



Team 435

# PATHOLOGY

As a doctor you should know what can threaten your patient's life  
should know what makes your patient suffers from pain

**That's why you study pathology**

## Lecture 4

## **Lecture Four: (Pneumonia)**

### Objectives:

- A- Understand that pneumonia is an inflammatory condition of the lung characterized by consolidation (solidification) of the pulmonary tissue.
- B- Is aware of the pathogenesis of pneumonia and its classification, which principally include bronchopneumonia, lobar pneumonia, and atypical pneumonia. □
- C- Is able to appreciate the aetiology and pathogenesis of lung abscess. □

### Contents:

- 1- General considerations and clinical characteristics of pneumonia.
- 2- Morphologic types of pneumonias including lobar pneumonia, bronchopneumonia and interstitial pneumonia (atypical pneumonia) with special emphasis on mycoplasma pneumonia, viral pneumonia and ornithosis (chlamydia induced).
- 3- Pneumocystis carinii pneumonia as the most common opportunistic infection in patients with AIDS.
- 4- Hospital acquired gram negative pneumonias.
- 5- Lung abscess: causes and manifestations.

## **Pneumonia:**

### **What is pneumonia?**

**It can be very broadly defined as any infection in the lung.** However, Pneumonia is an **inflammatory condition** affecting the pulmonary parenchyma; it's characterized mainly by consolidation<sup>1</sup> of the pulmonary tissue. This consolidation of parts of the lung occurs because of the presence of an exudate (w/inflammatory infiltrate), fibrin, and fluid.

### **Clinical Features:**

May be as an acute, fulminant clinical disease or as a chronic disease with a more protracted course. Acute bacterial pneumonias can manifest as one of two anatomic and radiographic patterns, referred to as *bronchopneumonia* and *lobar pneumonia*.

### **Other characteristics:**

1. Chills and fever
2. Productive cough<sup>2</sup>
3. Blood tinged sputum or rusty sputum<sup>3</sup>
4. Pleuritic pain
5. Hypoxia with shortness of breath and occasionally, cyanosis<sup>4</sup>.
6. Abscess:

Cavity lined by inflammatory vascular granulation tissue which contains pus. It can open up to the circulation and reach the brain.

7. **Effusion:** Accumulation of fluid within a body cavity (pleural, peritoneal (ascites), synovial)

If bacterial, it is most characteristically associated with neutrophilic leukocytosis with an **increase in band neutrophils** ("shift-to-the-left").

### **Consolidation (more dense tissue), can be appreciated by two ways:**

#### **1. Radiology:**

Chest X-ray or CT scan.

#### **2. Gross examination:**

A normal lung surface is spongy, however in a lung infected by pneumonia the surface is firm (solid beefy) because of the edema.

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<sup>1</sup> Solidification (زيادته الكثافة), the tissue becomes more dense.

<sup>2</sup> cough that produces sputum

<sup>3</sup> Blood in sputum

<sup>4</sup> Discoloration of skin due to lack of oxygen

**First of all, you need to understand that there are three types of pneumonia: (EXTRA)**

**1. Community-Acquired Acute Pneumonias:**

Most are bacterial in origin. Commonly, the infection follows a viral upper respiratory tract infection. The onset usually is abrupt, with high fever, shaking chills, pleuritic chest pain, and a productive mucopurulent cough; occasional patients may have hemoptysis. *S. pneumoniae* (i.e., the pneumococcus) is the most common cause of community-acquired acute pneumonia.

**2. Community-Acquired Atypical Pneumonias:**

Caused by a variety of organisms, *Mycoplasma pneumoniae* being the most common. *Mycoplasma* infections are particularly common among children and young adults.

