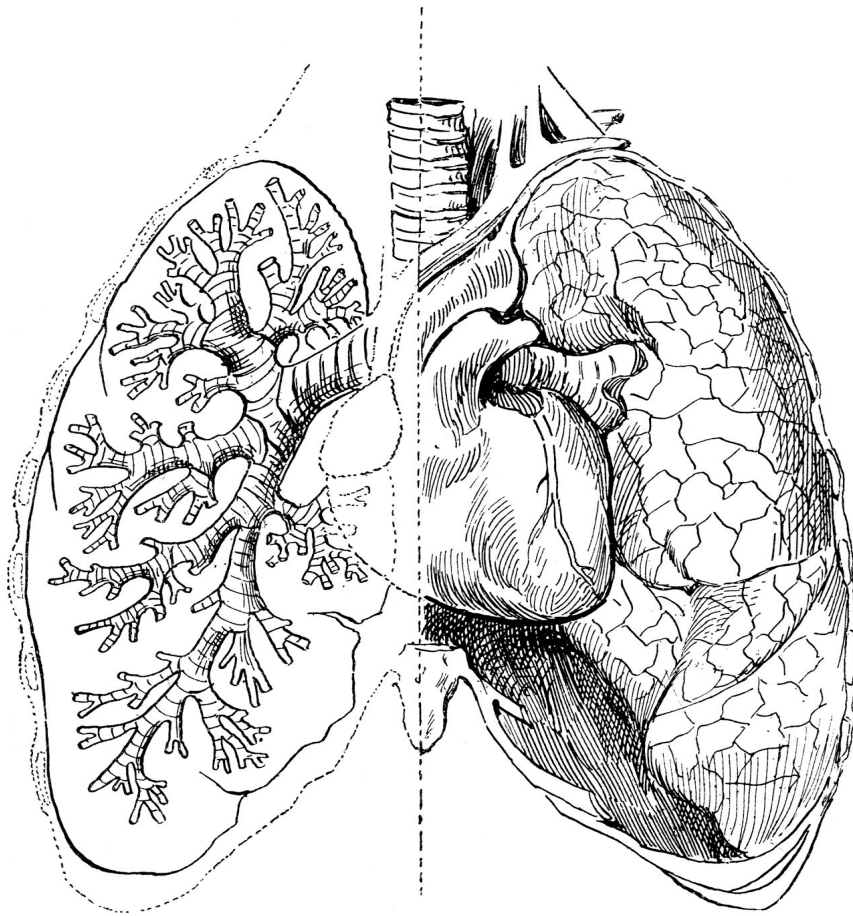


Microbiology

435's Teamwork
Respiratory Block



-
- Please contact the team leaders for any suggestion, question or correction.
 - Pay attention to the statements highlighted in **bold** and/or **red**.
 - **Footnotes color code:** General | **Females** | **Males**.

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Community Acquired Pneumonia (CAP)

- Lecture Six -

Learning Objectives:

- Define the term **pneumonia**.
 - Define community acquired pneumonia (**CAP**) and healthcare associated pneumonia (**HCAP**).
 - Define hospital acquired pneumonia (**HAP**) and ventilator associated pneumonia (**VAP**).
 - Describe their **pathogenesis**.
 - Name their different **causative agents**.
 - Classify them according to the **time of onset**.
 - Classify and describe their **types**.
 - Recognize the ways by which they are **prevented**.
 - Describe their different **chemotherapeutic antimicrobial agents**.
 - Evaluate response to treatment and recognize reasons for **failure of treatment**.
-

Introduction to Pneumonia:

Pneumonia is an infection of the pulmonary parenchyma (the alveoli¹) that causes inflammation, consolidation² and exudation. It is able to infect either one or both of the lungs. Bacteria, viruses, and fungi, are the main causative agents. Pneumonia is not a single disease, which means that it can have more than 30 different causes, unlike TB which is only caused by *Mycobacterium species*. However, well understanding of the different types and causes is essential because that is what the treatment based on. It variates in duration and severity, as it may be present as an acute, fulminant³ clinical disease, or as a chronic disease with more protracted⁴ courses.

