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PNEUMONIA



★ Objectives:

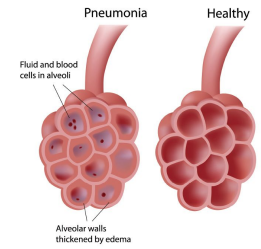
1. Define Pneumonia and be familiar with the possible causative agents.
2. Explain different types of pneumonia with special emphasis on the causative organisms for each.
3. Familiarize with the diagnostic tools and for pneumonia.
4. Identify which patient can be managed as outpatient.

★ Resources Used in This lecture:

Lecture slides, doctor's notes, Master the boards, Step up, Davidson.

What is Pneumonia?

Pneumonia is an acute respiratory illness characterized by inflammation of the parenchyma of the lung (**alveoli**). Abnormal alveolar filling with fluid causing **air space disease** (**consolidation and exudation**).



Types of pneumonia (The context in which it develops is highly indicative → organism)

	Community-acquired pneumonia (CAP)	Hospital-acquired pneumonia (HAP)
Definition	Pneumonia occurring before hospitalization or within the first 48 hours of hospital admission.	New episode of pneumonia occurring at least 2 days (≥ 48 hours) after admission to hospital.
Types	<ul style="list-style-type: none"> • Typical • Atypical 	<ul style="list-style-type: none"> • Healthcare-associated pneumonia (HCAP) • Ventilator-associated pneumonia (VAP)

Pathogenesis.

Inhalation, aspiration and hematogenous & direct extension are main mechanisms by which bacteria reaches the lungs.

Primary inhalation	Aspiration
<p>When organisms <i>bypass</i> normal respiratory defense mechanisms (e.g cilia, coughing, nose hair, humidification of respiratory tract) or when the patient inhales aerobic gram negative organisms that colonize the upper respiratory tract or respiratory support equipment.</p> <p>Most causative organisms: TB, viruses, Legionella.</p>	<p>Entry of material from the oropharynx or gastrointestinal tract into the lower respiratory tract:</p> <ul style="list-style-type: none"> • Pharyngeal -upper respiratory tract- secretions. • Food or drink. • Stomach contents - stomach is reservoir of GNR that can ascend, colonizing the respiratory tract. <p>(normally the patient will cough to remove the pathogen/fluids from respiratory tract, but if the patient becomes unconscious, or he is having seizures he will not be able to cough)</p> <p>Most causative organisms:</p> <ul style="list-style-type: none"> ○ Microaspiration from nasopharynx: <u>S. Pneumonia</u>. ○ Anaerobes
Hematogenous	Direct extension
<p>Originate from a distant source and reach the lungs via the bloodstream.</p> <p>E.g: Staph endocarditis, septic emboli.</p>	<p>Caused by trauma</p>

Community-acquired pneumonia (CAP)

Typical CAP

PRESENTATION

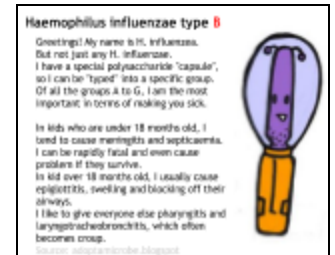
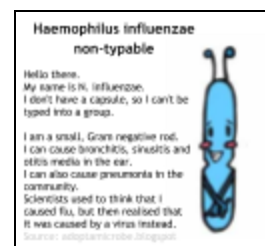
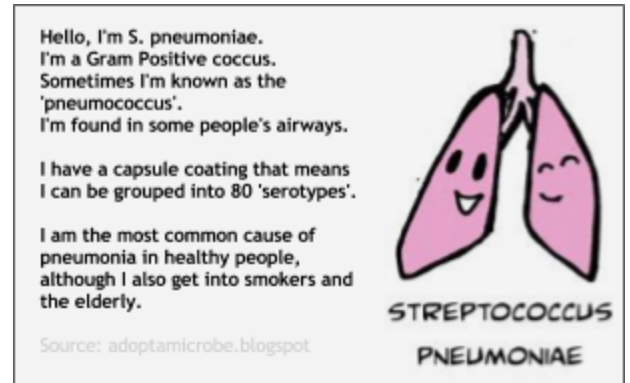
Symptoms

