Permanent, irreversible dilation of bronchial caused by destruction of muscle and elastic tissues of bronchial wall, resulting from chronic necrotizing infection
- Fever from infection, persistent cough
- Expectoration of copious amounts of foul smelling purulent sputum
- Dyspnea
- Occasional life-threatening hemoptyis

- Congenital condition
  - cystic fibrosis
  - intralobar sequestration of lung
  - primary ciliary dyskinesia
  - kartagener syndrome
- Post-infectious condition
  - necrotizing pneumonia
  - bacteria: TB, S. aureus, Pseudomonas, H. influenzae
  - virus: adenovirus, influenza, HIV
  - fungi: Aspergillus spp.
- Bronchial obstruction from tumor, foreign body, mucus impaction
- Other: rheumatoid arthritis, SLE, inflammatory bowel disease, lung transplantation
PATHOGENESIS

Repeated or severe infection induces widespread damage to bronchial wall (supporting smooth muscle, elastic tissue) together with mucous obstruction

- further fibrosis
- permanent dilatation of bronchi (bronchiectasis)

BRONCHOGENIC CARCINOMA

- Arise from bronchial epithelium
- WHO classification
  - Squamous cell carcinoma (25-40%)
  - Adenocarcinoma (25-40%)
  - Small cell carcinoma (20-25%)
  - Large cell carcinoma (10-15%)

BRONCHOGENIC CARCINOMA

- Cause:
  - Tobacco smoking
  - Industrial Hazards: asbestos and uranium exposure
  - Air pollution
  - Genetic
  - Scarring: previous TB, lung abscess
BRONCHOGENIC CARCINOMA

PARANEOPLASTIC SYNDROMES

- Antidiuretic hormone (ADH): hyponatremia
- Adrenocorticotropic hormone (ACTH): Cushing syndrome
  - small cell carcinoma
- Parathyroid hormone-related peptide: hypercalcemia
  - squamous cell carcinoma
- Calcitonin: hypocalcemia
- Gonadotropins: gynecomastia
DISEASES OF PLEURA

- Pleural effusion
- Pneumothorax
- Pleural tumor: mesothelioma

PLEURAL EFFUSION

- Accumulation of fluid in pleural cavity
- Pleural cavity filled with no more than 15 ml. of serous, relatively acellular, clear fluid lubricated the pleural surface

PLEURAL EFFUSION

- Increased accumulation of pleural fluid occurs in:
  - Increased hydrostatic pressure eg. congestive heart failure
  - Increased vascular permeability eg. Pneumonia
  - Decreased osmotic pressure eg. nephrotic syndrome
  - Increased intrapleural negative pressure eg. Atelectasis
  - Decreased lymphatic drainage eg. mediastinal carcinomatosis

PLEURAL EFFUSION

- Clinical
  - Dyspnea, pleural pain
- Physical examination
  - Decreased movement of chest
  - Dullness to percussion
  - Decreased breath sound
  - Decreased vocal resonance
PNEUMOTHORAX

- Air or gas in pleural cavities
- It causes compression and atelectasis of lung and may be marked respiratory distress
- Progressive increasing pressure may be sufficient to compress vital mediastinal structure and contralateral lung as “Tension pneumothorax”

PNEUMOTHORAX

- Classified as 3 types
  - spontaneous pneumothorax
  - traumatic pneumothorax
  - therapeutic pneumothorax
PNEUMOTHORAX

- Clinical features
  - sudden onset shortness of breath, dyspnea, chest pain, cyanosis
  - if severe, hypoxia and lead to coma
- Physical examination
  - decrease breath sound
  - hyperresonance to percussion