**Why is it atypical?**

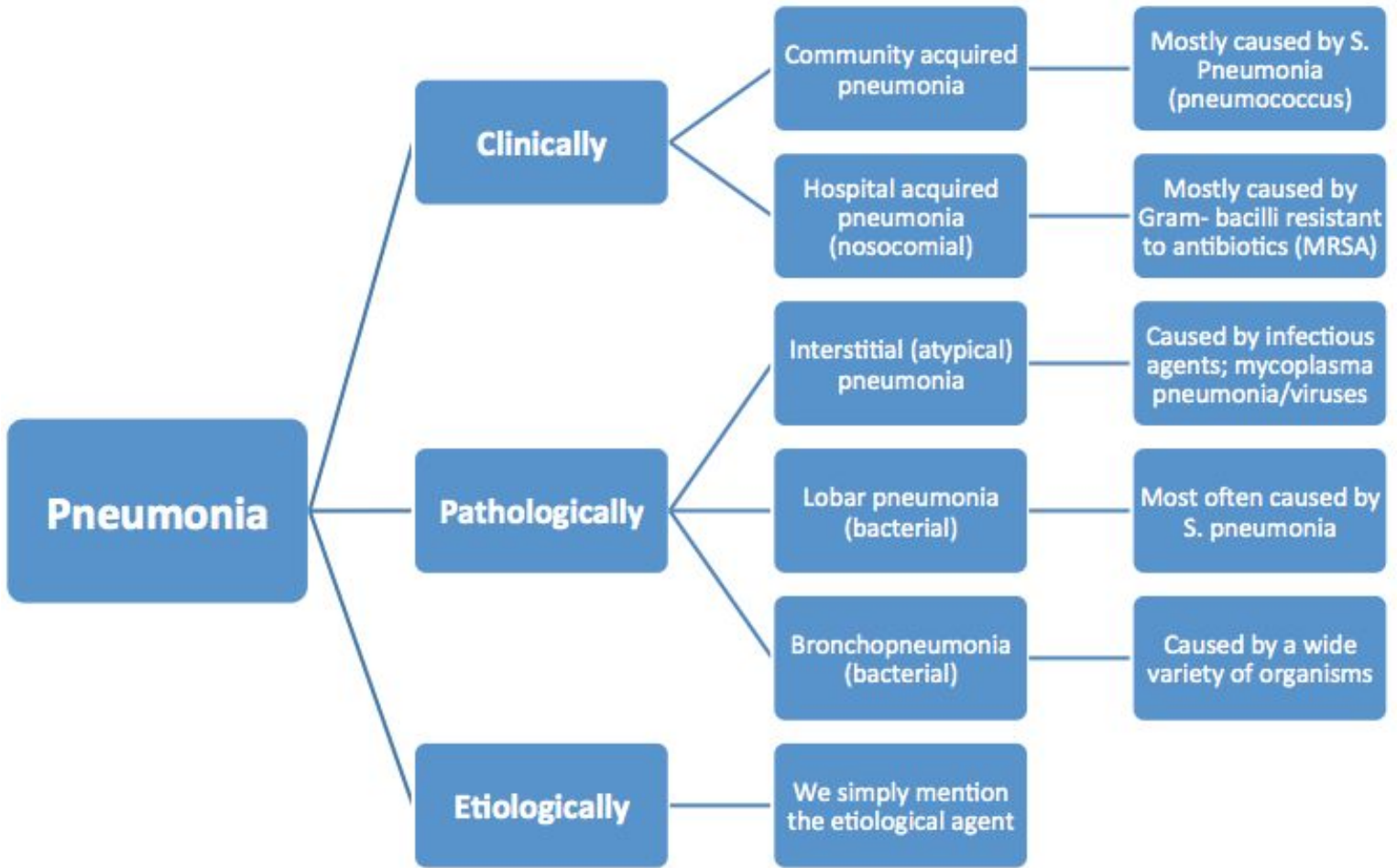
Moderate amounts of sputum, absence of physical findings of consolidation, only moderate elevation of white cell count, and lack of alveolar exudates.

Damage to and denudation of the respiratory epithelium inhibits mucociliary clearance and predisposes to secondary bacterial infections. Viral infections of the respiratory tract are well known for this complication. More serious lower respiratory tract infection is more likely to occur in infants, elderly persons, malnourished patients, alcoholics, and immunosuppressed persons. Not surprisingly, viruses and mycoplasmas frequently are involved in outbreaks of infection in hospitals.

**3. Hospital-Acquired Pneumonias (□Nosocomial):**

Defined as pulmonary infections acquired in the course of a hospital stay. Nosocomial infections are common in hospitalized persons with severe underlying disease, those who are immunosuppressed, or those on prolonged antibiotic regimens. Those on mechanical ventilation represent a particularly high-risk group, and infections acquired in this setting □ are given the distinctive designation ventilator-associated pneumonia. Gram-negative rods (members of Enterobacteriaceae and *Pseudomonas* spp.) and *S. aureus* are the most common isolates; unlike with community-acquired pneumonias, *S. pneumoniae* is not a major pathogen in nosocomial infections.