- Fever **and shaking chills**
- **Cough productive** (thick, purulent sputum)
- Pleuritic chest pain (**suggests pleural effusion**)
- Dyspnea

Sings

- Tachycardia, tachypnea
- Late inspiratory crackles, bronchial breath sounds, increased tactile and vocal fremitus
- Dullness on percussion
- Pleural friction rub (**associated with pleural effusion**)

Causative organism



organism	Risk factors	Association
S.Pneumoniae (most common)	<ul style="list-style-type: none"> - Splenectomy (Asplenia). - Sickle cell . - Hematologic diseases. - Smoking. - Bronchial Asthma and COPD. - HIV. 	Purulent sputum
H.Influenzae (second most common)	<ul style="list-style-type: none"> - COPD -Smoker hemoptysis influenzae. -Secondary infection on top of Viral disease, immunosuppression, splenectomy patients 	-
Klebsiella	<ul style="list-style-type: none"> - Diabetes - alcohol 	<ul style="list-style-type: none"> - Hymptisis - Currant jelly sputum
Anaerobic	<ul style="list-style-type: none"> - Aspiration , - poor dentition 	- Foul smelling sputum (rotten eggs)
S.Aureus	<ul style="list-style-type: none"> - Recent viral infection (influenza) 	-

Atypical CAP

- Refers to organisms not visible on Gram stain and not culturable on standard blood agar.
- Not Common in CAP



Why atypical organisms are not detectable on gram stain under gram stain?

Atypical organisms don't have cell wall that's why they don't appear under the gram stain & they don't grow in standard media.

PRESENTATION

Symptoms

- Insidious onset—**headache, sore throat**, fatigue, myalgias (present like viral infection).
- **Dry cough** (no sputum production)
- Fevers (chills are uncommon)

Sings

- Pulse-temperature dissociation—normal pulse in the setting of high fever is suggestive of atypical CAP.
- Wheezing, rhonchi, crackles

Causative organism

Organisms	Risk	Association
Mycoplasma pneumoniae (commonest)	Young ,Healthy patients.	Bullous myringitis
Chlamydia pneumoniae	-	Hoarseness.
Legionella spp.	Old, Smoker, contaminated water sources, air condition, ventilation systems.	GI or CNS symptoms.
Coxiella burnetii (Q fever)	Animals at time of birth , Farmers	(Q fever)
Pneumocystis jiroveci (PCP)	AIDS with <200 CD4 cells	-
Chlamydia psittaci	Birds	-
Viruses: influenza virus (A and B), adenoviruses, parainfluenza virus, RSV.	Not specified	-

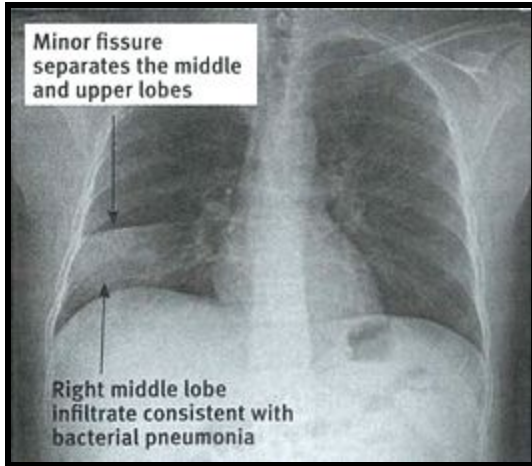


Atypical CAP often extrapulmonary manifestations (Unlike Typical CAP,) such as :

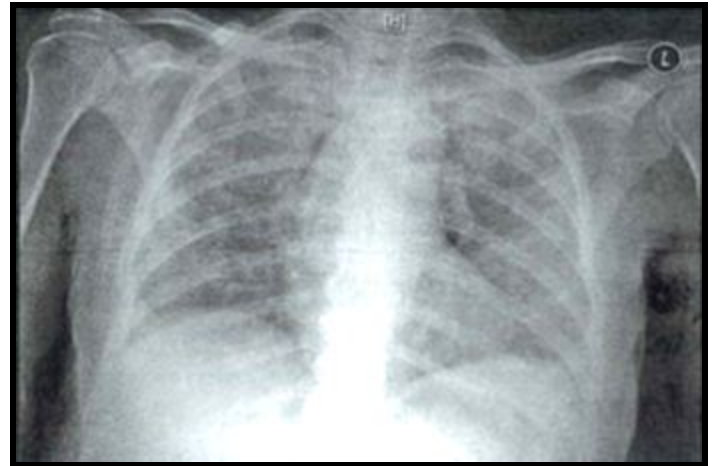
- **Mycoplasma:** otitis, nonexudative pharyngitis, watery diarrhea, erythema multiforme, increased cold agglutinin titre.
- **Chlamydia:** laryngitis.