First, we will discuss general informations about Pneumonia, then, we will start addressing CAP specifically. If you did not study HCAP yet, we recommend you to study this lecture first.

¹ Tiny sacs that allow oxygen and carbon dioxide to move between the lungs and bloodstream.

² Solidification; the process of becoming solidified.

³ Severe and sudden in onset.

⁴ Lasting for a long time or longer than usual.

Histology:

1. **Fibrinopurulent⁵ alveolar exudate** is seen in acute bacterial pneumonias.
2. **Mononuclear interstitial infiltrates** in viral and other atypical pneumonias.
3. **Granulomas and cavitation** seen in chronic pneumonias.

Epidemiology:

- Overall, the rate of CAP is 5-6 cases/1,000 persons per year.
- Approximate mortality is 23% of clinical cases.
- The incidence of pneumonia is high, especially in old people.
- Almost 1 million annual episodes⁶ of CAP in adults >65 years in the US.

Risk factors:

- **Less than 2 years and more than 65 years of age.**
- **Alcoholism, Smoking.**
- Asthma and COPD (Chronic obstructive pulmonary disease.) / Aspiration.
- Dementia⁷.
- Prior influenza.
- **Immunosuppression, HIV.**
- Institutionalization⁸.
- Travelling and staying in hotels: *Legionella*⁹ bacteria.
- Pets, occupational exposures to birds: *Chlamydophila psittaci*.

Pathogenesis: Two factors are involved in the formation of pneumonia:

- 1) **Pathogens.**
- 2) **Host defenses.**

Defense mechanisms of the respiratory tract:

- Filtration and deposition of environmental pathogens in the upper airways.
- **Cough reflex.**
- **Mucociliary clearance.**
- **Alveolar macrophages.**
- Humoral and cellular immunity.
- Oxidative metabolism of neutrophils.

Pathophysiology:

1. **Inhalation** or aspiration of pulmonary pathogenic organisms into a lung segment or lobe.
2. **Aspiration** of oropharyngeal contents with multiple pathogens¹⁰.
3. **Secondary bacteraemia**¹¹ from a distant source, such as *Escherichia coli* urinary tract infection and/or bacteraemia (less common).

⁵ Pus exudate that contains a large amount of fibrin.

⁶ حالات سنوية.

⁷ A chronic mental disorder marked by memory loss, personality changes, and impaired reasoning.

⁸ The process of committing someone to a facility like prisons and mental hospitals.

⁹ بكتيريا المكيفات المركزية. تعيش في وحدات التكييف خصوصًا في الفنادق وغرف العناية المركزة.

¹⁰ تسبب البكتيريا الأمراض عندما تنتقل من أماكنها الطبيعية غير الضارة كالأنف، الجلد، المهبل.. الخ إلى الأماكن الحساسة كالدماغ، الكبد، الرئة.. الخ.

¹¹ The presence of bacteria in the circulating blood.

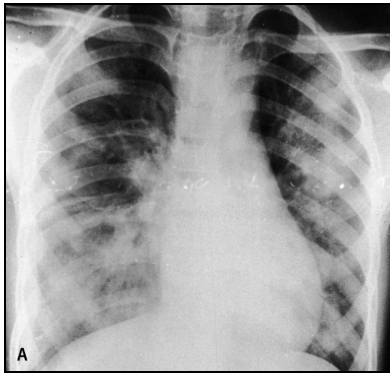
Etiology:

Can be **bacterial, fungal, viral**¹², **parasitic**, or non-infectious like **chemical** and **allergic**.

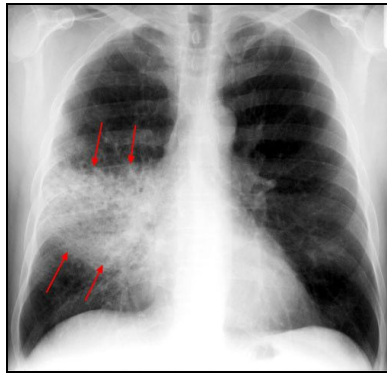
I. Bacterial pneumonia

We classify it according to anatomy, pathogen, or acquired environment.

