Pneumonia
What is pneumonia?

- Infection of the lung parenchyma
- Causative agents include bacteria, viruses, fungi, protozoa

[www.netmedicine.com/xray/xr.htm](http://www.netmedicine.com/xray/xr.htm)
Definition

- acute infectious disease, etiology usually bacterial;
- characterized by focal lesions of the lung and
- intra alveolar exudation
Categorization of Pneumonia by Clinical Setting

- Community Acquired Pneumonia (CAP) = pneumonia in person having no or little contact with the healthcare system

- Nosocomial/Hospital Acquired Pneumonia (HAP) = Pneumonia occurring ≥48 h post admission, excludes infection incubating at time of admission
Categorization of Pneumonia by Clinical Setting

**CAP**
- Pneumonia in immunocompetent patients
- Aspiration pneumonia
- Pneumonia in immunocompromised patients

**HAP**
- Hospital-associated pneumonia
- Ventilator-associated pneumonia
- Health care associated pneumonia (HCAP)
- Aspiration pneumonia
- Pneumonia in immunocompromised patients
Etiologic agents of CAP

**Typical pathogens:**
- Streptococcus pneumoniae - 30-70% +
- Haemophilus influenzae - 5-20% -
- Staphylococcus aureus 2-10% +
- Klebsiella pneumoniae -

**Atypical (intracellular) pathogens** (cannot be cultured on standard media):
- Mycoplasma pneumoniae - 1-30%
- Chlamydophila pneumoniae - 5-20%
- Legionella pneumophila - 1-6%
- Respiratory viruses - 10-20%

**Combination of typical and atypical pathogens** - 10-15%
Common Organisms in Pneumonia

Nosocomial
- Enteric GNB (e.g. E. coli)
- Pseudomonas aeruginosa
- S. aureus (including MRSA)

Aspiration
- Oral anerobes (e.g. Bacteroides)
- Enteric GNB (e.g. E. coli)
- S. aureus
- Gastric contents (chemical pneumonitis)
Common Organisms in Pneumonia

**Immunocompromised Patients**
- *Pneumocystis jiroveci*
- Fungi (e.g. Cryptococcus)
- *Nocardia*
- CMV
- HSV
- TB

**Alcoholic Patients**
- *Klebsiella*
- Enteric
- GNB
- *S. aureus*
- Oral anaerobes (aspiration)
- TB
When confronted with possible CAP, the physician must ask two questions:

Is this pneumonia, and, if so, what is the likely etiology?
DIAGNOSIS

- clinical history
- focused physical examination
- CXR
- Pulse oximetry
- Routine lab testing – complete blood count (CBC), basic metabolic panel (BMP)
- LFTs
- ABG
- Thoracentesis if pleural effusion present
- Sputum Gram Stain, culture, sensitivity
Pneumonia diagnostic standards

**X-ray criteria** for conformation of pneumonia (**plain chest radiograph, preferably posterior-anterior and lateral films**):

- Inflammatory infiltration (opacities) of the parenchyma in 1-2, sometimes 3-5 segments
- Large confluent foci of inflammation, spotted, not clearly defined opacities
Pneumococcal pneumonia
Image in a 48-year-old patient with *Haemophilus influenzae* pneumonia. The chest radiograph shows bilateral opacities with a predominantly peripheral distribution.
A community-acquired Staphylococcal pneumonia
Figure 1: (a) Chest X-ray PA view multiple rounded homogenous parenchymal shadows of varying size, 2-5 cm in diameter in both lung fields. Some of these shadows coalesce with each other and surrounding mediastinal structures.

Figure 1b: Chest X-ray PA view at 4 weeks showed clearing of the opacities with thin-walled cavities.
Klebsiella pneumonia. (A) Air-space consolidation involving much of the right upper lobe. (B) Progression of the necrotizing infection produces a large abscess cavity with an air-fluid level (arrows).
Mycoplasma pneumoniae CAP
Chlamydia pneumoniae
Legionella pneumophila CAP
Viral pneumonia

ARDS
Severe CAP criteria

**Small criteria:**

- RR ≥ 30 / min;
- Impaired consciousness, Sat O₂ < 92%, pO₂ < 60 mm Hg.;
- SBP < 90 mm Hg.;
- Multifocal or bilateral lung opacities, collapse, pleural effusion.

