



# Community acquired Pneumonia

## ● Objectives:

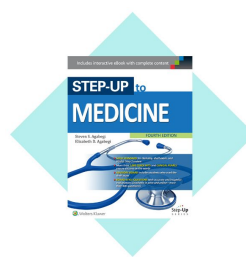
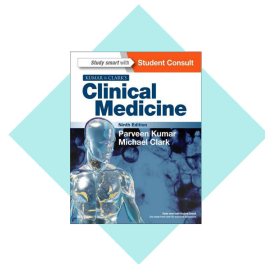
- Define Pneumonia and be familiar with the possible causative agents.
- Explain different types of pneumonia with special emphasis on the causative organisms for each.
- Familiarize with the diagnostic tools and for pneumonia.
- Identify which patient can be managed as outpatient.

[ Color index : **Important** | **Notes** | Extra ]

## ● Resources:

- 435 slides

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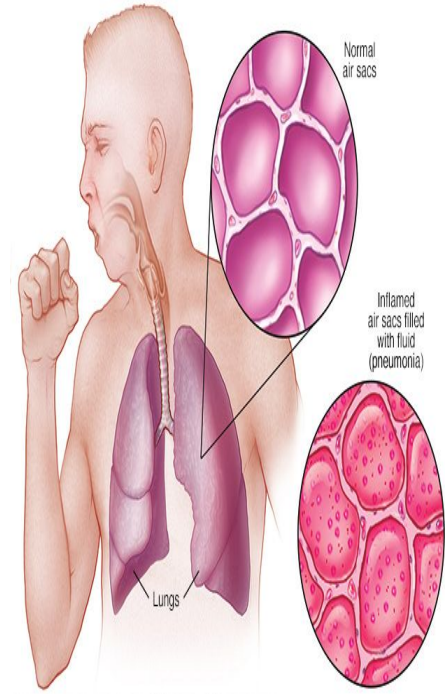


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- Revised by:

"Medicine is an art, nobody can deny it."

● **Pneumonia:**

- **Pneumonia** is an inflammatory condition of the lung characterized by **inflammation of the parenchyma** of the lung (alveoli) where **abnormal alveolar filling with fluid** causing **air space disease (consolidation and exudation)**.
- **Clinically** it usually presents as an **acute illness** with **cough, purulent sputum and fever** together with physical signs or radiological changes compatible with consolidation of the lung.



● **Epidemiology:**

- ❖ Unclear as population-based statistics on the condition alone are few.<sup>1</sup>
- ❖ Pneumonia & influenza = 6<sup>th</sup> leading causes of death in the world.
- ❖ **Single most common cause of infection-related mortality.**
- ❖ Age-adjusted death rate = 22 patient per 100,000 population per year.
- ❖ Mortality rate: 1-5% out-patients, 12% In-patients, 40% ICU.
- ❖ Death rates increase with comorbidity and age.
- ❖ Affects race and sex *equally*.

● **Pathogenesis:**

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 organisms that colonize the upper respiratory tract or respiratory support equipment (<i>intubation</i>).</p> <p>Most common causative organisms:</p> <ul style="list-style-type: none"> <li>→ TB.</li> <li>→ Viruses.</li> <li>→ Legionella.</li> </ul>	<p>Entry of colonized material from the <b>oropharynx</b><sup>2</sup> or stomach into the lower respiratory tract:</p> <ul style="list-style-type: none"> <li>❖ Secretions.</li> <li>❖ Food or drink.</li> <li>❖ Stomach contents.</li> </ul> <p>Most common causative organisms:</p> <ul style="list-style-type: none"> <li>→ <b>Nasopharynx:</b> <i>Streptococcus Pneumoniae</i>.</li> <li>→ <b>Stomach</b><sup>3</sup>: reservoir of GNR<sup>4</sup> anaerobes that can ascend, colonizing the respiratory tract.</li> </ul> <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>
Hematogenous spread	Direct Extension
<p>Originate from a distant source and reach the lungs <b>via the bloodstream</b>.</p> <p>E.g: Staphylococcus Aureus (septic emboli) <b>usually happens to endocarditis patients when a heart valve shoots a septic emboli (full of bacteria) that travels through the bloodstream reaching the lung causing pneumonia.</b></p>	<p>Direct trauma.</p>

<sup>1</sup> They lumped up pneumonia and influenza together in statistics that is why it is unclear.

<sup>2</sup> Majority of the organisms that cause CAP are normal inhabitants of the pharynx, this happens in the presence of tracheo-esophageal fistula or during sleep "impaired consciousness.

<sup>3</sup> produce an **extremely severe** and sometimes fatal illness owing to the intense destructiveness of gastric acid.

<sup>4</sup> Gram negative rods.

• **Types of Pneumonia:**

	Community Acquired Pneumonia (CAP)	Hospital-Acquired Pneumonia (HAP)
Timing	Occurs in the community or <b>within the first 48 hours</b> of hospitalization.	New episode of pneumonia occurring at least 2 days ( <b>&gt; 48 hours</b> ) after hospital admission.
Types	<ul style="list-style-type: none"> <li>→ <b>Typical.</b></li> <li>→ <b>Atypical.</b></li> </ul>	<p>→ <b>Healthcare-associated pneumonia (HCAP)</b></p> <p>Develops <b>within 48 hours</b> of admission in patients with: It's still not CAP as you have to be exposed to one of the risk factors below.</p> <ul style="list-style-type: none"> <li>❖ Hospitalization in <b>any hospital or</b> acute care for <b>≥ 2</b> days in the past 90 days.</li> <li>❖ Residence in Nursing Home or LTC<sup>5</sup> facility.</li> <li>❖ Chronic dialysis within 30 days.</li> <li>❖ Home IV therapy in the past 30 days.</li> <li>❖ Home wound care in the past 30 days.</li> <li>❖ Family member with a MDR<sup>6</sup> pathogen.</li> </ul> <p>→ <b>Ventilator-associated pneumonia (VAP)</b></p> <p>Develops <b>within ≥ 48 hours</b> after intubation.</p>
	<ul style="list-style-type: none"> <li>- CAP usually caused by a <u>single organism</u></li> <li>- Even with extensive diagnostic testing, most investigators cannot identify a specific etiology for CAP in ≥ 50% of patients.</li> <li>- Caused by a variety of Bacteria, Viruses, Fungi</li> </ul>	

