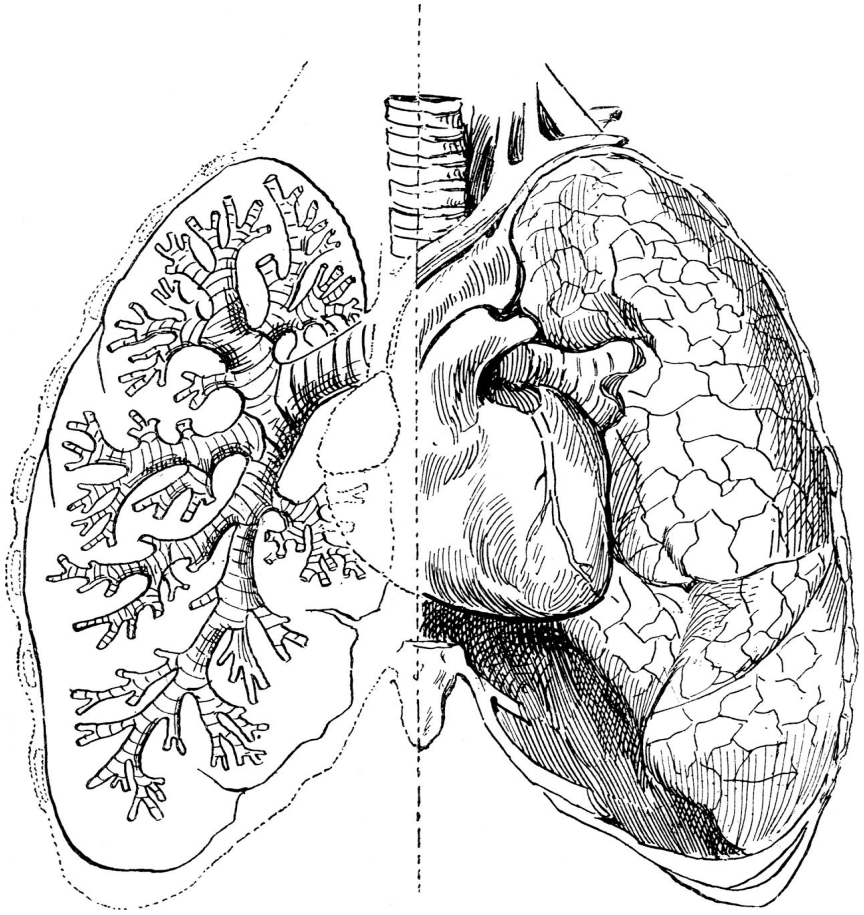
Microbiology

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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Healthcare Associated Pneumonia (HCAP)

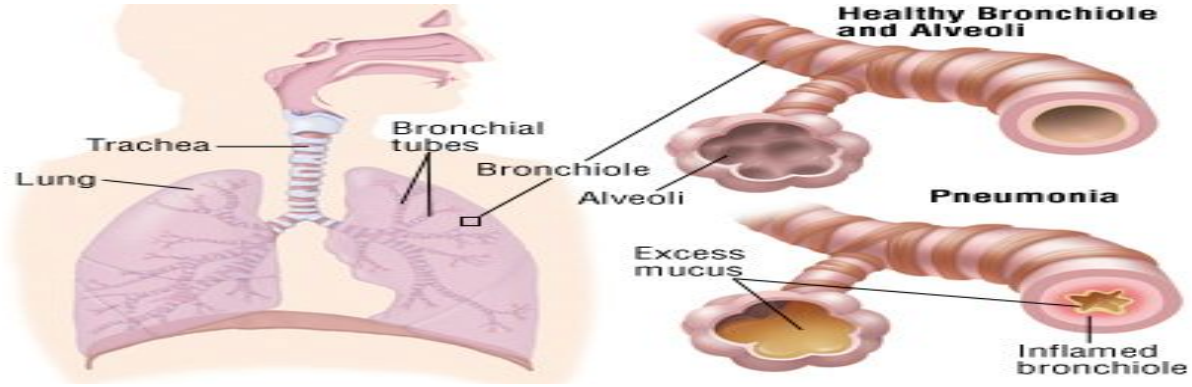
- Lecture Two -

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 is **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 alveoli[1]) that causes inflammation, consolidation[2] 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.



