



## Chapter 76 – Pneumonia

### Episode Overview:

1. What are the typical associative pathogens?
2. Describe the typical clinical presentation/RFs/Management for each of the following:
  - a. *S. pneumoniae*
  - b. *H. influenzae*
  - c. *Staph aureus*
  - d. *Klebsiella*
  - e. *Mycoplasma pneumoniae* & *Chlamydia pneumoniae*
  - f. *Legionella*
  - g. Anaerobes
  - h. *Pseudomonas*
  - i. PJP & Other Fungal Pneumonia
  - j. Tuberculosis
  - k. Tularemia
  - l. Hantavirus
3. List the typical etiologies of viral pneumonia.
4. Which patient groups should receive pneumovax?
5. Which pneumonias can present with cavitating lesions (abscesses) on x-ray?
6. What is the differential for possible pneumonia visible on CXR?
7. Describe the analysis of pleural fluid.
  - a. Which effusions should be sampled?
  - b. What are Light's criteria?
8. What is the CURB65 score?

### Rosen's in Perspective

- This is a common disease - thankfully most cases can be managed as an outpatient
  - This is suspected to change slightly over the next decades - with the aging population, antibiotic resistance increasing, and as the number of people burdened with chronic disease increases
- The ED goals are:
  - Make the diagnosis
  - Start empirical treatment (this is tough disease because we almost never culture the bug!)
  - Provide respiratory support
  - Risk stratification +/- admission
- In the grand scheme of things - it's amazing we don't get more infections in our lungs - with the surface area being over 140 m<sup>2</sup>; and us breathing over 10,000 L of air each day!!



- Pneumonia develops when:
  - Host defences are overwhelmed
  - A Virulent organism shows up
  - A large amount of oropharyngeal organisms is aspirated

#### Typical vs Atypical infections

- Typical ones:
  - **Streptococcus pneumoniae** (very virulent)
  - **Haemophilus influenzae**
  - **Staphylococcus aureus**
    - CA MRSA can commonly be associated with influenzae
    - IVDU's
    - Look for the cavitation, and necrosis on the CXR
- Atypicals
  - **Legionella**
  - **Mycoplasma**
  - **Chlamydomphila**
- Virals:
  - Influenzae
  - Parainfluenza

Usually named Community acquired (CAP) vs Healthcare associated pneumonia (HCAP), or Ventilator associated Pneumonia (VAP)

- (1) Hospitalization for 2 or more days in an acute care facility within 90 days of infection;
- (2) Attendance at a hemodialysis clinic; and
- (3) Intravenous antibiotic therapy, chemotherapy, or wound care within 30 days of infection.

HCAP is associated with a greater likelihood of resistant pathogens such as Pseudomonas and MRSA, and mortality is higher than that for CAP

### 1) What are the typical associative pathogens?

Big shout out to LITFL, where this list was acquired:

- Alcoholism** — Streptococcus pneumoniae, anaerobes, Gram negatives such as Klebsiella pneumonia, tuberculosis
- COPD/ smoker** — Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis
- Nursing home resident** — Streptococcus pneumoniae, Gram negatives, Haemophilus influenzae, S. aureus, Chlamydomphila pneumoniae consider tuberculosis and anaerobes (but less common)
- Poor dental hygiene** — anaerobes
- Bat / cave exposure** — Histoplasma capsulatum
- Bird exposure** — Chlamydomphila psittaci, Cryptococcus neoformans, Histoplasma capsulatum



- Rabbit exposure** — *Francisella tularensis*
- Exposure to farm animals or cats** — *Coxiella burnetti* (Q fever)
- Post-influenza** — *S. pneumoniae*, *S. aureus*
- Bronchiectasis, cystic fibrosis** — *Pseudomonas aeruginosa*, *S. pneumoniae*, *Burkholderia cepacia*
- Sickle cell disease, asplenia** — *S. pneumoniae*, *H. influenzae*
- Suspected bioterrorism** — Anthrax / Tularemia
- Tropical Australia** — melioidosis, *Acinetobacter*
- Potting mix** — *Legionella longbeachae*
- Travel to Asia** — SARS, tuberculosis, melioidosis

## 2) Describe the typical clinical presentation/RFs/Management for each of the following

In general the guidelines for CAP are as follows, but confirm with your local resistance patterns and guidelines:

CLINICAL SETTING	ANTIBIOTIC REGIMEN*	COMMENTS
Previously healthy, no antimicrobials in last 3 mo	Doxycycline 100 mg PO bid	Preferred for adolescent or young adult when likelihood of <i>Mycoplasma</i> is high; variable activity vs. <i>Streptococcus pneumoniae</i> .
	Azithromycin 500 mg once, followed by 250 mg daily for 4 days	Treats common typical bacterial and atypical pathogens. Clarithromycin can be substituted.
Comorbidities, or antimicrobials in last 3 mo	Levofloxacin 750 mg PO daily for 5 days	Can substitute moxifloxacin 400 mg daily for 7-14 days. Treats common typical and atypical bacterial pathogens; active vs. DRSP. Use fluoroquinolone if recently received $\beta$ -lactam or macrolide.
	Cefpodoxime 200 mg PO bid + azithromycin 500 mg PO daily	Use if fluoroquinolones recently received. Can substitute cefdinir, cefprozil, or amoxicillin-clavulanate for cefpodoxime. Variable activity against DRSP.