**Big criteria:**

- Necessity of mechanical ventilation;
- Rapid progression of focal infiltrative changes in the lungs (> 50% larger within 2 days);
- Septic shock or the necessity of vasopressors ≥ 4 h;
- Acute renal failure (urine < 80 ml for 4 h or serum creatinine level > 0.18 mmol / l in the absence of chronic renal failure).
SEVERE COMMUNITY-ACQUIRED PNEUMONIA = presence of ≥2 small or 1 big criteria, all big criteria significantly increases the risk of death.
Algorithm: Management-Oriented Risk Stratification of Community-Acquired Pneumonia In Immunocompetent Adults

Any of the ff:
1. RR ≥ 30/min
2. PR ≥ 125/min
3. T° ≥ 40°C or ≤ 35°C
4. Extrapulmonary evidence of sepsis
5. Suspected aspiration
6. Unstable comorbid conditions
7. CXR: multilobar, pleural effusion, abscess, progression to >50% within 24 hrs

YES

- Hypotension
- Altered mental state
- urine output <30ml/hr
2. PaO2 < 60mmHg acute hypocapnea PaCO2>50mmHg

YES

HIGH RISK CAP

ICU Admission

NO

MODERATE RISK CAP

Ward Admission

NO

LOW RISK CAP

Outpatient
SMART-COP
A tool for predicting which patients with community-acquired pneumonia (CAP) are likely to require intensive respiratory or vasopressor support (IRVS).

CAP confirmed on CXR

| S | Systolic BP <90 mmHg | □ (2 points) |
| M | Multilobar CXR involvement | □ (1 point) |
| A | Albumin <3.5 g/dL* | □ (1 point) |
| R | Respiratory rate – age-adjusted cut-offs | □ (1 point) |
|   | Age | RR | <50 yo | ≥50 yo | ≥25 br/min | ≥30 br/min |
| T | Tachycardia ≥125 bpm | □ (1 point) |
| C | Confusion (new onset) | □ (1 point) |
| O | Oxygen low – age-adjusted cut-offs | □ (2 points) |
|   | Age | <50 yo | ≥50 yo | <70 mmHg | <60 mmHg | <93% | <90% |
|   | PaO₂* | or: O₂ Saturation | or (if on O₂): PaO₂/FiO₂* | <333 | <250 |
| P | Arterial pH <7.35* | □ (2 points) |

Total Score □ points

Interpretation:

0 – 2 points Low risk of needing IRVS
3 – 4 points Moderate risk (1 in 8) of needing IRVS
5 – 6 points High risk (1 in 3) of needing IRVS
≥7 points Very high risk (2 in 3) of needing IRVS

*For primary care physicians, results for albumin, arterial pH, and PaO₂ can be overlooked and the following interpretation be used:

0 points Very low risk of needing IRVS
1 point Low risk (1 in 20) of needing IRVS
2 points Moderate risk (1 in 10) of needing IRVS
3 points High risk (1 in 6) of needing IRVS
≥4 points High risk (1 in 3) of needing IRVS
Differential diagnosis

- Tuberculosis
- Destructive pneumonia
Tuberculosis
Differential diagnosis

Mitral stenosis, pulmonary edema

Paraneoplastic pneumonia
Atelectasis
CAP – Patient Stratification

- CAP is present
  - Outpatient therapy
    - No Cardiopulmonary disease, No modifiers
      - Group I
    - History of Cardiopulmonary disease, and/or modifiers
      - Group II
  - Inpatient therapy
    - Mild-moderate illness
      - Cardiopulmonary disease and/or modifiers
        - Group IIIA
      - No Cardiopulmonary disease, no modifiers
        - Group IIIB
    - Severe CAP
      - No risk for P. aeruginosa
        - Group IVA
      - Risk for P. aeruginosa
        - Group IVB
# Empirical antibacterial CAP patients’ treatment

