

PULMONARY INFECTIONS:

- Pneumonia can be very broadly defined as **any infection of the lung parenchyma**; Pneumonias are common cause of death.
- Could be **bacterial (90% due to streptococcal pneumoniae)**, viral and fungal.

Predisposing factors:

1. Defect in immunity:
 - Defect in humoral immunity & neutrophils → pyogenic infection.
 - Defect in cellular immunity → intracellular infections (tuberculosis, viruses, pneumocystic carinii).
2. Cigarette smoking
 - decrease in mucociliary clearance
 - Affect pulmonary macrophages activity.
3. Alcohols
 - Decrease cough & epiglottis reflexes.
 - Increase aspiration
 - Decrease neutrophils activity.
4. Head injury & surgery → increase aspiration
5. Lung cancers & cystic fibrosis → Pulmonary Obstruction → increases risk of pneumonia.

Classification of pneumonia:

1. According to anatomical (and radiographic) patterns
2. According to setting in which the pneumonia is occurred
3. Microbiological classification: it Could be: bacterial, Viral, fungal...

I. According to anatomical (and radiographic) patterns:

- 1) **Bronchopneumonia** showing a patchy distribution of inflammation that generally involves more than one lobe. The initial infection is of the bronchi and bronchioles with extension into the adjacent alveoli.
- 2) **Lobar pneumonia**, which affect the airspaces of part or all of a lobe; these are homogeneously filled with an exudate that can be visualized on radiographs as a lobar or segmental consolidation.
 - **The anatomic distinction between lobar pneumonia and bronchopneumonia is often become blurred because:**
 - 1- many organisms can produce either of the two patterns of distribution
 - 2- Confluent bronchopneumonia can be hard to distinguish radiologically from lobar pneumonia.

II According to setting in which the pneumonia is occurred:

1. **Community acquired bacterial pneumonia:** characterized by

- This is the commonest type.
- Often follow viral upper respiratory tract infection.
- Streptococcus pneumoniae, or pneumococcus, is the most common cause of community-acquired pneumonia.
- Haemophilus influenzae can cause life-threatening lower respiratory tract infections and meningitis in children and is a common cause of pneumonia in adults, especially those with COPD
- Moraxella catarrhalis: especially in the elderly; it exacerbates COPD and is a common cause of pediatric otitis media.
- Staphylococcus aureus pneumonia often complicates viral illnesses and has a high risk of abscess formation and empyema. Intravenous (IV) drug abusers are at high risk of staphylococcal pneumonia in association with endocarditis.
- Klebsiella pneumoniae is the most common cause of Gram negative pneumonia; it affects debilitated individuals, especially chronic alcoholics.
- Pseudomonas aeruginosa is a common cause of **nosocomial infections** with a propensity to invade blood vessels and spread systemically; it is also common in cystic fibrosis and neutropenic patients.
- Legionella pneumophila: cause severe pneumonia in the immunocompromised patient (**particularly in organ transplant recipients**).
- Mycoplasma pneumoniae: common among **children and young adults**. They occur **sporadically** or as **local epidemics** in closed communities (schools, military camps, prisons).
- ❖ **Morphology of bacterial pneumonia**
 - Depending on bacterial virulence and host resistance, the same organism can cause bronchopneumonia, lobar pneumonia.
 - **Bronchopneumonia**
 - The consolidation is patchy centered around inflamed bronchi that involve more than one lobe (Multifocal & may be bilateral)

Grossly:

- The lungs exhibit focal areas (**patches**) of palpable consolidation.
- Lesions are multiple & may be bilateral.

Microscopically:

- There is a neutrophil-rich exudate fills the bronchi, bronchioles, and adjacent alveolar spaces
- **Lobar pneumonia**
 - Consolidation of a large portion of a lobe or of an entire lobe defines
 - There are **four stages** of evolution of lobar pneumonia, they are:

1- Congestion stage:

Grossly:

The lung is heavy, boggy, and red.

Microscopically:

Characterized by vascular engorgement, intraalveolar fluid with few neutrophils, and often the presence of numerous bacteria.

2- Red hepatization:

Grossly:

- Lobe is red, firm, airless, look like a liver.

Microscopically:

- The inflammatory exudate composed of RBC, neutrophils and fibrin fill the alveolar spaces

3- Gray hepatization:

Characterized by red cell disintegration but persistence of fibrinopurulent exudates.

Grossly:

- Gray –brownish, dry surface & firm.

Microscopically:

- The exudate within alveoli is fibrino-suppurative (WBC, fibrin and lysed RBC).

4- Resolution:

- Characterized by progressive enzymatic digestion of the exudates and macrophage resorption of the debris, or organized by fibroblasts growing into it.
- **Exudate resolution** usually restores normal lung structure and function, but **organization** with fibrous scarring can occur.

✓ **The anatomic distinction between lobar pneumonia and bronchopneumonia is often become blurred because:**

1. Many organisms can produce either of the two patterns of distribution
 2. Confluent bronchopneumonia can be hard to distinguish radiologically from lobar pneumonia.
- **Most important from the clinical standpoint are identification of the causative agent and determination of the extent of disease.**
 - **Symptoms of pneumonia (in general):**
 - Abrupt onset of **high fever** with **shaking chills**, **pleuritic chest pain**, **cough with mucopurulent (rusty) sputum**. Occasionally **hemoptysis**.
 - **Diagnostic tests:**
 - Sputum examination: for Gram stain (numerous neutrophils contain diplococci). (nonspecific because due to presence of normal flora)
 - Blood culture: More specific, 20-30% is positive in early cases.
 - CXR: The whole lobe is radiopaque in lobar pneumonia, whereas there are focal opacities in bronchopneumonia.