[1] Tiny sacs that allow oxygen and carbon dioxide to move between the lungs and bloodstream.
[2] Solidification; the process of becoming solidified.

It has two types:

- **Community Acquired Pneumonia (CAP)**[3]:
- Acquired in the **community**, by a community acquired organism like *Streptococcus Pneumoniae*. It is usually susceptible (sensitive) to antibiotics. (Easy to treat.)
- **Healthcare Associated Pneumonia (HCAP)**[4]**:**
- Acquired 48-72 hours after admission to a **healthcare institution**. Pneumonia that is caused by organisms in a hospital like *Pseudomonas Aeruginosa*[5] are usually resistant to antibiotics. (Difficult to treat.)[6]

Healthcare Associated Pneumonia (HCAP)

Healthcare associated pneumonia, or "nosocomial[7] pneumonia" is the type of pneumonia that is not already incubated before the time of hospitalization. It is divided into:

- **Hospital Acquired Pneumonia (HAP).**
- **Ventilator**[8] **Associated Pneumonia (VAP).**

[3] Explained in another lecture.

[4] When the patient is admitted to the hospital with pneumonia, this type is community also, to be healthcare associated it has to appear after 48-72 hours AFTER admission.

[5] The strongest bacteria which caused pneumonia are: Pseudomonas Aeruginosa & Acinetobacter.

[6] التفسير المنطقي لمقاومة بكتيريا المستشفيات للمضادات الحيوية يمكن تشبيهه بالفئران. مع التعرض المستمر للسموم المدسوسة بعشوائية من قبل البشر لقتل الفئران، أصبحت هذه الكائنات لا تتأثر بالسم ولا تموت، بل تعيش وتتكاثر وتنتج أجيالاً أكثر مقاومة ووحشية. قس على ذلك أن المضادات الحيوية والمعقمات هي بمثابة السم للبكتيريا، والتعرض المستمر لها بجرعات غير قاتلة في أماكن خصبة كالمستشفيات يولد أجيالاً جديدة محصنة ضد هذه السموم، وهذه من أهم بل وأخطر المشكلات التي تواجهنا في القرن الحادي والعشرين. الموضوع يستحق البحث، لا تبخل على عقلك بالمعرفة.

[7] مرتبط بالمستشفيات. نيمونيا المستشفيات.

[8] Assisted respiration.

I. HAP

Epidemiology:

Nosocomial pneumonia is the second most common hospital-acquired infection after urinary tract infection, accounting for 31% of all nosocomial infections.
The incidence of nosocomial pneumonia is at its **highest** in the ICU (Intensive Care Unit) patients, and ventilated patients are in 10-fold higher risk those who are non-ventilated.
Nosocomial pneumonia is the leading cause of death from hospital-acquired infections, and the reported crude mortality for HAP is 30%-70%.

Pathogenesis[9]:

One of the following three conditions <u>at least</u>[10] is required for pneumonia to occur:
1) Significant impairment (weakness) of the host defenses[11].
2) Introduction of a sufficient-size inoculum[12] that overwhelms the host's lower respiratory tract defenses indirectly.
3) Introduction of highly virulent organisms directly into the **lower respiratory tract**, which is common in micro-aspiration[13] of oropharyngeal[14] secretions[15] that are colonized with pathogenic bacteria.[16]

Classification:

The classification of nosocomial pneumonia is based on its onset duration.

- **Early-onset nosocomial pneumonia:**
- Occurs during the **first 4 days** of admission.
- Usually due to *Streptococcus Pneumoniae*, *MSSA*, *Haemophilus influenzae*, or anaerobes.
- **Late-onset nosocomial pneumonia:**
- Occurs after more than 4 days of admission.
- **Usually due to *MRSA*, or Gram negative organisms, especially:**

1) *Pseudomonas Aeruginosa.*
2) *Acinetobacter.*
3) *Enterobacteriaceae* (*Klebsiella, Enterobacter* and *Serratia*).
4) **VRE:** vancomycin resistant enterococci.