Classification of pneumonia:



Morphology:

There are three morphologic and clinical patterns: **lobar pneumonia**, **bronchopneumonia** and **interstitial pneumonia**. Therefore, it is best to classify pneumonias either by the specific etiologic agent or, if no pathogen can be isolated, by the clinical setting in which infection occurs.

## 1. Interstitial (atypical) pneumonia:

- ❑ It's a type of interstitial lung disease which can be caused by viruses or by atypical organisms such as **Mycoplasma<sup>5</sup> pneumoniae, Chlamydia pneumoniae.** (**Most commonly mycoplasma and viruses**)
- ❑ In children however, the most common cause are viruses such as **adenovirus, respiratory syncytial virus (RSV), rhinovirus, and influenza virus.**
- ❑ It is characterized by **diffuse, patchy inflammation** localized to interstitial areas of **alveolar walls.**

### Signs and symptoms:

Interstitial (atypical) pneumonia patients can present with:

1. **Interstitial infiltrate<sup>6</sup>** with the major inflammatory cell being lymphocytes, however if we do find neutrophils it means that there's a second infection, patients can also present with
2. **Dyspnea.**
3. **Cough.**

### Diagnosis (Cold Agglutinin test)<sup>7</sup>:

#### **How does it work?**

Mycoplasma will lead to formation of some **IgM** in the circulation, when we take a blood sample from the patient and add RBC's from a sheep to it, the RBC's of the lamb will agglutinate<sup>8</sup> because of the formed **IgM**.

### Subtypes:

#### 1. **Ornithosis (psittacosis) pneumonia:**

It's caused by **chlamydia psittaci**, an organism that can also affect the eyes and genital areas. **Who is it seen in?** It's seen in people who raise birds, especially parrots. Droppings (feces) of these birds contain **chlamydia**.



#### 2. **Hypersensitivity pneumonitis (pigeon-breeder's lung)[NOT PNEUMONIA]:**

Causes very small granuloma in the lung, it's commonly seen in people who are immunocompromised (weak humoral immunity/weak T-cell mediated immunity or even both) because of AIDs, etc. This type of infection is one of many very common pulmonary infections correlating with AIDS, the affecting organism is **pneumocystis jiroveci** and the stain for this organism is **silver stain** or **glucate stain**.

#### 3. **Non specific urethritis:** also caused by chlamydia.

<sup>5</sup> Between fungus and bacteria

<sup>6</sup> Mainly localized in the alveolar wall and interstitium of lungs, not inside the alveoli or the lumen of bronchi.

<sup>7</sup> It's called cold because the test is done under a low temperature

<sup>8</sup> Stick to/ يلتصق

### So how do we differentiate these from other lung diseases like asthma?

We perform a chest x-ray where we will find interstitial pneumonitis and then we can go on and ask the patient more specific questions to know which type of pneumonia we are dealing with like for example if the patient raises birds or not.

#### Mycoplasma pneumonia:

1. This is the **most common form of interstitial pneumonia**; it usually occurs in children and young adults and it **may occur in epidemics**.
2. Onset is more insidious compared to bacterial pneumonia and usually follows a mild, self-limited course.
3. Characteristics include an inflammatory reaction confined to the interstitium, with no exudate in alveolar spaces and intra-alveolar hyaline membranes.
4. **Diagnosis** is by sputum cultures, requiring several weeks of incubation and by complement fixing antibodies.
5. Mycoplasma pneumonia may be associated with non specific agglutinins reactive to red cells. This phenomenon is the basis for a quick and easy laboratory test that can provide early diagnostic information.

### 2. Bronchopneumonia:

**Multifocal and patchy** inflammation of the bronchi and the surroundings of the bronchi. It can affect more than one lobe in the same lung or in both lungs, it can be caused by any organism and may also be secondary to **TB**. This pattern results from an **initial infection** of the bronchi and bronchioles with extension into the adjacent alveoli.