Diagnosis of CAP

- ❑ **History and Physical examination** : To differentiate is it upper or lower respiratory tract infection
- ❑ **CXR(lateral and PA)** : Differentiate between pneumonia and acute bronchitis
- **Acute Bronchitis** → Normal
- **Atypical Pneumonia** → Diffuse reticulonodular (interstitial) infiltration
- **Typical Pneumonia** → Either lobar consolidation or Multilobar consolidation



Right middle lobe infiltrate characteristic of bacterial pneumonia.



Interstitial infiltrates leave the air space empty. This chest x-ray can be consistent with PCP, Mycoplasma, viruses, and Chlamydia.

- ❑ **Sputum Gram stain and Culture** : To determine specific organism of typical Pneumonia
- ❑ **Blood culture**
- ❑ **Specific diagnostic test** :

Organisms	Diagnostic test
Mycoplasma pneumoniae (commonest)	Cold agglutinin , PCR,Serology, Special culture media.
Chlamydia pneumoniae	Rising serological titre.
Legionella spp.	Urine antigen , culture.
Coxiella burnetii (Q fever)	Rising serologic titers.
Pneumocystis jiroveci (PCP)	Bronchoalveolar lavage (BAL).
Chlamydia psittaci	Rising serologic titers.
Viruses: influenza virus (A and B), adenoviruses, parainfluenza virus, RSV.	Not specified

- ❑ **Bronchoscopy and thoracentesis** → unclear etiology + patient doesn't respond to treatment



- History of Nasal discharge, sore throat or ear pain → upper respiratory tract infection.
- CXR: Best initial test for all respiratory infection + **Gold standard** test for pneumonia
- Patient suspected to have pneumonia should get laboratory test such as ABG, CBC, BUN, CR, O₂ saturation and urea/electrolytes → to assess severity
- After diagnosing a patient with pneumonia, you should decide whether the patient is going to be treated as an inpatient or outpatient, and whether the inpatient will be in the medical ward or in the intensive care unit (ICU), **based on the severity of the disease not organism.**

Management Of CAP

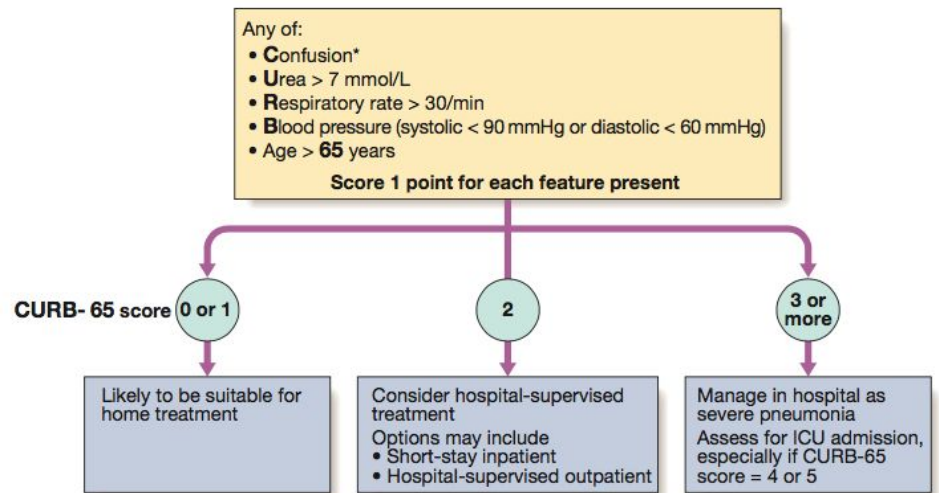
☐ Outpatient or Inpatient?