The etiological agents for CAP are divided into two groups: **Typical and Atypical** according to whether the organism has a cell wall or not. Gram stain is a pigment that dyes the organism's cell wall, and  $\beta$ -Lactams (Penicillins, Cephalosporins, Monobactams and Carbapenems) are a group of antibiotics that kill the organism by attacking its cell wall. Consequently, atypical organisms are marked by their inability to be identified by gram stain, and their resistance to  $\beta$ -Lactams; but that does not necessarily mean that all typical organisms will be sensitive to  $\beta$ -Lactams. Haemophilus Influenzae (gram negative coccobacilli that is one of CAP's typical causative organisms) for example, is able to produce an enzyme "Beta-Lactamase" that inactivates the antibiotic causing resistance. Treatment of atypical organisms requires antibiotics that penetrate the cell and interfere with bacterial protein synthesis, such as macrolides, tetracyclines, quinolones. Finally, typical organisms tend to cause prominent intrapulmonary symptoms e.g. cough and chest pain, meanwhile atypical organisms often cause extrapulmonary symptoms e.g. otitis media and laryngitis, making atypical pneumonia a diagnostic challenge.

Typical Organisms of CAP		Atypical Organisms of CAP	
<i>Streptococcus Pneumoniae</i>	<i>Haemophilus Influenzae</i>	<i>Mycoplasma Pneumoniae</i>	<i>Chlamydothila Pneumoniae</i>
<i>Klebsiella Pneumoniae</i>	<i>Staphylococcus Aureus</i>	<i>Legionella</i>	<i>Coxiella Burnetii</i>
<i>Pseudomonas Aeruginosa</i>	<i>Acinetobacter</i>	<i>Pneumocystis jiroveci</i>	<i>Chlamydia psittaci</i>
Anaerobics		<i>Francisella Tularensis</i>	<b>Viral CAP</b>

<sup>5</sup> Long-term care facilities.

<sup>6</sup> multidrug-resistant organisms.

# Streptococcus Pneumoniae

- **Organism:**

Gram positive diplococci.

- **Prevalance:**

**Most common cause of CAP!!**

- **Symptoms:**

Malaise, shaking chills<sup>7</sup>, fever, rusty sputum, pleuritic chest pain and cough (**Typical symptoms**).

- **Findings:**

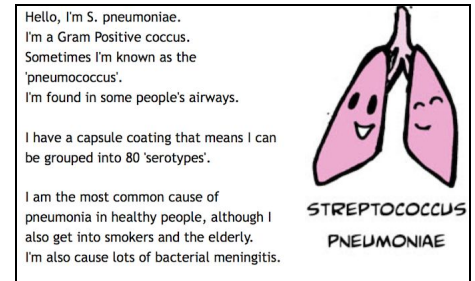
- **Lobar infiltrate on X-Ray.**
- **Purulent sputum.**

- **Pathogenesis:**

25% bacteremic (via blood).

- **Risk Factors:**

- **Splenectomy (Asplenia).** Why? encapsulated organisms like *S. Pneumoniae* and others are phagocytosed in the spleen. That is why we demonstrate a vaccine against these organisms 2 weeks prior to any elective splenectomy.
- Sickle cell disease, or hematologic diseases. Why? Click [here](#) to know.
- HIV.
- Bronchial Asthma and COPD.
- Smoking.
- Ethanol consumption.



- **Prevention:**

Pneumococcal conjugate vaccine (PCV)	Pneumococcal polysaccharide vaccine (PPSV)
13 serotypes of <i>Streptococcus</i>	23 serotypes of <i>Streptococcus</i>
Used to protect infants and young children.	For both children and adults <b>in special risk categories</b> of serious problems like: <b>Should be used</b> Pulmonary (COPD, Asthma), Cardiac (CHF), Severe Renal problems, Liver failure, DM, Immunosuppression (due to disease: HIV or SLE) or (due to treatment: Chemotherapy, radio therapy, or long-term steroids), Asplenia

- **Specific treatment:**

Guided by sensitivity test.

1. If sensitive to Penicillins: give **Penicillin G**. Resistant? ↓
2. If sensitive to Cephalosporins: give **Ceftriaxone**. Resistant? ↓
3. If sensitive to Macrolides: give **Azithromycin**. Resistant? ↓
4. If sensitive to Fluoroquinolone (FQ): give **Levofloxacin**.
5. If the organism shows **high Penicillin Resistance**, it is likely to be resistant to all of the above.  
Instead: give **Vancomycin**.

<sup>7</sup> Classic CAP presents with sudden chills followed by fever, pleuritic pain and cough

# Haemophilus Influenzae

- **Organism:**

Nonmotile Gram negative rods.

Has many serotypes (from A to F).

**HIB** has a capsule made of a polymer of Polyribosylribitol Phosphate (PRP) that is able to cause acute life threatening invasive infections. The capsule allows them to resist phagocytosis and complement mediated lysis in the **nonimmune** host.

- **Pathogenesis:**

Secondary infection on top of Viral disease.