#### Usually, there's a predisposing cause such as:

- Smoking.
- Old age.
- COPD.
- Morbidity.
- Secondary TB.
- Dementia.

#### If you take an alveolar specimen (by BAL for example) you will see:

- 1) Pus.                      2) Neutrophils.                      3) Bacteria.                      4) Macrophages.

**But** if the patient has **TB bronchopneumonia**; you'll see granulomas, epithelioid histiocyte, and caseous necrosis.

### 3. Lobar pneumonia:

- ❑ The contiguous air spaces of part or all of a lobe are homogeneously filled with an **exudate** that can be visualized on radiographs as a lobar or segmental consolidation
- ❑ Lobar pneumonia is often caused by *Streptococcus pneumoniae* (**pneumococci**) and usually affects a single lobe, it's usually community acquired (من المسجد, من دار العجزة من, من المجتمع بشكل عام), and is now rare.
- ❑ It affects **older patients** who have a debilitating<sup>9</sup> disease, have comorbidity (simultaneous presence of two chronic diseases or conditions in a patient), or are immunocompromised.
- ❑ It is characterized by predominantly **intra-alveolar exudate and may involve an entire lobe** of the lung.

#### Signs and symptoms:

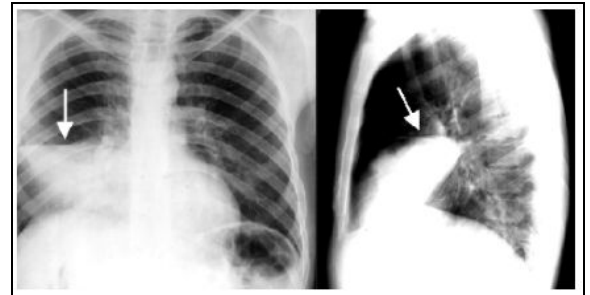
- **Productive rusty brownish cough.**
- **Chest pain.**
- **Chills.**
- **Dyspnea.**
- **High fever.**
- **Hypoxia.**

#### Diagnosis:

- **Increased white blood cell count:**

WBC count will be high, you will also find that polymers are in band form<sup>10</sup> (shift to the left).

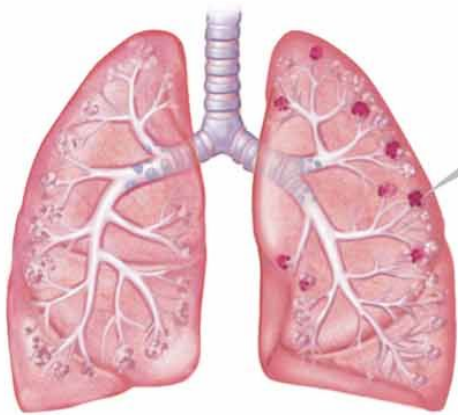
- **X ray:** You'll notice consolidation



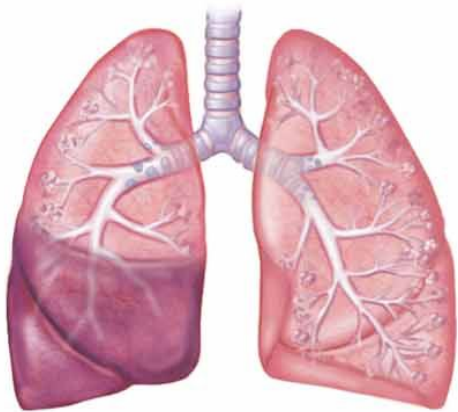
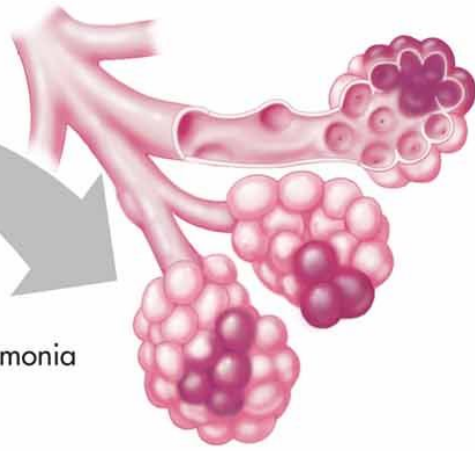
<sup>9</sup> disease that causes weakness

<sup>10</sup> Immature WBC are produced by bone marrow and released to peripheral blood because of the increase demand for them.