1) Anatomy:



Bronchopneumonia¹³



Lobar pneumonia¹⁴



Interstitial pneumonia¹⁵

2) Pathogen¹⁶:

Gram-positive bacteria ¹⁷ :	Gram-negative bacteria:	Anaerobic bacteria.
<p><i>Streptococcus pneumoniae</i> (The most common cause of typical pneumonia) (Associated with lobar pneumonia)</p>	<p><i>Klebsiella pneumoniae</i> <i>Haemophilus influenzae</i> <i>Moraxella catarrhalis</i> <i>Escherichia coli</i></p>	-
<p><i>Group A Beta hemolytic streptococci</i> (in children less than 5 years) <i>Staphylococcus aureus</i></p>		

3) Acquired environment:

- **Community** acquired, **hospital** acquired, or **nursing home** acquired.
- **Immunocompromised host**.¹⁸

¹² Most common is bacteria, in children we see viruses, and in immunocompromised fungal and viral.

¹³ Arising in the bronchi or bronchioles.

¹⁴ **(Typical)** Arising in the entire pulmonary lobe.

¹⁵ **(Atypical)** Network of tissue that extends throughout both lungs.

¹⁶ More [here](#) and [here](#).

¹⁷ [Review](#) for +ve and -ve bacteria.

¹⁸ Because all of the bacteria we mentioned are classified as opportunistic normal respiratory flora.

II. Atypical pneumonia¹⁹

- **Legionnaires pneumonia** (*Legionella*).
- ***Mycoplasma pneumoniae*. (most common)**
- *Chlamydia pneumoniae*.
- *Chlamydophila Psittaci*²⁰.
- *Rickettsias*.
- *Francisella tularensis* (tularemia).

III. Fungal pneumonia²¹

- *Candida*.
- ***Aspergillosis***.
- *Pneumocystis jiroveci* (carinii) that causes PCP²².

IV. Viral pneumonia²³

The most common cause of pneumonia in children less than 5 years of age.

- *Respiratory syncytial virus*.
- *Influenza virus*.
- *Adenoviruses*.
- *Human metapneumovirus*.
- *SARS and MERS CoV*.
- *Cytomegalovirus*.
- *Herpes simplex virus*.

V. Other pathogen

- Parasites.
- Protozoa.

VI. Bioterrorism factors²⁴

- *Bacillus anthracis* → Anthrax²⁵.
- *Yersinia pestis* → Plague.
- *Francisella tularensis* → Tularemia.
- *Coxiella burnetii* → Q fever.

¹⁹ Also known as “walking pneumonia”, it is the type of pneumonia that is not caused by a traditional pathogen. Its clinical presentation is different from that of "typical" pneumonia. A variety of microorganisms can cause it. ([here](#))

²⁰ الببغائية. تنتقع عبر طائر الببغاء.

²¹ Study it from Fungal Infection lecture.

²² **P**neumo**C**ystis **P**neumonia.

²³ Study it from Viral Infection lectures.

²⁴ The disease is not itself pneumonia, instead, pneumonia develops within the disease's symptoms.

²⁵ مرض الجمره الخبيثة.

Community Associated Pneumonia (CAP)

Definition:

Pneumonia **acquired outside of hospitals** or extended-care facilities for >14 days before the onset of symptoms. Commonly caused by *Streptococcus pneumoniae*, and **drug resistant streptococcus pneumoniae (DRSP)** is a major concern on this aspect.

It has two types (according to the type of organism):

- I. Typical
- II. Atypical

What is the difference between typical and atypical community-acquired pneumonia?