★ **CURB-65:** 5 indicators of increased mortality:

- Confusion
- BUN (Blood urea nitrogen) >7
- RR >30
- SBP <90 or DBP <60
- age ≥ 65

★ **Mortality risk:**

- 2 factors = 9%
- 3 factors = 15%
- 5 factors = 57%



☐ Medical floor or ICU?

1 major or **3 minor** criteria¹ = severe CAP → ICU

Major criteria	Minor criteria	
1- Invasive ventilation 2- septic shock on pressors	1- RR >30 2- multilobar infiltrates 3- confusion; BUN >20 4- WBC <4,000 5- Platelets <100,000	6- Temp <36 7- hypotension requiring aggressive fluids 8- PaO ₂ /FiO ₂ <250

¹ No prospective validation of these criteria.

Empiric Therapy

Empiric Tx		
Out-Patients	Healthy & non Antibiotic past 3 months	Macrolides (azithromycin or clarithromycin) or doxycycline
	Comorbidity or Antibiotic past 3 months	Fluoroquinolones (levofloxacin or moxifloxacin)
Continuous 5 days, stop when patient is afebrile for 48 hours		
In-Patient	Fluoroquinolones (levofloxacin or moxifloxacin) Or Ceftriaxone and azithromycin	



Pearls of CAP Inpatient Therapy.

- Give 1st dose Antibiotics in ER (no specified time frame)
- Switch from IV to oral when pts are hemodynamically stable and clinically improving.
 - E.g.: When WBC become near normal, fever became normal, pts is able to eat.. etc
- **Discharge from hospital:** As soon as clinically stable, off oxygen therapy, no active medical problems.
- Duration of therapy is usually 7-10 days: Treat for a minimum of 5 days
- **Before stopping therapy:** afebrile for 48-72 hours, hemodynamically stable, RR <24, O2 sat >90%, normal mental status
- Treat longer if initial therapy wasn't active against identified pathogen; or if complications (lung abscess, empyema)

S. Pneumonia Prevention:

There are 2 types of vaccines.

Pneumococcal conjugate vaccine (PCV7) & (PCV13)	Pneumococcal polysaccharide vaccine (PPSV) 23 serotypes of Streptococcus
Works against 13 serotypes of pneumococcus	Works against 23 serotypes of pneumococcus
Given to pts with special conditions (hematological malignancies, steroids) because it is more immunogenic = better antibody response, then it is followed by PPSV to cover the other 10 stereotypes.	Recommended (routine vaccination) for those over the age of 65

You must give one of them for both children and adults in special risk categories:

- Serious pulmonary problems, eg. Asthma, COPD
- Serious cardiac conditions, eg., CHF
- Severe Renal problems
- Long term liver disease
- DM requiring medication
- Immunosuppression due to disease (e.g. HIV or SLE) or treatment (e.g. chemotherapy or radio therapy, long-term steroid use)
- Asplenia



Hospitality acquired pneumonia (HAP)

Healthcare-associated pneumonia (HCAP)	Ventilator-associated pneumonia (VAP)
Pneumonia that develops within 48 hours of admission in patients with: <ul style="list-style-type: none"> - Hospitalization in acute care hospital for ≥2 days in past 90 days. - Residence in nursing home or long-term care (LTC) facility. - Chronic dialysis within 30 days - Home IV therapy, home wound care in past 30 days. - Family member with (Multi-drug resistance)MDR pathogen. 	pneumonia \geq 48 hours after intubation Mechanical ventilation which interfere with normal mucociliary clearance of the respiratory tract such as ability to cough.

Causative organism

- E.coli (most common)
- Pseudomonas (most common)
- Staphylococcus Aureus

Treatment One of the following drugs.

- 1- Antipseudomonal caplaspitnes : cefepime or ceftazidime
- 2- Antipseudomonal penicillins : piperacillin / tasopactem
- 3- Antipseudomonal Carbapenems : imipenem , meropenem or doripenem



- Pseudomonas usually **associated with Structural lung abnormality (bronchiectasis)** (question in Exam)
- **Macrolides not used in HAP as emric therbay**

Ventilator Associated pneumonia

Findings: New infiltrate by CXR + purulent secretion from endotracheal tube+ fever + \uparrow WBC.