Complications:

- **90%** of cases will end up with **resolution**, otherwise complication includes:
 1. Abscess formation because of tissue destruction and necrosis
 2. Spread of infection to the pleural cavity → empyema (pus inside the pleural cavity).
 3. Bacteremic dissemination cause meningitis, infective endocarditis, arthritis
 4. Organization (fibrosis) of the exudate → part of the lobe will turn solid.

2. Community acquired atypical pneumonias:

- The most common causes are influenza types A and B, the respiratory syncytial viruses, adenovirus, rhinoviruses, rubeola virus, and varicella virus Nearly all of these agents also cause upper-respiratory tract infections (“common cold”).

❖ **Morphology:**

➤ **Grossly:**

- Patchy or lobar areas of congestion (red- blue areas) appear **without the consolidation** of bacterial pneumonias (hence the term atypical pneumonia).

➤ **Microscopically:**

- Interstitial Pneumonia;

The **inflammatory reaction** is largely confined within the alveolar walls and connective tissue of lung (interstitial tissue). Alveolar walls widened by edema & inflammatory infiltrate of lymphocytes, histiocytes, and occasionally plasma cells.

- **In contrast to bacterial pneumonias** alveolar spaces are free of cellular exudates. Superimposed bacterial infection, as expected, results in a mixed histologic picture.

3- Nosocomial Pneumonia (hospital-acquired):

- Defined as "pulmonary infections acquired in the course of a hospital stay".
- They are common in hospitalized persons with severe illness, immune suppression, or prolonged antibiotic therapy and those on mechanical ventilation are also susceptible.
- Gram negative rods (*Klebsiella* spp., *Escherichia coli* and *Pseudomonas* spp.) and *Staphylococcus aureus* are the most common cause.

4- Aspiration Pneumonia:

- Occurs in markedly debilitated patients or those who aspirate gastric contents either while unconscious (e.g., after a stroke) or during repeated vomiting.
- The resultant pneumonia is partly chemical, resulting from the extremely irritating effects of the gastric acid, and partly bacterial.
- This type of pneumonia is often necrotizing with a fulminant clinical course. In those who survive, abscess formation is a common complication.

5- Necrotizing pneumonia & Lung Abscess

- Necrotizing pneumonia often coexists or evolves into lung abscess, making the distinction between the two somewhat subjective.

Lung abscess

- Define as necrosis of pulmonary parenchyma and formation of cavity containing necrotic debris and fluids or pus.
- The formation of multiple small abscesses in lung parenchyma is referred as necrotizing pneumonia.

Clinically:

- Cough, copious amount of foul smell sputum and fever.

Complications:

- Extension into the pleural cavity (Empyema), hemorrhage, septic embolization, and secondary amyloidosis.

Pathogenesis:

These microorganisms reach lungs via the followings mechanisms:

- 1) Aspiration of infected material from carious teeth, infective sinuses or tonsils, this is occurring during oral surgery & anesthesia, acute alcoholism, coma, in which the cough reflexes are depressed.

- 2) Aspiration of gastric contents
- 3) Complications of necrotizing bacterial pneumonia (staph. aureus, strepto. Pyogenes, & pseudomonas).
- 4) Bronchial obstruction: particularly with bronchogenic cancers; Obstruct the bronchi, impaired drainage of secretion & increase risk of abscess formation.
- 5) Septic embolism from infective endocarditis of right side of heart or from septic thrombophlebitis.
- 6) Hematogenous spread of bacteria (Staphylococcal Bacteremia).
- 7) Direct traumatic penetrations of the lungs; spread of infections from a neighboring organ, such as pleural cavity.

Gross:

- Various size cavities, filled with pus.
- Those occur on right side are mostly due to aspiration (more vertical airway).
- Those follow pneumonia & Bronchiectasis are multiple, basal in locations

Microscopically:

Suppurative inflammation, necrosis & destruction of the lung parenchyma

6- Chronic Pneumonia:

- Localized lesion in an **immunocompetent person**, with or without regional lymph node involvement.
- There is typically **granulomatous inflammation**, which may be due to **bacteria** (e.g., **M. tuberculosis; discussed in infection**) or **fungi**.
- In the **immunocompromised**, there is usually systemic dissemination of the causative organism, accompanied by widespread disease.

Fungal pneumonia:

- Histoplasmosis, Coccidioidomycosis and Blastomycosis
- Mainly caused by Histoplasma capsulatum, Coccidioides immitis and Blastomyces dermatidis.
- Most are asymptomatic and result in only limited granulomatous disease; however, immunocompromised can cause fulminant, widespread dissemination.
- Initiated by **delayed-type hypersensitivity response to the organism**.
- The lesions develop in to small granulomas with giant cells, may develop central necrosis and later fibrosis and calcification
- Should be differentiated from tuberculosis; by identification of the yeast forms which are best seen with periodic acid- Schiff or silver stains.

7- Pneumonia in the Immunocompromised Host

- A wide variety of opportunistic microorganisms, many of which rarely cause infection in normal hosts, but can cause life-threatening pneumonias in the immunocompromised host.

Examples of pulmonary opportunistic pathogens include;

1. **Bacteria** (Pseudomonas aeruginosa, Mycobacterium spp., etc)
2. **Viruses** (cytomegalovirus and herpesvirus)
3. **Fungi** (Pneumocystis jiroveci, Candida spp., Aspergillus spp., and Cryptococcus neoformans).