(Table continues next page)

	Typical ²⁶ CAP	Atypical ²⁷ CAP
Gram Stain	Useful.	Useless (No cell wall to be stained).
Radiography	Lobar infiltrate.	Dramatic changes: Patchy or interstitial .
Penicillin	Sensitive	Resistant ²⁸
Etiology	<i>Streptococcus Pneumoniae</i> <i>Haemophilus influenzae</i> <i>Moraxella catarrhalis</i> <i>Staphylococcus aureus</i> <i>Klebsiella pneumoniae</i>	<i>Chlamydia pneumoniae</i> <i>Mycoplasma pneumoniae</i> <i>Legionella species</i> Psittacosis (parrots) Q fever (<i>Coxiella</i>)
Diagnosis	<ul style="list-style-type: none"> ● History & physical examination. ● X-ray examination ● Lab test : <ul style="list-style-type: none"> - CBC showing leukocytosis. - Sputum Gram stain.²⁹ - Blood culture. - Pleural effusion culture. 	<ul style="list-style-type: none"> ● Serology test. ● X-ray.

²⁶ Usually caused by bacteria.

²⁷ Not detectable on gram stain, Won't grow on standard media.

²⁸ Because Penicillin kill the bacteria by destroying their cell wall.

²⁹ Ciliated columnar epithelium, but in saliva it contains squamous epithelium cells (which is not useful in culture).

Symptoms	<ul style="list-style-type: none"> - The onset is acute. - Fever. - Shaking chills. - Shortness of breath. - Cough with sputum production (rusty-sputum). - Chest pain. - Pleurisy³⁰. 	<ul style="list-style-type: none"> ● Mycoplasma: <ul style="list-style-type: none"> - Otitis. - Nonexudative pharyngitis. - Watery diarrhea. - Erythema multiforme³¹. - Increased cold agglutinin titre³². - Sore throat. - Fatigue. ● Chlamydia: <ul style="list-style-type: none"> - Laryngitis.
	Often intrapulmonary.	Often extrapulmonary.
Treatment	<p>Penicillin or Cephalosporin for β-lactam resistance.</p> <p>We increase the dose (except in meningitis) for MDR³³, we use:</p> <ul style="list-style-type: none"> - Quinolone - Linezolid - Vancomycin 	<p>Do not have a cell wall. Do not respond to β-lactams, so we use:</p> <ul style="list-style-type: none"> - Macrolides - Tetracyclines - Quinolones

After knowing the difference, we will go through some examples of Atypical Pneumonia.

³⁰ Inflammation of the pleurae.

³¹ Hypersensitivity reaction usually triggered by infections. (Skin rash)

³² More about it [Here](#).

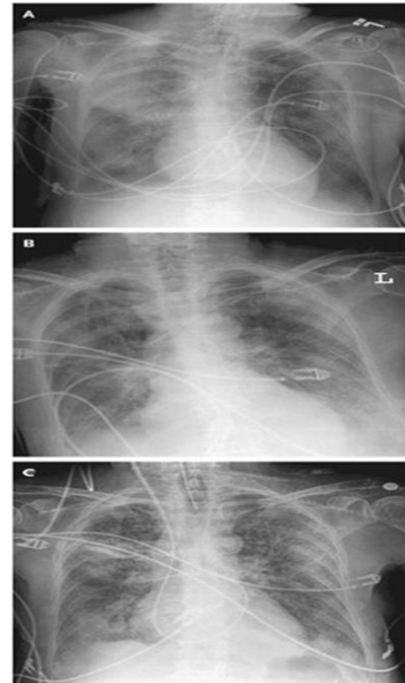
³³ Multidrug resistance.

1- *Chlamydia pneumoniae*

- Obligate intracellular organism.³⁴
- **50% of adults are seropositive.**
- Mild disease.
- Subclinical infections are common. (HCAP)
- 5-10% of community acquired pneumonia.

2- *Mycoplasma pneumoniae*

- Eaton agent (1944).
- **No cell wall.**
- **Common.**
- Rare in children and in >65.
- People **younger than 40.**
- **Crowded places** like schools, homeless shelters, prisons.
- Usually mild and **responds** well to antibiotics.
- Can be very serious.
- May be associated with a **skin rash**, hemolysis, myocarditis or pancreatitis.