- **Risk Factors:**

- COPD<sup>8</sup>
- Smoking.
- Immunodeficiency. .
- Splenectomy.

- **Prevention:**

HIB conjugate vaccine.

- **Specific treatment:**

Guided by sensitivity test.

- Amoxicillin + Clavulanic Acid (Augmentin).
- Ceftriaxone, Fluoroquinolones (FQ), or Trimethoprim sulfamethoxazole (TMP-SMX).

# Pseudomonas Aeruginosa

- **Risk Factors:**

- Rare in previously healthy patients.
- **Immunocompromised patients** (HIV, solid organ or bone marrow transplant, neutropenic, chronic oral steroids).
- Alcoholics.
- Frequent prior antibiotic use.
- Recent hospital admission.
- **Structural lung abnormalities (MCQ)!!**
  - Cystic fibrosis, bronchiectasis, *severe* COPD.
  - Prophylaxis with tobramycin nebs (antibiotic inhaler).

- **Diagnosis:**

Gram stain and sputum culture (if good quality) is usually adequate to exclude the need for empiric coverage.

- **Treatment:**

- **Ceftazidime**. It is the drug of choice
- **Cefepime, Piperacillin/Tazobactam (Pip/Tazo), Amikacin, Tobramycin, Aztreonam, Ciprofloxacin, Carbapenems, or Polymyxin B.**

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<sup>8</sup> frequent cause of exacerbation of chronic bronchitis and can cause pneumonia in COPD patients.

# Acinetobacter

- **Risk Factors:**

- In CAP:**

- Alcoholics.
- Smoking.
- Chronic lung disease.
- DM.
- Residence in tropical developing country.

- In HAP & VAP:**

- Admission to burns unit or ICU.
- **Mechanical ventilation.** Number 1 cause of VAP in KSA
- Length of hospital stay.
- Surgery.
- Wounds.
- Previous infection (independent of previous Abx use).
- Fecal colonization with *Acinetobacter*.
- Treatment with broad spectrum antibiotics.
- Indwelling central intravenous or urinary catheters.
- Parenteral nutrition.

- **Treatment:**

**Polymyxin B** (colistin) or **Tigecycline**.

# Coxiella Burnetii (Q-Fever)

- **Epidemiology:**

**Epidemic** in Middle east, recent large outbreaks in Iraq, and Occupied territories (Israel).

- **Risk Factor:**

Exposure to **farm animals or parturient (about to give birth) cats**.

- **Symptoms:**

**Acute:** Pneumonia, severe headache, hepatitis.

**Chronic:** Endocarditis, FUO (fever of unknown origin), granuloma in liver.

- **Diagnosis:**

Complement fixation (immunological test), new NAAT (nucleic acid test).

- **Treatment:**

**Doxycycline, Rifampin or hydroxychloroquine.**

## *Chlamydophila Psittaci* (Psittacosis)

- **Risk Factor:**

Exposure to **birds** by bird owners, pet shop employees and vets (normal flora in parrots).

- **Treatment:**

**1st:** Tetracycline or doxycycline

**Alternative:** Macrolide.

## *Francisella Tularensis* (Tularemia)

- **Risk Factor:**

Exposure to **rabbits, squirrels and rodents** by landscapers and hunters (spread by their urine).

- **Treatment:**

Streptomycin.

## *Influenza*

- **Prevalence :**

RSV<sup>9</sup>, Influenza and Parainfluenza are:

- Most common cause of pneumonia in **children**.
- Influenza is the most important viral cause of pneumonia in **adults**, especially during winter.
- **Preventable with annual vaccination.**

- **Pathogenesis:**

Inhaling small aerosolized particles from **coughing or sneezing** → 1-4 day incubation → '**uncomplicated influenza**' (fever, myalgia, malaise, rhinitis) → '**complicated Pneumonia**'.

- **Epidemiology:**

- Adults >65 account for 63% of annual influenza-associated hospitalizations and 85% of influenza-related deaths.
- First worldwide pandemic of H1N1 Influenza A (2009-2010).
- H1N1 is an ongoing epidemic in Saudi Arabia.

- **H1N1 Risk Factors:**

- Pregnancy.
- Obesity.
- Cardiopulmonary disease.
- Chronic renal disease.
- Chronic liver disease.

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<sup>9</sup> Respiratory Syncytial Virus.

- **Findings:**

- Chest X-Ray is often subtle (difficult to describe), to full blown ARDS<sup>10</sup>.
- Nasopharyngeal swab for rapid Ag test of Influenza A and B.
- H1N1 PCR RNA.

- **Precautions:**

- Respiratory (Droplet) isolation for suspected or documented influenza.
- Wear mask and gloves.
- Current Seasonal Influenza Vaccine prevents disease (given every season).
- Bacterial Pneumonia (S. Pneumo, S. Aureus) may follow viral pneumonia.

- **Therapy:**

<b>Neuraminidase Inhibitors</b>	<b>Oseltamivir / Tamiflu<sup>11</sup></b>	75 mg PO (orally) BID (twice a day)	<b>Influenza A, B</b>
	Zanamivir (Relenza)	10 mg (2 inhalations) BID	
<b>Adamantanes</b>	<b>Amantadine / Symmetrel</b>	100 mg PO BID	<b>Influenza A</b>
	Rimantadine / Flumadine	100mg PO QD (daily)	

- **H1N1 is resistant to Adamantanes.**
- **Neuraminidase inhibitors:**
  - 70-90% effective for prophylaxis.
  - Give within 48 hours of symptom onset to reduce duration/severity of illness, and viral shedding.
  - Oseltamivir dose in severe disease = 150 mg BID.