DRSP, drug-resistant *S. pneumoniae*; PO, orally.

\*Doses are for 70-kg adult with normal renal and hepatic function.



**Table 76-2 Community-Acquired Pneumonia in Older Children and Adults: Inpatient Antimicrobial Treatment**

CLINICAL SETTING	ANTIBIOTIC REGIMEN*	COMMENTS
Community-acquired, nonimmunocompromised	Ceftriaxone 1 g q24h + azithromycin 500 mg q24h IV or PO Respiratory fluoroquinolone (levofloxacin 750 mg IV q24h or moxifloxacin 400 mg IV q24h)	Can substitute cefotaxime, ceftaroline, ampicillin-sulbactam, or ertapenem for ceftriaxone. Treats most common bacterial and atypical pathogens. Active vs. DRSP.
Severe pneumonia (ICU)	Ceftriaxone 1 g IV q24h + levofloxacin 750 mg IV q24h + vancomycin 1 g IV q12h	Can substitute cefotaxime, cefepime, ceftaroline, ertapenem, or $\beta$ -lactam or $\beta$ -lactamase inhibitor for ceftriaxone. Can substitute moxifloxacin for levofloxacin. Can substitute linezolid for vancomycin.
Health care-associated pneumonia or severe pneumonia with neutropenia, bronchiectasis (risk for <i>Pseudomonas</i> )	Cefepime 2g IV q12h + ciprofloxacin 500 mg IV q12h + vancomycin 1 g IV q12h	Can substitute other antipseudomonal $\beta$ -lactam, such as piperacillin-tazobactam, imipenem, meropenem, or doripenem, for cefepime. Can substitute aminoglycoside plus macrolide for ciprofloxacin.
Presumed PCP	TMP-SMX 240/1200 mg IV q6h	Add ceftriaxone to TMP-SMX if severe, until PCP confirmed. Alternatives for sulfa allergy include clindamycin + primaquine.

DRSP, drug-resistant *S. pneumoniae*; ICU, intensive care unit; IV, intravenously; PCP, *Pneumocystis pneumonia*; PO, orally; TMP-SMX, trimethoprim-sulfamethoxazole.

\*Doses are for a 70-kg adult with normal renal and hepatic function.

## S. pneumonia

- A gram +ve cocci that is the most common cause of pneumonia requiring hospitalization - it colonizes 40% of health adults' nares
- This is the bug targeted by the pneumococcal vaccine: By getting a vaccine with 13 or 23 of the capsular polysaccharides of pneumococcus it is thought to make any infections that occur less severe
- RF: unvaccinated / COPD / Smoker / ETOH / Asplenism / Sickle Cell / Nursing Home / Post Influenza
- Drug resistant *S. pneumoniae* (DRSP) is increasing. DRSP usually penicillin /  $\beta$ -lactams, macrolides, tetracyclines, and trimethoprim-sulfamethoxazole (TMP-SMX) are no good or variably effective.
- Extended- spectrum/ respiratory fluoroquinolones, (Levofloxacin or Moxifloxacin), are active against DRSP and other typical and atypical bacterial pathogens. 3rd gen cephalosporin plus macrolide also okay.
- Treatment:** If admitted: 3rd gen. cephalosporin + macrolide OR respiratory fluoroquinolone

## H. influenzae

- 2nd most frequently isolated organism in CAP among adults
- Pleomorphic gram-negative rod.
- RF: COPD, alcoholism, malnutrition, malignancy, diabetes
- Treatment:** Amoxicillin or a second- or third-generation cephalosporin

## Staph aureus

- S. aureus* common cause of CAP
- CAP MRSA more common to cause severe disease
- Often associated with influenza
- Often necrotizing, with cavitation and pneumatocele formation.
- RF: Intravenous drug users, immunosuppressed, known colonised
- Treatment:** Vancomycin or Linezolid



## Klebsiella

- Klebsiella pneumoniae* is a gram-negative
- Rare cause of CAP in immunocompetent
- RF: alcoholism, diabetes, or other chronic illness.
- There is a high incidence of antibiotic resistance because the organism is often hospital acquired
- High risk for ESBL and CRO
- Treatment:** No risk for MDR: Piperacillin-tazobactam / Cefepime / Imipenem / Meropenem / Levofloxacin
- MDR risk factors than add Amikacin / or Gentamicin / or Tobramycin

## *Mycoplasma pneumoniae* & Chlamydia

- Mycoplasma pneumoniae* is one of the most common causes of CAP
- C. pneumoniae*, an intra cellular parasite that is transmitted between humans by respiratory secretions or aerosols
- Treatment:** Macrolides such as erythromycin and azithromycin, doxycycline, or a fluoroquinolone such as levofloxacin or moxifloxacin.