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[9] ICU patients are surrounded by many tubes which contain large number of inoculum "organisms" which invade in his respiratory tract.
[10] The gold standard **for any bacterial infection** is culture.
[11] The patient has diabetes, taking steroids, chemotherapy, or other diseases.
[12] The infective agent which may be vaccinated or introduced to the body.
[13] Inhalation of foreign materials into the lower airways.
[14] الفم و البلعوم.
[15] Secretions gathering while the patient is lying down on ventilation.
[16] Normal nose and throat flora are very dangerous in sterile sites of the body like the deep lungs.

Causative agents:

Enteric[17] Gram negative bacilli (*Enterobacteriaceae)*
Isolated most frequently, particularly in patients with **late-onset** disease as we just mentioned, and in patients with serious underlying disease who are often already on **broad-spectrum**[18] antibiotics[19]. The of broad-spectrum antibiotics, in addition to an **immunocompromised** state make Gram-negative organisms more resistant.
Pseudomonas Aeruginosa* and *Acinetobacter
Common causes of **late-onset**[20] pneumonia as we just mentioned, particularly in the **ventilated** patients.
Staphylococcus Aureus
Isolated in about 20-40% of cases, and is particularly common in: 1) **Ventilated** patients after head trauma, neurosurgery, and wound infection. 2) Patients who had **received** prior antibiotics or prolonged care in ICU.
MRSA
Seen more commonly in patients who: - Received corticosteroids. - Undergone mechanical **ventilation** >5 days. - Presented with a chronic lung disease (Like TB). - Had prior antibiotics therapy.
Anaerobes(bacteroids)
Common in patients predisposed to **aspiration**[21].

[17] الأمعائيات.

[18] **Why broad-spectrum antibiotics?** Because it needs to cover gram +ve & gram –ve.

[19] Antibiotics that act against a wide range of disease-causing bacteria.

[20] If someone **ask you** what is the most common organism in late-onset pneumonia, you have to say Pseudomonas Aeruginosa or Acinetobacter.

[21] Anaerobes do not cause pneumonia in a normal person. So, **why does Anaerobes cause hospital acquired pneumonia?** Because Anaerobes are found as normal flora, so if the patient is in the ICU, especially on the ventilator**,** all lung secretions gather while he's lying down, and he can't cough, this induces the aspiration of Anaerobes deeply in the sterile area of the lung, and that is how it cause pneumonia.

II. VAP

Definition:

Nosocomial pneumonia that has developed in patient who are receiving mechanical ventilation.

Classification:

Just as we previously discussed, the classification is based on the **onset duration.**

- **Early-onset[22]:** Within 48-72 hours after tracheal **intubation**[23], which complicates the intubation process.
- **Late-onset:** After 72 hours.

Pathogenesis[24]:

Requires two important processes:

1) Bacterial colonization[25] of the aerodigestive tract[26].
2) Aspiration of contaminated secretion into the lower airway, which prevents the mechanical clearance by cough and the mucociliary escalator.

Preventation[27]:

Treating the oropharyngeal colonization could prevent VAP. **The oral regimen:**
Topical Gentamicin, Colistin[28], or Vancomycin[29] cream given every 6 hours for 3 weeks.

(Continued next page).

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[22] Both early-onset and late-onset have to be after 2 or 3 days.

[23] The placement of a flexible plastic tube into the trachea (windpipe) to maintain an open airway.

[24] **How does a bacterium cause diseases?** by invasion or toxigen. and it's most common in micro aspiration.

[25] Before infection there should be bacterial colonization, the bacteria colonize the respiratory tract.

[26] Combined organs and tissues of the respiratory tract and the upper part of the digestive tract (lips, mouth, tongue, nose, throat, vocal cords, and part of the esophagus and windpipe.)

[27] How to prevent getting pneumonia? Wipe with typical cholesterol vancomycin swab.

[28] Gentamicin and Colistin cover gram -ve.

[29] Vancomycin covers gram +ve.