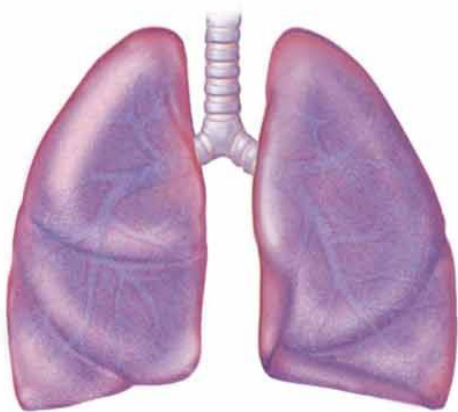
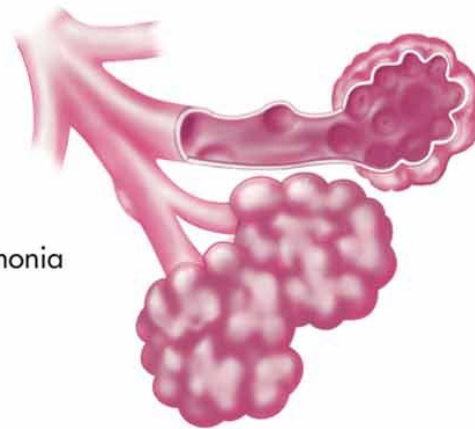




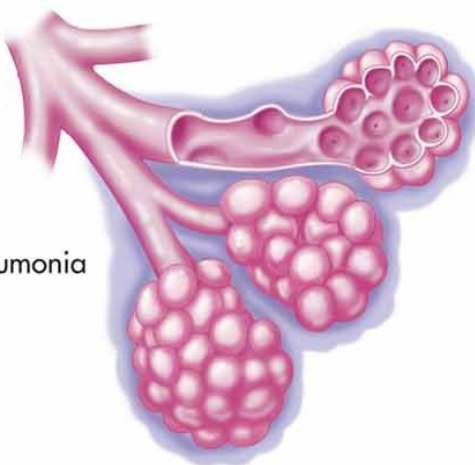
**A.** Bronchopneumonia



**B.** Lobar pneumonia



**C.** Interstitial pneumonia



## Morphologic Variants of Pneumonia: Causative Organisms and Characteristics

### ❑ **Viral pneumonias are the most common type of pneumonia in childhood:**

They may also arise after childhood exanthems (viral eruption) such as rubeola (measles) or varicella (children box); the measles virus produces giant cell pneumonia, marked by numerous giant cells and often complicated by tracheobronchitis.

### ❑ **Rickettsial pneumonias:**

**Q fever** is the most common **rickettsial pneumonia**; it is caused by *Coxiella burnetii*. It may infect persons working with infected cattle or sheep, who inhale dust particles containing the organism, or those who drink **unpasteurized milk** from infected animals.

### ❑ **Pneumocystis carinii pneumonia:**

It's the most common **opportunistic infection in patients with acquired immunodeficiency syndrome (AIDS)**; it also occurs in other forms of immunodeficiency.

- It is caused by *pneumocystis carinii* (recently renamed *Pneumocystis jiroveci*) which is **now classified as a fungus**.
- Diagnosis is by morphologic demonstration of the organism in biopsy or bronchial washing specimens.

### ❑ **Hospital-acquired gram-negative pneumonias:**

- These pneumonias are often fatal and occur in hospitalized patients, usually those with serious, debilitating diseases.
- Causes include many gram-negative organisms, including *Klebsiella*, *Pseudomonas aeruginosa* and *Escherichia coli*. Endotoxins products by these organisms play an important role in the infection.

## Immunocompromised patients:

When you perform a **BAL** test (bronchoscope reaches the lung, fluid is squirted and then recollected for examination) and WBC test, you will find:

- Soap bubble exudate.
- No inflammatory cells.
- You will also notice a decrease in WBC levels.

This is because our patient is **immunosuppressed**.

If you perform a **silver stain**, you'll find an organism called **pneumocystis jiroveci** (fungus); **it's the most common cause of pneumonia in HIV patients**.

Fungal infections **rarely** affect healthy people and are more prone to infect immunocompromised patients (E.g *aspergillus*) and causes fungal bronchopneumonia.