## MERS-CoV

- **Organism:**

- New novel Coronavirus first described in September 2012 in Saudi Arabia.
- Titled Middle East Respiratory Syndrome Corona Virus (**MERS-CoV**).
- **Camels well established as reservoirs of virus.**

- **Epidemiology:**

- Causes severe disease, with high mortality rate reaching 40%.
- 1643 laboratory-confirmed cases with 702 deaths (in KSA alone).
- **Mostly related to hospital outbreaks** : Early recognition and immediate placement on airborne and contact isolation is vital in controlling the spread of disease.
- Clinically **indistinguishable** from any other FRI<sup>12</sup>.

<sup>10</sup> Acute respiratory distress syndrome.

<sup>11</sup> Trade name.

<sup>12</sup> Febrile Respiratory Illness



# TYPICAL CAP

- **Typical CAP:** A sudden chill followed by fever, pleuritic pain, and productive cough.
- **Causative agents:**

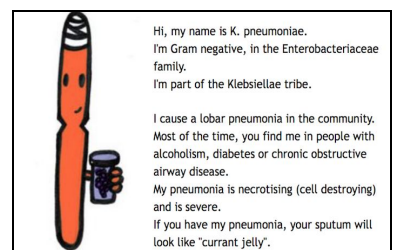
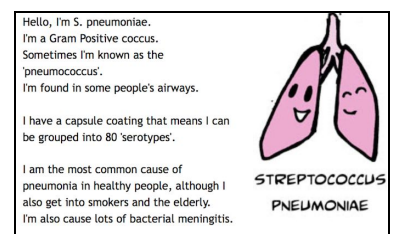
Organism	Risk Factors	Associated Symptoms
<i>S. Pneumoniae</i> (Most Common)	<ul style="list-style-type: none"> <li>❖ Splenectomy (Asplenia).</li> <li>❖ Sickle cell disease / Hematologic diseases.</li> <li>❖ Smoking, bronchial Asthma and COPD.</li> <li>❖ HIV.</li> <li>❖ Alcoholism.</li> <li>❖ Recent viral infection (influenza).</li> </ul>	<ul style="list-style-type: none"> <li>❖ Purulent sputum.</li> </ul>
<i>H. Influenzae</i>	<ul style="list-style-type: none"> <li>❖ COPD, Smoker.</li> <li>❖ Secondary infection on top of Viral..</li> <li>❖ Immunosuppression, HIV.</li> <li>❖ Splenectomy patients.</li> </ul>	-
<i>Klebsiella</i>	<ul style="list-style-type: none"> <li>❖ Diabetes.</li> <li>❖ Alcoholism.</li> <li>❖ Aspiration.</li> </ul>	<ul style="list-style-type: none"> <li>❖ Hymoptisis.</li> <li>❖ Red currant-jelly sputum.</li> </ul>
Anaerobic	<ul style="list-style-type: none"> <li>❖ Alcoholism.</li> <li>❖ Aspiration.</li> <li>❖ Poor Dentition.</li> </ul>	-
<i>Pseudomonas</i>	<ul style="list-style-type: none"> <li>❖ Bronchiectasis, COPD, Smoker.</li> <li>❖ HIV.</li> <li>❖ Hospitalization.</li> <li>❖ Long term care facility/nursing home resident.</li> </ul>	
<i>Acinetobacter</i>	<ul style="list-style-type: none"> <li>❖ Alcoholism.</li> <li>❖ Hospitalization.</li> <li>❖ Long term care facility/nursing home resident.</li> </ul>	
<i>S. Aureus</i>	<ul style="list-style-type: none"> <li>❖ Chronic Hemodialysis.</li> <li>❖ Recent viral infection (influenza).</li> <li>❖ Bronchiectasis.</li> <li>❖ Hospitalization.</li> <li>❖ Long term care facility/nursing home resident.</li> </ul>	-

- **Symptoms of typical CAP:**

- Acute onset of fever and shaking chills.
- Cough productive of thick, purulent sputum.
- Pleuritic chest pain (suggests pleural effusion).
- Dyspnea.
- Cachexia, Abnormal mental status, and wheeze

- **Signs of typical CAP:**

- Tachycardia, tachypnea.
- Late inspiratory crackles, bronchial breath sounds, increased tactile and vocal Fremitus<sup>13</sup>
- Dullness on percussion.
- Pleural friction rub (associated with pleural effusion).



<sup>13</sup> Aegophony (E to A sound). E.g. When a patient says "Bee" it sounds like "Bay"

# ATYPICAL CAP

- **Atypical CAP:** ( 15% of all CAP )

Organisms not visible<sup>14</sup> on Gram stain and not culturable on standard blood agar.