## Legionella

- Legionella is an intracellular organism that lives in aquatic environments.
- There is no person-to-person transmission.
- often implicated in point outbreaks related to cooling towers and similar aquatic sources, the organism also lives in ordinary tap water and is underdiagnosed as a cause of CAP. Legionella prevalence seems to vary greatly by region.
- Symptoms: important bug to think of in patients with both resp and GI symptoms (the diarrhea)
- 53% of patient have neuro abnormalities such as confusion and delirium
- Treatment:** Azithromycin or levofloxacin, can consider doxy, spectra or imipenem for refractive

## Anaerobes

- Generally from aspiration
- These infections are typically polymicrobial
- including *Peptostreptococcus*, *Bacteroides*, *Fusobacterium*, and *Prevotella* species.
- RF: central nervous system depression or swallowing dysfunction, severe periodontal disease, fetid sputum, and the presence of a pulmonary abscess or empyema.
- Treatment:** Ampicillin-sulbactam or amoxicillin-clavulanate in mild disease. Can also use flagyl plus amox for mild as well.
- Severe disease consider imipenem, meropenem or piperacillin-tazobactam
- Add vanco if MRSA suspected



## Pseudomonas

- HAP and CAP w: A compromised immune system (eg, HIV-infected patients, solid organ or hematopoietic cell transplant recipients, neutropenic hosts, and those on immunosuppressive or immunomodulatory agents such as TNF-alfa inhibitors)
  - Recent prior antibiotic use
  - Structural lung abnormalities such as cystic fibrosis or bronchiectasis
  - Repeated exacerbations of chronic obstructive pulmonary disease requiring frequent glucocorticoid and/or antibiotic use
  - Treatment:** Piperacillin-tazobactam, ceftazidime, cefepime, imipenem, meropenem, and doripenem. Antipseudomonal quinolones include ciprofloxacin and levofloxacin

## PJP & Other Fungal Pneumonia

- Bugs that live in the soil - so be suspicious in dirt bikers or people not responding to antibiotics (or those geographic areas in the USA rosen's lists...Mississippi. Valley...)
  - Histoplasma capsulatum - histoplasmosis
  - Blastomyces dermatitidis - blastomycosis
  - Coccidioides immitis - coccidioidomycosis
- Treatment:** This is a super important differential to think of in the patient with “non-resolving” pneumonia
  - Get help from ID and Respirology (need a bronchoscopy)
  - Managed with: Amphotericin B, Azoles (itraconazole, ketoconazole, fluconazole, etc)

## Pneumocystis pneumonia (PCP)

- Occurs in immunocompromised hosts, principally people with immune deficiency syndrome (AIDS) or malignancy. Pneumocystis jirovecii (previously known as Pneumocystis carinii) is one of the most common infections leading to a diagnosis of HIV infection and AIDS
- Patients with pulmonary complaints should be questioned about HIV risk factors, and clinicians should search for signs of HIV-related immunosuppression, such as weight loss, lymphadenopathy, and oral thrush.
- Presentation: PCP typically manifests subacutely with fatigue, exertional dyspnea, nonproductive cough, pleuritic chest pain, and fever.
- Treatment:** Septra

## Tuberculosis

- Mycobacterium tuberculosis is a slow-growing bacterium transmitted between people by droplet nuclei produced from coughing and sneezing.
- M. tuberculosis survives within macrophages and may remain dormant in the body for many years.
- Active tuberculosis (TB) develops within 2 years of infection in approximately 5% of patients, and another 5% develop reactivation disease at some later time.