<table>
<thead>
<tr>
<th>group</th>
<th>1-st line</th>
<th>Alternative</th>
</tr>
</thead>
</table>
| I     | **Monotherapy PO:**  
- Amoxicillin (Ospamoks);  
- Macrolide: azithromycin, clarithromycin, Midecamycin, spiramycin | **PO:**  
- If Amoxicillin is ineffective - macrolide or doxycycline or fluoroquinolone III-IV generation;  
- If macrolide is ineffective – aminopenicillin or fluoroquinolone III-IV generation |
| II    | **Monotherapy PO:**  
- protected aminopenicillins (amoxicillin + clavulanic acid: amoxiclav)  
- second-generation cephalosporin (cefuroxime) | **Monotherapy PO:**  
ADD **macrolide** to β-lactame or or instead – a **fluoroquinolone III-IV generation** (monotherapy) |
## Antibacterial CAP patients treatment

<table>
<thead>
<tr>
<th>Group</th>
<th>I-st line</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>Parenteral (i.m, i.v): - Protected aminopenicillin or cephalosporins II-III generation + Macrolide</td>
<td>I.V.: fluoroquinolons III-IV generation or carbapenem</td>
</tr>
<tr>
<td>IV</td>
<td>I.V.: - Protected aminopenicyllin or cephalosporins II-III generation + Macrolide</td>
<td>I.V.: fluoroquinolone III-IV generation + β- lactam</td>
</tr>
</tbody>
</table>

In susp. P. aeruginosa:  
- i.v. antypseudomonas cephalosporins III, IV g. + aminoglycoside + levofloxacin (ciprofloxacin)  

In susp. P. aeruginosa:  
- i.v. carbapenem + aminoglycoside + macrolide
Duration of Therapy

- 5 - 7 days - outpatients
- 7 - 10 days – inpatients, S. pneumoniae
- 10 - 14 days – Mycoplasma, Chlamydia, Legionella
- 14+ days - chronic steroid users

Am J Respir Crit Care Med 163:1730-54, 2001
HAP

- Pneumonia occurring $\geq 48$ h post admission
- Excludes infection incubating at time of admission
Definitions

1) *Hospital-acquired pneumonia (HAP)* is pneumonia that occurs 48 hours or more after admission, which was not incubating at the time of admission.

2) *Ventilator-associated pneumonia (VAP)* refers to pneumonia that develops more than 48 to 72 hours after endotracheal intubation.

3) *Healthcare-associated pneumonia (HCAP)* includes any patient who was either hospitalized in an acute care hospital for two or more days within 90 days of the infection; or resided in a long term care facility; or received intravenous antimicrobial therapy, chemotherapy, or wound care within the 30 days prior to the current infection; or attends a hospital or hemodialysis clinic.
ETIOLOGY

HAP, VAP, and HCAP

- **aerobic gram-negative bacilli** (eg, Escherichia coli, Klebsiella pneumoniae, Enterobacter spp, Pseudomonas aeruginosa, Acinetobacter spp)

- **gram-positive cocci** (eg, Streptococcus spp, Staphyloccoccus aureus, including MRSA)

- **viruses or fungi** is significantly less common except in the immunocompromised patient.
Patients with Mild-to-Moderate HAP, No Unusual Risk Factors, Onset Any Time or Patients with Severe Hospital-Acquired Pneumonia with Early Onset*

Core organisms

- Enteric gram-negative bacilli
- (Non-Pseudomonal) Enterobacter
- E. coli
- Klebsiella
- Proteus
- Serratia
- Hemophilus influenza
- Methicillin-sensitive S. aureus
- Streptococcus pneumoniae

Core antibiotics

- Cephalosporin
  - Second generation
  - or nonpseudomonal third generation
- Beta-lactam/beta-lactamase inhibitor
- If allergic to penicillin: fluoroquinolone
  - or clindamycin + aztreonam

* Excludes patients with immunosuppression
HAP – Stratification

Patients with Mild-to-Moderate HAP, With Risk Factors, Onset Any Time*

<table>
<thead>
<tr>
<th>Core organisms</th>
<th>Core antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobes (recent abdominal surgery, witnessed aspiration)</td>
<td>Clindamycin or beta-lactam/ beta-lactamase inhibitor</td>
</tr>
<tr>
<td>Staphylococcus aureus (coma, head trauma, diabetes mellitus, renal failure)</td>
<td>+/- Vancomycin (until methicillin-resistant S. aureus is ruled out)</td>
</tr>
<tr>
<td>Legionella (high-dose steroids)</td>
<td>Erythromycin +/- rifampin†</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa (prolonged ICU stay, steroids, structural lung disease)</td>
<td>Treat as severe hospital acquired pneumonia</td>
</tr>
</tbody>
</table>