Often present with **Extrapulmonary manifestations.**

- **Causative agents:**

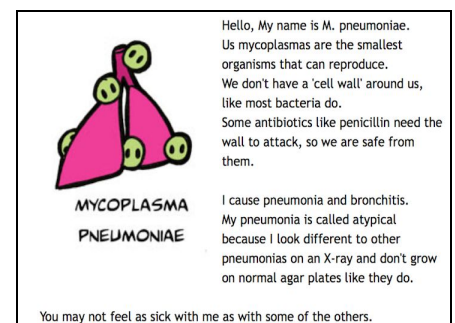
Organism	Risk Factors	Associated Symptoms
<i>Mycoplasma Pneumoniae</i> (Most common)	<ul style="list-style-type: none"> <li>❖ Young.</li> <li>❖ Healthy patients.</li> </ul>	<ul style="list-style-type: none"> <li>❖ <b>Otitis media</b> (Bullous myringitis).</li> <li>❖ Nonexudative pharyngitis.</li> <li>❖ Watery diarrhea.</li> <li>❖ Erythema multiforme.</li> <li>❖ <b>Increased cold agglutinin titre.</b></li> </ul>
<i>Chlamydomphila Pneumoniae</i>	<ul style="list-style-type: none"> <li>❖ Smoker.</li> <li>❖ COPD.</li> </ul>	<ul style="list-style-type: none"> <li>❖ Laryngitis.</li> <li>❖ <b>Hoarseness.</b></li> </ul>
<i>Legionella</i>	<ul style="list-style-type: none"> <li>❖ <b>Hotel/cruise ship.</b></li> <li>❖ <b>Smokers, COPD.</b></li> <li>❖ Males, young and healthy.</li> <li>❖ Inhaling <b>water mist containing bacteria.</b></li> </ul>	<ul style="list-style-type: none"> <li>❖ GI or CNS symptoms.</li> <li>❖ By inhalation.</li> </ul>
<i>Coxiella burnetii</i> (Q fever)	<ul style="list-style-type: none"> <li>❖ Exposure to farm animals or parturient cats.</li> </ul>	<ul style="list-style-type: none"> <li>❖ Severe headache.</li> <li>❖ Hepatitis.</li> <li>❖ Recognized cause of endocarditis.</li> </ul>
<i>Pneumocystis jiroveci</i> (PCP)	<ul style="list-style-type: none"> <li>❖ HIV</li> </ul>	-
<i>Chlamydia psittaci</i>	<ul style="list-style-type: none"> <li>❖ Exposure to birds.</li> </ul>	-
<i>Francisella Tularensis</i> (Tularemia)	<ul style="list-style-type: none"> <li>❖ Exposure to rabbits, squirrels, rodents).</li> <li>❖ Landscapers, Hunters.</li> </ul>	-
<i>TB</i>	<ul style="list-style-type: none"> <li>❖ Alcoholism.</li> <li>❖ HIV.</li> </ul>	<ul style="list-style-type: none"> <li>❖ Hemoptysis... etc.</li> </ul>

- **Symptoms of Atypical CAP:**

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

- **Signs of Atypical CAP:**

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



<sup>14</sup> They don't have a cell wall.

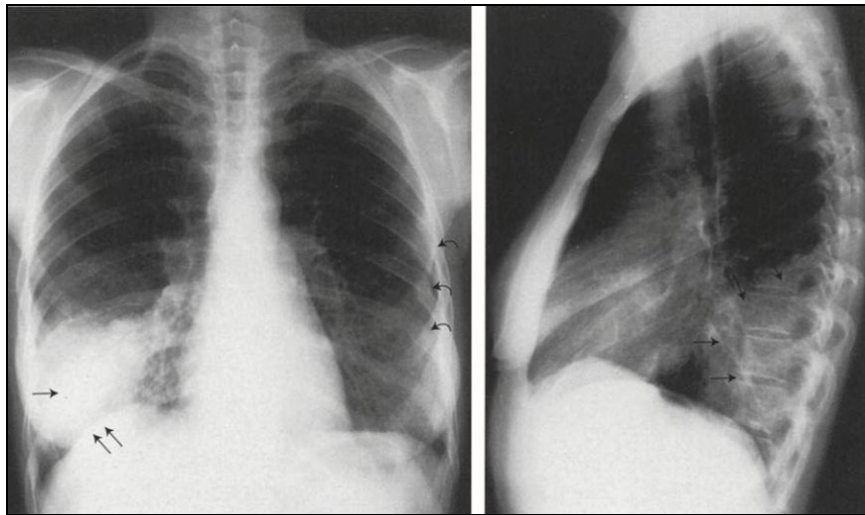
# Diagnosis of CAP

- **CXR<sup>15</sup>: The gold standard.**

- CXR is the only reasonable method of differentiating between **pneumonia<sup>16</sup>** and **acute bronchitis**
- Establish Dx and presence of complications (Eg.pleural effusion, multilobar disease)

- **PA and lateral CXR**

- ❑ **Acute Bronchitis** → Normal
- ❑ **Atypical Pneumonia** → Diffuse reticulonodular (interstitial ) infiltration
- ❑ **Typical Pneumonia** → Either lobar consolidation or Multilobar consolidation (Multilobar indicates very serious illness)



Right middle lobe infiltrate characteristic of bacterial pneumonia.

Here's a table from the doctor's slides with some patterns that you can see in the CXR and the suggestive organisms :

Pattern	Possible causative organism
<b>Lobar</b>	S. pneumo, Kleb, H. flu, Gram -ve
Patchy	Atypicals, viral, Legionella
Interstitial	Viral, PCP (Pneumocystis pneumonia), Legionella
Cavitary	Anaerobes, Kleb, TB, S. aureus, fungi
Large effusion	Staph, anaerobes, Kleb

<sup>15</sup> **If the finding are not suggestive of pneumonia don't treat the pt with antibiotics**

<sup>16</sup> Should return to normal after 6 weeks, Persistent changes on the chest X-ray after this time suggest a bronchial abnormality.