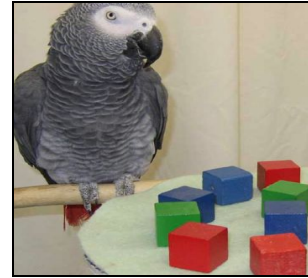


وجه الشبه بين الاثنين: عدم وجود الجدار الخلوي، لا يصيب كبار السن والأطفال، لا يسبب حالات خطيرة (غالبًا).
وجه الاختلاف بين الاثنين (مهم جدًا): المايكوبلازما تسبب طفح جلدي وأمراض في القلب والبنكرياس، بالإضافة لأماكن العدوى.

³⁴ They don't have cell wall.

3- Psittacosis³⁵

- *Chlamydophila psittaci*.
- Exposure to **birds**.
- Bird owners, pet shop employees, vets.
- **Parrots, pigeons** and poultry.
- Birds themselves are often asymptomatic.
- 1st: **Tetracycline**.³⁶
- Alternative: **Macrolide**.



الفرق بينها وبين الكلاميديا في الأعلى أنها تنتقل بوجود البيغاء، بينما الكلاميديا تعتبر من النورمل فلورا في الجسم.

4- Q fever

- *Coxiella burnetti*
- Exposure to farm animals mainly **sheep**.
- 1st: **Tetracycline**.
- 2nd: **Macrolide**.



وجه الشبه بين الاثنين: ينتقلون من الحيوانات للإنسان، نفس طرق العلاج.

³⁵ الناس اذا رجعت من السفر غالبا يحملون هذي الباكثيريا خصوصا لو سافروا القلبيين وتايلاند.

³⁶ If pregnant, use the alternative. If you do not know why, please get back to Pharmacology. [it is a drug of choice](#).

5- Legionella Pneumophila³⁷

- **Causes Legionnaire's disease.**
- Serious **outbreaks** linked to exposure to cooling towers or water.³⁸ (ICU admissions).

Signs and Symptoms

- Hyponatraemia common (<130 mMol).
- WBC <15,000.
- Bradycardia.
- Abnormal Liver Function Test.
- Raised **CPK** (Creatine phosphokinase).
- Acute Renal failure.
- Positive urinary antigen.
- Insidious onset.
- Mild URTI to severe pneumonia.
- Headache / Malaise / Fever³⁹ / Dry cough.
- Arthralgia. (pain in a joint).
- Myalgia.
- Few crackles and rhonchi⁴⁰.

Diagnosis

- CBC.
- Mild elevation WBC.
- **Serology.**
- **Cold agglutinins (Mycoplasma).**
- DNA detection.

Treatment of choice⁴¹

Macrolide (Erythromycin), Rifampicin, Quinolones or Tetracycline.

³⁷ Pneumophila: Pneumo: (Lungs) Phila: (loves the lung) so this type of legionella is in lungs mostly otherwise the other legionella affecting other organs. more than 90% are legionella type 1. also the pipes in the hotels for the AC mostly has legionella so the bacteria will spread to the travellers, also in hospitals they had to change the pipes to avoid the spreading of the bacteria.

³⁸ They found a solution which is raising the temp. of water more than 65 °C but it wasn't effective.

³⁹ Very high fever.

⁴⁰ Coarse rattling respiratory sounds, usually caused by secretions in bronchial airways.

⁴¹ We never treat with B-lactam.

Treat for **10-14** days (**21** in immunosuppressed)

(High temperature + Fever + in ICU) you should think first in *Legionella Pneumophila*.

Drugs Review (will help you summarize)

	Typical	Atypical	pseudomonas	MRSA
Macrolides		✓		
B-lactams	✓			
Antipseudomonal			✓	
Vancomycin				✓
Doxycyclin		✓		
Quinolones	✓	✓		



« قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ »
سورة الزمر الآية ٩

Heartful thanks to Microbiology 435's Team

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