* Excludes patients with immunosuppression
†Rifampin may be added if Legionella is documented

Am J Respir Crit Care Med 153:1711-25, 1995
Definition of Severe Hospital-Acquired Pneumonia

Admission to the intensive care unit
Respiratory failure, defined as the need for mechanical ventilation or the need for >35% oxygen to maintain an arterial oxygen saturation >90%
Rapid radiographic progression, multilobar pneumonia, or cavitation of a lung infiltrate
Evidence of severe sepsis with hypotension and/or end-organ dysfunction:
  Shock (systolic blood pressure <90 mmHg or diastolic blood pressure <60 mmHg)
  Requirement for vasopressors for more than 4 hours
  Urine output <20 mL/hour or total urine output <80 mL in 4 hours (unless another explanation is available)
  Acute renal failure pending dialysis
HAP – Stratification

Patients with Severe Hospital-Acquired Pneumonia with Risk Factors, Early Onset or Patients with Severe HAP, Late Onset*

Core organisms, Plus

P. aeruginosa
Acinetobacter species
Consider MRSA

Therapy

Aminoglycoside or ciprofloxacin

plus one of the following:

Antipseudomonal penicillin
Beta lactam/beta-lactamase inhibitor
Ceftazidime or cefoperazone
Imipenem
Aztreonam†
+/- Vancomycin

* Excludes patients with immunosuppression
† Aztreonam efficacy is limited to enteric gram-negative bacilli and should not be used in combination with an aminoglycoside if gram-positive or H. influenzae infection is of concern.

Am J Respir Crit Care Med 153:1711-25, 1995
Optimal Antibiotic Therapy

MRSA pneumonias:
- prolonged intubation periods
- prior use of antibiotics

Pseudomonas aeruginosa pneumonias:
- structural pulmonary disease
- 1 week of prior hospitalization
- prolonged periods of intubation (>5 days)
- prior exposure to antibiotics

A. Baumannii VAP:
- neurosurgery
- ARDS
- head trauma
- large-volume pulmonary aspiration.

Combination piperacillin/tazobactam + ciprofloxacin, or amikacin + imipenem, meropenem or an antipseudomonal cephalosporin.

carbapenems, sulbactam, tigecycline, colistin
Incorrect diagnosis – it is not pneumonia
• Atelectasis, CHF, PE with infarction, lung contusion, chemical pneumonitis, ARDS, pulmonary hemorrhage

Pathogen resistance

Host factors that increase mortality
• Age > 60, prior pneumonia, chronic lung disease
• immunosuppression

Antibiotic resistance

Am J Respir Crit Care Med 153:1711-25, 1995
HAP - Prevention

- Hand washing
- Vaccination
  - Influenza
  - Pneumococcus
- Isolation of patients with resistant respiratory tract infections
- Enteral nutrition
- Choice of GI prophylaxis
- Subglottic secretion removal?

Am J Respir Crit Care Med 153:1711-25, 1995
*Pneumocystis Carinii*

(*Pneumocystis jiroveci* Pneumonia (PCP))

- Uncommon until 1980’s with emergence of HIV disease
- Caused by organism most closely related to fungi
- Mode of transmission unclear, possibly - reactivation of latent infection

PCP reference = Harrison’s Principles of Internal Medicine

1http://www.cdc.gov/ncidod/EID/vol8no9/02-0096.htm
PCP Pneumonia

- Gradual onset of symptoms
- Common symptoms include fever, cough, progressive dyspnea
- Many patients asymptomatic
- May present as a spontaneous pneumothorax
PCP - Treatment

- **TMP/SMX (trimethoprim/sulfamethoxazole)**
  - Drug of choice
  - High incidence of side effects in HIV+ pts

- Dapsone + TMP

- Clindamycin + primaquine