- **Sputum Gram Stain & Culture:**

Used to determine specific organism of **typical Pneumonia**

- **Pleural fluid analysis** (Thoracentesis) **If the etiology is unclear**
- **Specific diagnostic test:** (for atypical organisms)

Organism	Specific diagnostic Test
<i>Mycoplasma pneumoniae</i>	<b>Cold agglutinin</b> , PCR,Serology, Special culture media.
<i>Chlamydia pneumoniae</i>	Rising serological titre
<i>Legionella spp.</i>	<b>Urine antigen</b> , culture
<i>Coxiella burnetii</i> (Q fever)	Rising serological titre
<i>Pneumocystis jiroveci</i> (PCP)	Bronchoalveolar lavage (BAL)
<i>Chlamydia psittaci</i>	Rising serological titre

- **Other tests:**

- |                                                    |                                                 |
|----------------------------------------------------|-------------------------------------------------|
| - <b>CBC</b>                                       | - Special stain (eg. Silver stain, India Ink)   |
| - <b>Blood Culture</b>                             | - LFT                                           |
| - <b>ABG</b>                                       | - CT chest                                      |
| - <b>Urea / Electrolytes</b>                       | - <b>Urine Legionella Ag</b>                    |
| - <b>NPA <sup>17</sup>MERS- CoV, Influenza PCR</b> | - Serology (for Atypical organisms eg. Q fever) |
| - Sputum AFB and TB culture                        |                                                 |
| - Bronchoscopy                                     |                                                 |
| - Sputum fungal culture                            |                                                 |

## Empiric Therapy

- **Pathogenic Organisms**

Outpatient	Inpatient\ non-ICU	ICU
<ul style="list-style-type: none"> <li>● <i>Strep pneumo</i></li> <li>● <i>Mycoplasma</i></li> <li>● <i>Chlamydophila</i></li> <li>● <i>H. influenzae</i></li> <li>● Respiratory viruses</li> </ul>	<ul style="list-style-type: none"> <li>● <i>Strep pneumo</i></li> <li>● <i>Mycoplasma</i></li> <li>● <i>Chlamydophila</i></li> <li>● <i>H. influenzae</i></li> <li>● <i>Legionella</i></li> <li>● Respiratory viruses</li> </ul>	<ul style="list-style-type: none"> <li>● <i>Strep pneumo</i></li> <li>● <i>Staph aureus, Legionella</i></li> <li>● <i>Gram neg bacilli, H. influenzae</i></li> </ul>

Empiric Therapy		
Out Patient	Healthy & no Antibiotic past 3 months	<b>Macrolides</b> (azithromycin or clarithromycin) or doxycycline
	Comorbidity or Antibiotic <b>past 3 months</b>	<ul style="list-style-type: none"> <li>❖ <b>Fluoroquinolones</b> (levofloxacin or moxifloxacin)</li> <li>❖ Advanced macrolide + Beta-lactam<sup>18</sup> (Amoxicillin)</li> <li>❖ Advanced macrolide + amoxicillin-clavulanate</li> </ul>
	Continuous 5 days, stop when patient is afebrile for 48 hours	
In Patient	<ul style="list-style-type: none"> <li>❖ <b>Fluoroquinolones</b> (levofloxacin or moxifloxacin)</li> <li>❖ Advanced macrolide + beta-lactam (azithromycin &amp; Ceftriaxone)</li> </ul>	

Pearls of CAP Inpatient Therapy.
<ul style="list-style-type: none"> <li>❖ Give 1st dose Antibiotics in ER (no specified time frame)</li> <li>❖ 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</li> <li>❖ Discharge from hospital: As soon as clinically stable, off oxygen therapy, no active medical problems.</li> <li>❖ Duration of therapy is usually 7-10 days: <b>Treat for a minimum of 5 days</b></li> <li>❖ Before stopping therapy: <b>afebrile for 48-72 hours</b>, hemodynamically stable, RR &lt;24, O2 sat &gt;90%, normal mental status</li> <li>❖ Treat longer if initial therapy wasn't active against identified pathogen; or if complications (lung abscess, empyema)</li> </ul>

## Management - Outpatient or Inpatient?

- **CURB-65** (Confusion, Urea, Respiratory rate, Blood pressure, age 65 or older) **This is VERY IMPORTANT!!**

5 indicators of increased mortality:

- **Confusion**
- **BUN (blood urea nitrogen) >7**
- **RR (respiratory rate) >30**
- **SBP (systolic blood pressure) <90**
- **DBP (diastolic blood pressure) <60**
- **Age ≥ 65**

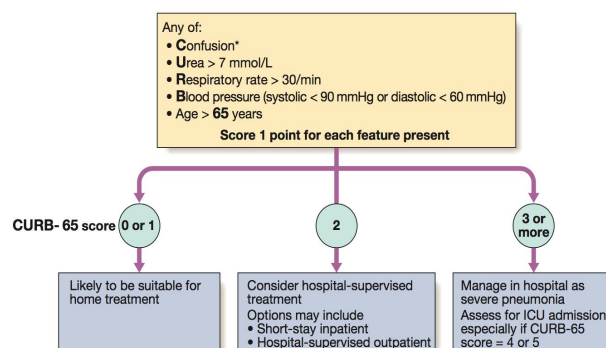
Mortality : 2 factors → 9%, 3 factors → 15%, 5 factors → 57%.

Score 0-1 → **outpatient**, Score 2 → **inpatient**, Score >3 → **ICU**.

- **Pneumonia Severity Index (PSI)** **Difficult and not commonly used**

20 variables including underlying diseases; stratifies pts into 5 classes based on mortality risk

No RCTs (trials) comparing CURB-65 and PSI.