Non-pharmacologic strategies:	Pharmacologic strategies:
- Effective hand washing and using of protective gowns and gloves. - Semirecumbent[30] positioning. - Avoidance of large gastric volume. - **Using oral intubation instead of nasal.** - Continuous subglottic suctioning[31]. - Humidification of the surrounding environment with heat and moisture exchanger. - Posture change.	- Stress-ulcer **prophylaxis**. - Combination **antibiotic** therapy. - **Prophylactic**[32] antibiotic therapy. - Chlorhexidine[33] oral rinse. - Prophylactic treatment of neutropenic[34] patients. - **Vaccines**.

III. Treatment of HAP and VAP:

- Most initial therapy is empiric[35] because **no pathogen** is identified or results are not yet available when antimicrobial decisions are made.
- First, we will treat with a broad-spectrum antibiotic regimen to cover all likely bacterial pathogens, after that, the regimen should subsequently be narrowed into a more specific antibiotic according to the bacteria shown in the culture's result.
- The pathogen is influenced by coexisting illnesses, prior treatment, and the length of hospitalization[36].
- The frequency of ICU-acquired *Pseudomonas Aeruginosa* carriage, colonization or infection is 23.4% at 7 days and 57.8% at 14 days. The mortality can be reduced with early appropriate empiric therapy (Form 30% with appropriate therapy to more than 90% with inappropriate therapy.)

Guidelines by American Thoracic Society has divided HAP patients into three groups, each with a set of probable pathogens.

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[30] The head of the bed elevated 45°, this decreases secretion gathering.
[31] Removal of air in order to force fluid into a vacant space or procure adhesion. Vacuuming.
[32] The prevention of infection complications using antimicrobial therapy.
[33] Mouthwash that reduces bacteria in the mouth.
[34] Patients with a low neutrophil count.
[35] Based on experience.
[36] The type of treatment before lab result, depends on doctor expectation.

Group 1	**Mild to moderate with no risk factor.**
Group 2	**Mild to moderate with risk factor.**
Group 3A	**Severe, early-onset with no risk factor.**
Group 3B	**Severe, late-onset or with risk factor.**

For mild-to-moderate HAP
Monotherapy[37] has been shown to be effective.
For severe HAP with resistant organisms
Combination[38] therapy probably should be instituted until culture result are available.
For patients with *Staph. Aureus* infection
Agents against this organism are necessary, including Vancomycin if *MRSA* is suspected. Linezolid[39] is comparable with Vancomycin, nevertheless, one of the main advantages of Linezolid is that it does not cause nephrotoxicity.
For patients with *Pseudomonas Aeruginosa* infection
Combination of antipseudomonal drugs is controversial. 1) Traditional approach: - **Antipseudomonal Beta-lactam** + Aminoglycoside[40]. - **Synergy**[41] but potential nephrotoxicity. 2) Another approach: - **Antipseudomonal Beta-lactam** + Fluoroquinolone[42]. - No **benefit of synergy** but reduces the concern of nephrotoxicity, and quinolone gets into the lungs at higher concentrations.

[37] Vancomycin if it's early.
[38] To cover gram +ve and –ve.
[39] When i can't give the patient Vancomycin, because of renal failure.
[40] Piperacillin + Gentamicin or Ceftazidime + Gentamicin.
[41] Working together to enhance the effectiveness.
[42] Piperacillin + Ciprofloxacin.

IV. Response to therapy:

If no clinical response is noted or deterioration[43] occurs, we need to consider the following:

Infectious causes	Noninfectious events
- Resistant pathogen. - Unusual pathogens. - Superinfection[44]. - Extrapulmonary infection. - Lung abscess.	**Heart:** - Congestive heart failure (CHF). **Lung:** - Fibroproliferative acute respiratory distress syndrome (ARDS[45]). - Pulmonary embolism[46]. - Atelectasis[47].

We will be taking CAP later on.
That lecture goes through "pneumonia" as a particular disease, more precisely than this lecture.

[43] تدهور الحالة.

[44] Infection occurring after or on top of an earlier infection, especially following treatment with broad-spectrum antibiotics.

[45] Severe, acute lung injury.

[46] Sudden blockage in a lung artery.

[47] Partial or complete collapse of the lung.

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

Heartful thanks to Microbiology 435's Team

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