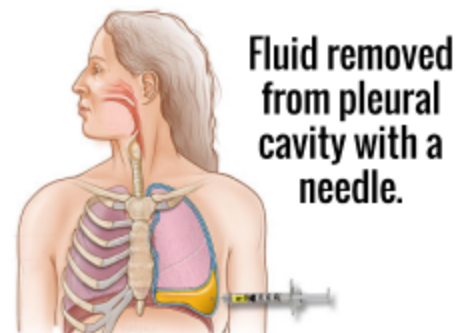
Diagnosis: Bronchoalveolar lavage but most accurate is lung biopsy.

Treatment: Combination of the following three different drugs.

- 1- Antipseudomonal beta-lactam \rightarrow Cephalosporins or penicillin or carbapenem,
- 2- Second antipseudomonal agent \rightarrow Aminoglycosides or fluoroquinolones
- 3- Methicillin- resistant antistaphylococcal agent \rightarrow Vancomycin or linezolid

Complications of Pneumonia.

- Bacteremia
- Respiratory and circulatory failure
- Pleural effusion (Parapneumonic² effusion) :most of cases is uncomplicated removed by antibiotic of pneumonia , but if it more than 1 cm always do thoracentesis and send the fluid for (Gram stain , culture PH , cell count , protein , glucose , LDL levels
- Pleural empyema (infrequent) Always needs drainage by chest tube
- abscess.



² Next to the pneumonia, it is not necessarily empyema but you call it empyema when PH < 7.

Summary

Asplenia	Pneumococci, H. influenzae
Alcoholism	Pneumococci, oral anaerobes, Klebsiella pneumoniae , Acinetobacter, MTB
COPD/ smoking	H. influenzae , Pseudomonas (more in bronchiectasis), Legionella, Pneumococci, Moraxella catarrhalis, Chlamydomphila pneumoniae
Aspiration	Klebsiella, E. Coli, oral anaerobes
HIV	Pneumococci, H. influenzae, P. aeruginosa, Mycobacterium TB , Pneumocystis carinii pneumonia ³ (PCP), Crypto, Histo, Aspergillus, atypical mycobacteria
Recent hotel, cruise ship	Legionella : may present with gastrointestinal symptoms (abdominal pain, diarrhea) or CNS symptoms such as headache and confusion.
Structural lung disease (bronchiectasis)	Pseudomonas, Burkholderia cepacia, Staph aureus
ICU, Ventilation	Pseudomonas, Acinetobacter

MCQ's.

A 65-year-old woman is admitted to the hospital with CAP. Sputum Gram stain shows Gram-positive diplococci but the sputum culture does not grow a specific organism. Chest x-ray shows a lobar infiltrate and a large effusion. She is placed on ceftriaxone and azithromycin. Thoracentesis reveals a marked elevated LDH and protein level with 17,000 white blood cells per Blood cultures grow Streptococcus pneumoniae with a minimal inhibitory concentration (MIC) to penicillin less than 0.1 Her oxygen saturation is 96% on room air. Blood pressure is 110/ 70, temperature is 102•F, and pulse is 112 per minute. What is the most appropriate next step in the management of this patient?

- Repeated thoracentesis
- Placement of chest tube for suction
- Add ampicillin to treatment
- Place patient in intensive care unit
- Consult pulmonary

Answer: B. Infected pleural effusion or empyema will respond most rapidly to drainage by chest tube or thoracostomy. A large effusion acts like an abscess and is hard to sterilize. Each side of the chest can accommodate 2 to 3 liters of fluid. There is no benefit of adding ampicillin to ceftriaxone. A low MIC to penicillin automatically means that the organism is sensitive to ceftriaxone and, in fact, all cephalosporins. There is no need to be in the ICU just because of an effusion or for chest tube drainage. The patient is not unstable and, despite the effusion, has no evidence of instability because her pulse is only mildly abnormal and the blood pressure and pulse oximeter are normal. Pulmonary consultation will not add anything, although it may be commonly done in practice.

³ Also known as *Pneumocystis jiroveci* pneumonia (PJP)