<sup>18</sup> • β -lactams: cefotaxime, ceftriaxone, ampicillin; ertapenem

# Complications of Pneumonia

- ❖ Bacteremia
- ❖ Respiratory and circulatory failure
- ❖ Pleural effusion (Parapneumonic effusion), empyema, and abscess:
  - Pleural fluid always needs analysis in setting of pneumonia (Do a thoracentesis)
  - Always needs drainage: Chest tube, surgical

## Summary

Asplenia	Pneumococci, H. influenzae
Alcoholism	Pneumococci, oral anaerobes, <b>Klebsiella pneumoniae</b> , Acinetobacter, <b>MTB</b>
COPD/ smoking	<b>H. influenzae</b> , Pseudomonas (more in bronchiectasis), Legionella, Pneumococci, Moraxella catarrhalis, Chlamydomphila pneumoniae
Aspiration	Klebsiella, E. Coli, oral anaerobes
HIV	Pneumococci, H. influenzae, P. aeruginosa, <u>Mycobacterium TB</u> , <b>Pneumocystis carinii pneumonia</b> <sup>3</sup> (PCP), Crypto, Histo, Aspergillus, atypical mycobacteria
Recent hotel, cruise ship	<b>Legionella</b> : 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

## Cases

**1) A 65-year-old cigarette smoker with a history of hypertension and mild congestive heart failure presents to the emergency room with worsening cough, fever, and dyspnea at rest. The illness began 1 week ago with fever, muscle aches, abdominal pain, and diarrhea, with nonproductive cough developing later that week and rapidly becoming worse. Therapy for which of the following atypical organisms must be considered in this case?**

- A. Chlamydia pneumoniae
- B. Mycoplasma pneumoniae
- C. Legionella pneumophila
- D. Coccidioidomycosis
- E. Aspergillus fumigatus

**2) An 85-year-old nursing home resident with a history of congestive heart failure has dementia such that she requires assistance in all activities of daily life. She has a 3-day history of fever and productive cough. Chest X-ray reveals a right middle lobe consolidation. Which of the following is the most appropriate initial antibiotic choice?**

- A. Oral amoxicillin
- B. Intravenous linezolid
- C. Intravenous cefepime
- D. Oral azithromycin

**3) A 56-year-old man is brought into the emergency room intoxicated with alcohol. He has repeated bouts of emesis and is found choking. Lung examination reveals some crackles in the right lung base. Which of the following is the most appropriate management?**

- A. Initiate azithromycin.
- B. Initiate corticosteroid therapy.
- C. Initiate haloperidol therapy.
- D. Observation with follow-up chest radiograph.

**4) An 84-year-old woman presents to the ED with shortness of breath. She has been coughing for the past 2 to 3 days. The patient has a history of mild dementia, but has been able to maintain independent living at home with the assistance of her daughters and a home health agency. Her daughter denies any fever at home. Vital signs include a heart rate of 102/minute, respiratory rate of 24/minute, blood pressure 142/58 mmHg, and temperature of 37.8°C with a weight of 52 kg. Oxygen saturation is 93% on room air. Upon examination, she appears to be in mild respiratory distress. She is pleasant but oriented only to self. Chest auscultation reveals few crackles in the left upper lung field. WBC count is 12,500, BUN is 30 mg/dL, and creatinine is 1.3 mg/dL. A chest radiograph shows an infiltrate in the left upper lung lobe. What is the best initial course of therapy for this patient?**

- a. Begin a third-generation cephalosporin and admit her to the hospital.
- b. Begin a renal-dosed third-generation cephalosporin and a macrolide, and admit her to the hospital.
- c. Begin a respiratory fluoroquinolone and discharge her home for follow-up.
- d. Begin a loop diuretic and monitor her oxygen saturation.
- e. Begin bronchodilator therapy with an inhaled beta agonist.

**5) A 48-year-old man is admitted to your service after an inhalational chemical exposure. He develops respiratory distress and requires endotracheal intubation and mechanical ventilation. Which of the following is the best way to decrease his risk of developing ventilator-acquired pneumonia?**

- a. Daily interruption of sedation to assess respiratory status.
- b. Nasopharyngeal rather than oropharyngeal endotracheal intubation.
- c. Institution of protocol to keep bed flat during ventilation.
- d. Intermittent nasopharyngeal suctioning.
- e. Prophylactic broad-spectrum intravenous antibiotics.

**6) Which of the following organisms would typically be found in a patient with atypical community-acquired pneumonia?**

- A. Staphylococcus aureus
- B. Pseudomonas spp.
- C. Streptococcus pneumoniae
- D. Legionella pneumophila
- E. Haemophilus influenzae

**7) A 55-year-old man, who has never smoked and with no past medical history, has been diagnosed with right basal community-acquired pneumonia. There are minimal changes on his chest x-ray and bloods reveal a neutrophil count of 8.2 and a C-reactive protein (CRP) of 15. He has no drug allergies. Although he has a productive cough of green sputum, his respiratory rate is 16, oxygen saturations are 97 per cent on room air and his temperature is 37.4°C. You are asked to place him on treatment. Which of the following treatment options would be appropriate for this patient?**

- A. Oral amoxicillin
- B. Oral erythromycin
- C. Intravenousertapenem
- D. Intravenousertapenem with a macrolide (e.g. clarithromycin)
- E. Intravenousertapenem

**8) A 56-year-old woman who has recently been discharged from your ward, with oral antibiotics for right basal community-acquired pneumonia, is re-admitted with transient pyrexia and shortness of breath. She is found to have a right-sided pleural effusion which is drained and some pleural aspirate sent for analysis. The results reveal an empyema. Which of the following, from the pleural aspirate analysis, would typically be found in a patient with an empyema?**

- A. pH>7.2, ↑ LDH, ↑ glucose
- B. pH <7.2, ↑ LDH, ↑ glucose
- C. pH>7.2, ↓ LDH, ↓ glucose
- D. pH<7.2, ↑ LDH, ↓ glucose
- E. pH<7.2, ↓LDH, ↓glucose