**Pneumonias Caused by other Important Pathogens:**  
**Important Features of Selected Bacterial Pneumonias**

Organism	Characteristics	Complication
<b>Streptococcus pneumonia</b>	Most common in elderly or debilitated patients, especially those with cardiopulmonary disease and malnourished persons	May lead to <b>empyema</b> (pus in the pleural cavity)
<b>Staphylococcus aureus</b>	Often a complication of influenza or viral pneumonias in children and healthy adults or a result of blood-borne infection in <b>intravenous drug users</b> ; seen <b>principally</b> in debilitated hospitalized patients, the elderly, and those with chronic lung disease.	Focal inflammatory exudates or <b>abscess</b> formation frequent; may lead to <b>empyema</b> or to other infectious complications, including bacterial endocarditis and brain and kidney abscesses
<b>Streptococcus pyogenes</b>	Often a complication of influenza or measles.	Lung abscess
<b>Klebsiella pneumonia</b>	Most frequent in debilitated hospitalized patients (gram-negative bacterial pneumonia) and diabetic or alcoholic patients, high mortality rate in elderly patients. Thick and gelatinous sputum is characteristic, which the patient may have difficulty coughing up. □	Considerable <b>alveolar wall damage</b> ; leading to necrosis, sometimes with abscess formation.
<b>Haemophilus influenza</b>	Usually seen in infants and children but may occur in debilitated adults, most often those with COPD.	<b>Meningitis</b> and <b>epiglottitis</b> in infants and children
<b>Legionella pneumophila</b>	Infection from inhalation of aerosol from contaminated stored water most often in air conditioning systems. Common in persons with some predisposing conditions such as cardiac, renal, immunologic, or hematologic disease. <b>Organ transplant recipients are particularly susceptible.</b> □	Can be quite severe requiring hospitalization, immunosuppressed persons may have a fatality rate of 30% to 50%. □
<b>Haemophilus influenzae</b>	Adults at risk for developing infections include those with chronic pulmonary diseases such as chronic bronchitis, cystic fibrosis, and bronchiectasis.  <i>S.pneumoniae, H.influenzae and M.catarrhalis</i> are one of the three most common causes of otitis media (infection of the middle ear) in children. □	<i>Most common bacterial cause of acute exacerbation of COPD</i>

## Pathogenesis:

In the era before antibiotics, pneumococcal pneumonia involved entire or almost entire lobes and evolved through four stages: **congestion, red hepatization, gray hepatization, and resolution**. Early antibiotic therapy alters or halts this typical progression. What happens if it's not treated?

### → **Congestion:**

- ❑ The affected lobe(s) is (are) heavy, red, and boggy.
- ❑ Congested alveolar wall with little exudate and increased vascular permeability.
- ❑ Histologically, vascular congestion can be seen, with proteinaceous fluid, scattered neutrophils, and many bacteria in the alveoli.

### → **Red hepatization:**

In which the lung lobe has a liver-like consistency; excess fibrin and neutrophils within the alveoli.

### → **Grey hepatization:**

The lung is dry, gray, and firm, because the red cells are lysed, while the fibrinosuppurative exudate persists within the alveoli and we can find RBCs, macrophages, and *a little amount of neutrophils (unlike red)*,

### → **Resolution:**

Follows in uncomplicated cases, as exudates within the alveoli are enzymatically digested to produce granular, semifluid debris that is resorbed, ingested by macrophages, coughed up, or organized by fibroblasts growing into it. The pleural reaction (fibrinous or fibrinopurulent **pleuritis**) may similarly resolve or undergo organization, leaving fibrous thickening or permanent adhesions. Meaning very little fibrin, more macrophages, less neutrophils, infection subsides<sup>11</sup>.

## ❑ **In the bronchopneumonic pattern:**

- Foci of inflammatory consolidation are **distributed in patches** throughout one or several lobes, most frequently bilateral and basal.
- Well- developed lesions are slightly elevated and are gray-red to yellow.
- Confluence of these foci may occur in severe cases, **producing the appearance of a lobar consolidation**.
- The lung substance immediately surrounding areas of consolidation is usually hyperemic and edematous, but the large intervening areas are generally normal.
- Pleural involvement is less common than in lobar pneumonia.
- Histologically, the reaction consists of focal suppurative exudate that fills the bronchi, bronchioles, and adjacent alveolar spaces.