- Reactivation is more likely to occur in people with: impaired cell-mediated immunity, such as patients with diabetes, renal failure, immuno- suppressive therapy, malnutrition, or AIDS.
- Approximately one third of the world's population is infected with M. tuberculosis. Approximately 8 million new cases of active disease develop annually, resulting in 3 million deaths worldwide. An estimated 10 to 15 million people in the United States (3-5% of the population) are infected with TB.
- Multidrug-resistant strains of M. tuberculosis are found in increasing numbers, especially among immigrants from Southeast Asia and AIDS patients.
- Treatment:** Non drug resistant suggest isoniazid or rifampicin consider consult with ID and admission

### Tularemia

- Not specifically covered in this chapter but important
- Tularemia is the zoonotic infection caused by Francisella tularensis
- an aerobic and fastidious gram-negative bacterium.
- Treatment:** Gentamicin or Doxy / Ciprofloxacin if mild disease. Aminoglycosides are generally the agents of choice. Duration 7 to 10 days, but can extend to 14 days

### Hantavirus

- Zoonotic infection from rodent family
- Two major forms of hantavirus disease are recognized: hemorrhagic fever with renal syndrome (HFRS) and hantavirus cardiopulmonary syndrome (HCPS, also called HPS)
- most severe forms are associated with Sin Nombre virus (SNV) and the southern (prototypical) form of Andes virus;
- In general, case-fatality ratios of HCPS range from 30 to 50 percent for severe forms
- Treatment:** Supportive care / ECMO / Ribavirin

### 3) List the typical etiologies of viral pneumonia?

Infants: Respiratory syncytial virus and parainfluenza virus

Children and Adults: Add Influenza (mostly A) and Metapneumovirus

Don't forget to order your Nasopharyngeal aspirate for your viral panel to determine what pathogen you're dealing with

### 4) Which patient groups should receive pneumovax?

Patients with:

- a) Diabetes
- b) Alcoholism
- c) Cardiovascular disease
- d) Sickle cell disease



- e) Splenectomy
- f) Malignancy
- g) Immunosuppression
- h) Older than 65 years

## 5) Which pneumonias can present with cavitating lesions (abscesses) on x-ray?

- Staph. Aureus (MRSA)
- Anaerobes
- aerobic gram-negative bacilli,
- Fungal disease ie PCP
- TB
- Noninfectious processes (e.g., malignancy and pulmonary vascular disease).

## 6) What is the differential for ?Pneumonia visible on CXR?

Note: Many non-infectious conditions can cause inflammatory lung processes

- Exposure to mineral dusts (e.g., silicosis)
- Chemical fumes (e.g., chlorine and ammonia)
- Toxic drugs (e.g., bleomycin)
- Radiation
- Thermal injury
- Oxygen toxicity
- Immunologic diseases (e.g., sarcoidosis, Goodpasture's syndrome, and collagen vascular disease)
- Hypersensitivity to environmental agents (e.g., farmer's lung disease)
- Tumors may appear initially as a postobstructive infection or adenopathy with peripheral infiltrates.
- Lymphangitic spread of lung malignancy (looks like interstitial PNA)

## 7) Describe the analysis of pleural fluid

Check out: <https://lifeinthefastlane.com/cc/pleural-effusion/>

Pleural effusions can be blood, chyle, transudative or exudative

- Blood – post-op, trauma, malignancy, pulmonary infarct
- Chyle - trauma or rupture thoracic duct (eg strongyloides)
- Transudate – increased hydrostatic pressure (heart and liver failure, fluid overload), decreased oncotic pressure (nephrotic syndrome, losing protein), negative pleural pressure (atelectasis)
- Exudate – parapneumonic effusion, empyema, subphrenic abscess, pancreatitis

Many bugs can cause pleural effusion, including many types of pyogenic bacterial pneumonias, Chlamydomphila species, Legionella species, and TB.





Note: Anaerobic infections associated w/ effusion are prone to empyema.

Which effusions should be sampled?

- Pleural effusion >5cm on lateral upright posterior-anterior chest radiograph
- Significant resp distress
- Anyone with signs of tension / mediastinal shift

What are Light's criteria?

<https://lifeinthefastlane.com/investigations/pleural-fluid-analysis/>

Lights criteria (High protein and LDH = exudate), determines presence of exudate with protein and LDH levels

- Pleural fluid protein to serum protein ratio >0.5
- Pleural fluid LDH to serum LDH ratio >0.6
- Pleural fluid level >2/3 of upper value for serum LDH
- Additional criteria – Confirm exudate if results equivocal
  - Serum albumin – pleural fluid albumin <1.2g/dL

## 8) What is the CURB65 score?

Confusion

Uremia (blood urea nitrogen >20 mg/dL)

Respiratory rate greater than 30

Blood pressure less than 90 systolic or less than 60 diastolic,

65 years (age) or greater.

How to use it: The risk of 30-day mortality increases with a greater number of these factors present:

- 0.7% with zero factors
- 9.2% with two factors
- 57% with five factors.
- Patients with zero or one feature can receive o/p management
- 2 - Admit
- 3 - consider ICU

## Summary

Key point: \*\*\*Radiologic and clinical findings are nonspecific for predicting a particular infectious cause!\*\*\*