## Answers

- 1) **C.** Legionella typically presents with myalgias, abdominal pain, diarrhea, and severe pneumonia.
- 2) **C.** This nursing home resident would be considered to have a nosocomial rather than community-acquired infection, with a higher incidence of gram-negative infection. Her age and comorbid medical conditions place her at high risk, requiring hospitalization for intravenous antibiotics such as a third-generation cephalosporin.
- 3) **D.** Antibiotic therapy is generally not indicated for aspiration pneumonitis, but patients need to be observed for clinical deterioration.
- 4) **B.** Empiric therapy for community-acquired pneumonia (CAP) includes either a respiratory fluoroquinolone or a third-generation cephalosporin plus a macrolide, the latter to cover for “atypical” pathogens. This would limit the correct answer options to a, b, or c. CAP can be caused by viruses, bacteria, fungi, or protozoa. The common bacterial causes of CAP include Streptococcus pneumoniae, Mycoplasma pneumoniae, Haemophilus influenzae, Chlamydia pneumoniae, and Staphylococcus aureus. Answer a is incorrect as our patient has an estimated creatinine clearance of 26 mL/minute and an adjustment of the antibiotics based on renal function may be indicated depending on the specific drug that is selected. Furthermore, a cephalosporin would not cover Mycoplasma or Chlamydia. The patient in question has several risk factors for poor outcome (age, change in mental status, depressed glomerular filtration rate), so immediate discharge to home would be inappropriate (answer c). There is also a theoretical risk of worsening delirium from fluoroquinolones crossing the blood-brain barrier in patients at risk of delirium. The examination and chest x-ray do not suggest congestive heart failure, so treatment with a loop diuretic would not be efficacious. Inhaled bronchodilators do not improve outcomes in pneumonia and are used if the patient develops wheezing or other evidence of bronchospasm.  
  
5) **A.** Daily interruption of sedation (“sedation holiday”) to assess readiness for extubation has been shown to decrease the risk of ventilator-acquired pneumonia. Oropharyngeal (rather than nasopharyngeal) intubation, elevating the head of the bed (rather than keeping the patient flat), and subglottic secretion suctioning can also decrease ventilator-acquired pneumonia. Nasopharyngeal and gastrointestinal tract bacterial flora modulation via topical or oral antibiotics may also decrease VAP risk, although it is not routinely recommended. Prophylactic intravenous antibiotics are not recommended.
- 6) **D.** From the list of answers above, H. influenzae (E) and S. pneumoniae (C) are organisms which are usually responsible for community-acquired pneumonia. S. aureus (A) and Pseudomonas spp. (B) are usually found in patients with hospital-acquired pneumonia. L. pneumophila (D), along with Chlamydia spp. and Mycoplasma pneumoniae, are the atypical pneumonia-causing organisms. A urinary antigen test is routinely used for the detection of Legionella spp. Serological tests can be used for the detection of Mycoplasma and Chlamydia spp. and also Legionella spp.

7) **A.** From the history we can see that this patient has a CURB-65 score of 0 putting him into a good prognostic category. Second, he is normally fit and well and has no past medical history. Therefore, he is in the category of non-severe pneumonia and does not require hospitalization. Hence, oral antibiotic therapy is preferred. From the list, amoxicillin (A) would be preferred over erythromycin (B) as it covers the most common organism (*S. pneumoniae*) and has a broad spectrum of action while the macrolide will cover for atypical organisms (e.g. legionella, mycoplasma, etc.). In some centres, amoxicillin with a macrolide may be given if there is any reason to suspect atypical pneumonia (e.g. patient works with air conditioners, or has just come back from holiday and living in an air-conditioned room, plumber dealing with water tanks, etc.). Intravenous tazocin (E) and ertapenem (C + D) are not always used across all hospital trusts; antibiotic protocols vary and it is important to check the hospital trust policy for updated guidelines.

8) **D.** Empyema can be defined as pus in the pleural space which can occur in patients with resolving pneumonia. Associated symptoms include transient fever, shortness of breath and pleural effusion on the side of the resolving pneumonia. Management includes ultrasound-guided chest drain insertion coupled with antibiotic therapy. The pleural aspirate obtained during the chest drain insertion may appear turbid and (yellow) straw in colour. Empyema falls into the category of exudates, hence protein content is  $>30\text{g/L}$ .

The pH of pleural fluid is used to ascertain pleural infection. The normal pH of pleural fluid is approximately 7.6. A pleural pH of  $<7.2$  with a normal blood pH is usually found in:

Pleural infections; empyema; TB; malignancy; oesophageal rupture.

Light's criteria states that pleural fluid can be categorized as an exudate if one or more of the following exist: (1) The pleural fluid protein divided by serum protein  $>0.5$ ; (2) Pleural fluid LDH divided by serum LDH  $>0.6$  and (3) Pleural fluid LDH is more than two-thirds the upper limits of normal serum LDH. A low glucose level ( $<3.3\text{mmol/L}$ ) is usually seen in the following conditions: empyema; rheumatoid arthritis; SLE; TB; malignancy; oesophageal rupture. Therefore, from the answers above, D is the most appropriate.

### Clinical Pearls

- It is difficult to reliably distinguish clinically between typical and atypical causes of pneumonia. Therefore, diagnosis and empiric treatment of pneumonia are based upon the setting in which it was acquired (community acquired or nosocomial) and the immune status of the host.
- Clinical criteria, such as patient age, coexisting illnesses, tachycardia, and tachypnea, can be used to risk stratify patients with pneumonia to decide who can be treated as an outpatient and who requires hospitalization.
- Although initial antibiotic therapy is empiric, the etiologic agent frequently can be identified based on chest radiography, blood cultures, or sputum Gram stain and culture.
- Aspiration pneumonitis is a noninfectious chemical burn caused by inhalation of acidic gastric contents in patients with a decreased level of consciousness, such as seizure or overdose.
- Aspiration pneumonia is pulmonary infection caused by aspiration of colonized oropharyngeal secretions and is seen in patients with impaired swallowing, such as stroke victims.