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<sup>11</sup> goes away

### **Lung Abscess:**

This is a localized area of suppuration within the parenchyma, usually resulting from bronchial obstruction (often by cancer) or from aspiration of gastric contents; may also be a complication of bacterial pneumonia. necrotizing pneumonia often coexists or evolves into lung abscess, making this distinction somewhat arbitrary.

Frequent causes include *Staphylococcus*, *pseudomonas*, *Klebsiella* or *Proteus*, often in combination with anaerobic organisms.

### **The causative organism may be introduced into the lung by any of the following mechanisms:**

Patients predisposed to the formation of lung abscesses are those who have aspiration by loss of consciousness from alcohol or drug overdose, neurologic disorders, or general anesthesia.

- *Aspiration of gastric contents*, usually accompanied by infectious organisms from the oropharynx.
- *As a complication of necrotizing bacterial pneumonias*, particularly those caused by *S. aureus*, *Streptococcus pyogenes*, *K. pneumoniae*, *Pseudomonas* spp.
- *Mycotic infections* and *bronchiectasis* may also lead to lung abscesses. □
- *Bronchial obstruction*, particularly with bronchogenic carcinoma obstructing a bronchus or bronchiole. Impaired drainage, distal atelectasis, and aspiration of blood and tumor fragments all contribute to the development of abscesses.
- *Septic embolism*, from septic thrombophlebitis or from infective endocarditis of the right side of the heart □
- *Hematogenous spread of bacteria* in disseminated pyogenic infection. This occurs most characteristically in staphylococcal bacteremia and often results in multiple lung abscesses. □
- *Anaerobic bacteria* are present in almost all lung abscesses, sometimes in vast numbers, and they are the exclusive isolates in one third to two thirds of cases.

[The most frequently encountered anaerobes are commensals normally found in the oral cavity, principally species of *Prevotella*, *Fusobacterium*, *Bacteroides*, *Peptostreptococcus*, and microaerophilic streptococci.]

## Pathogenesis:

- ❑ Pulmonary abscesses resulting from **aspiration of infective material** are much more common on **the right side** (with its more vertical airways), and most are **single**.
- ❑ On the right side, they tend to occur in the posterior segment of the upper lobe and in the apical segments of the lower lobe. (Because these locations reflect the probable course of aspirated material)
- ❑ Abscesses that develop in the course of **pneumonia or bronchiectasis** commonly are **multiple, basal, and diffusely scattered**.
- ❑ Abscesses arising from **hematogenous seeding** are commonly **multiple** and may affect **any region** of the lungs.
- ❑ As the focus of suppuration enlarges, it almost inevitably **ruptures into airways**. Thus, the contained exudate may be partially drained, producing an **air-fluid** level on radiographic examination. Occasionally, abscesses rupture into the pleural cavity and produce bronchopleural fistulas, the consequence of which is **pneumothorax or empyema**.
- ❑ On histologic examination, the suppurative focus is surrounded by variable amounts of fibrous scarring and **mononuclear infiltration** (lymphocytes, plasma cells, macrophages), depending on the chronicity of the lesion.

## Clinical Features:

The manifestations of a lung abscess are much like those of bronchiectasis and include:

- **Fever**.
- **Malaise**.
- **Weight loss**.
- **Anemia**.
- **Clubbing of the fingers**.
- A prominent **cough** that usually yields **foul-smelling purulent sputum**.
- Radiographic (chest x-ray) show evidence of a **fluid-filled cavity**.
- Occasionally, **hemoptysis** occurs.
- **Secondary amyloidosis** may develop in chronic cases.

[Infective abscesses occur in 10% to 15% of patients with bronchogenic carcinoma; thus, when a lung abscess is suspected in an older person, underlying carcinoma must be considered.]

Treatment includes antibiotic therapy and, if needed, surgical drainage. Overall, the mortality rate is in the range of 10%.

## Team members

### Special thanks to team 434

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قال صلى الله عليه وسلم: من سلك طريقاً يلتمس به علماً سهل الله له به طريقاً إلى الجنة.  
دعواتنا لكم بالتوفيق.