Pneumonia

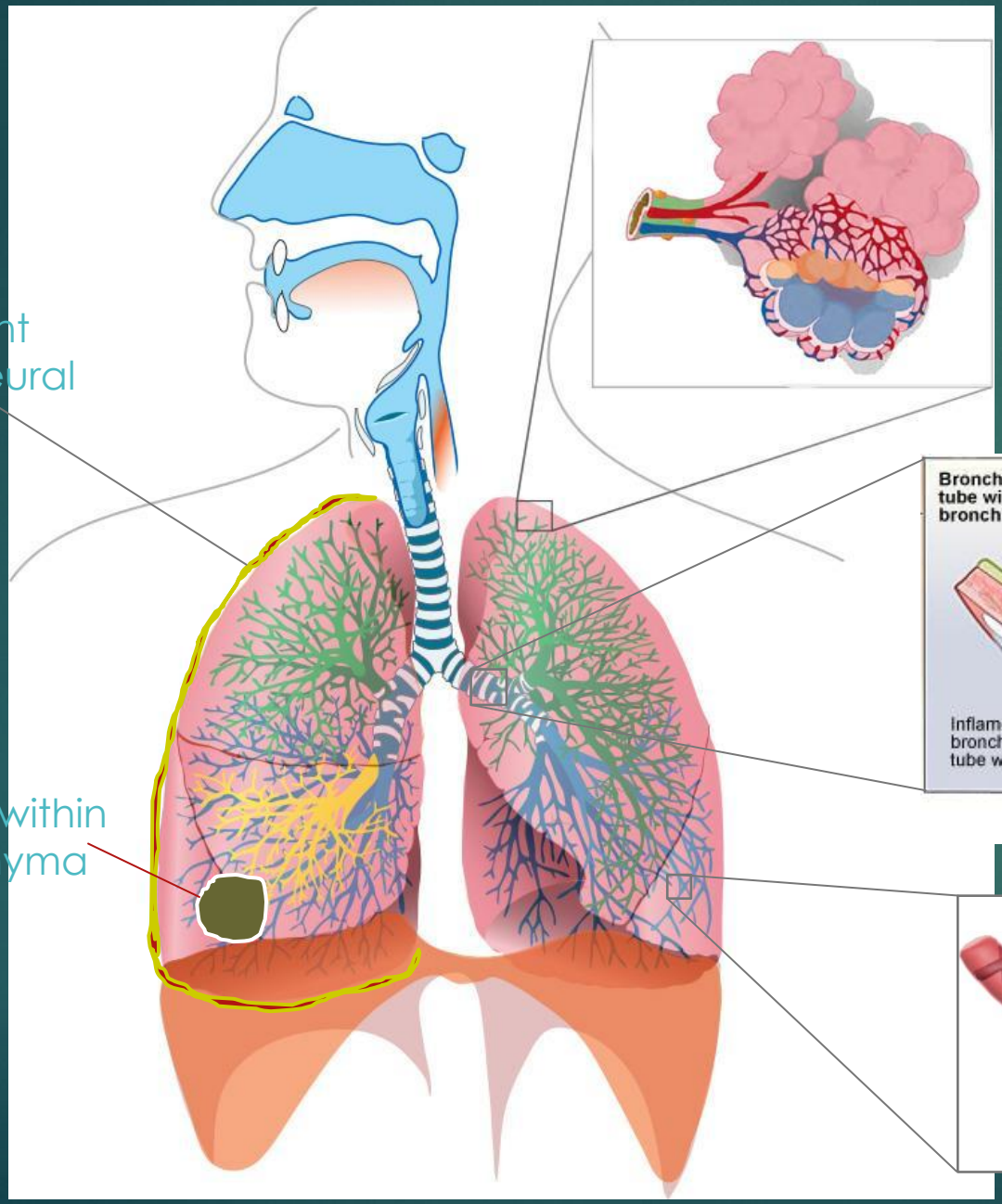
Pneumonia

- Definitions
- Classifications
- Epidemiology
- Pathophysiology/Pathogenesis
- Microbiology
- History
- Physical Examination
- Investigations: Imaging and labs
- Complications
- Differential diagnosis
- Management
- Prevention

Definitions

- The term **"Pneumonia"** is usually used to describe an **infection** of the lung **parenchyma**. Although it is still used to describe some non infectious diseases (e.g. eosinophilic pneumonia).
- Don't confuse it with other infections of the lower respiratory tract.
- Because it is affecting the lung parenchyma almost all pneumonias will have some **radiologic findings** (with rare exceptions)

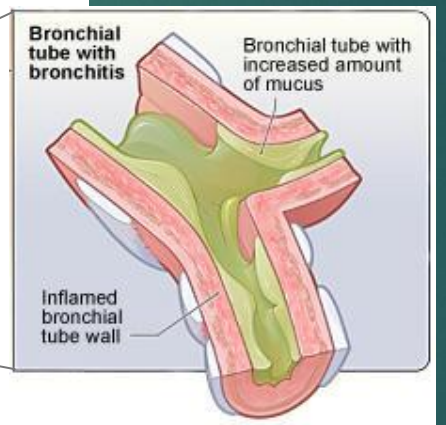
Lower respiratory and pleural disease



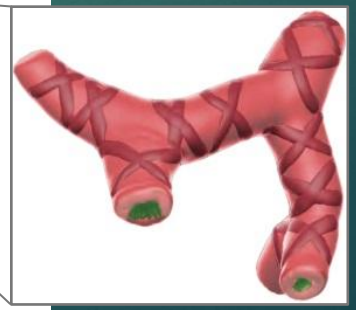
Empyema: purulent exudate in the pleural cavity

Abscess: circumscribed collection of pus within the lung parenchyma

Pneumonia -- infection of alveoli (viral or bacterial)
vs. **Pneumonitis** -- immune-mediated inflammation of alveoli, XRT pneumonitis, aspiration pneumonitis…



Bronchitis -- inflammation of bronchi, may be **immune-mediated**, e.g. asthma, COPD, or **infectious** (usually viral but can be bacterial)



Bronchiolitis: inflammation of bronchioles (often viral but can be bacterial or autoimmune)

Classifications

ATS/IDSA:

- Community Acquired Pneumonia
- Hospital Acquired Pneumonia
- Ventilator Associated Pneumonia
- Others (Pneumonia in immunocompromised patients, TB etc..)

What are these:

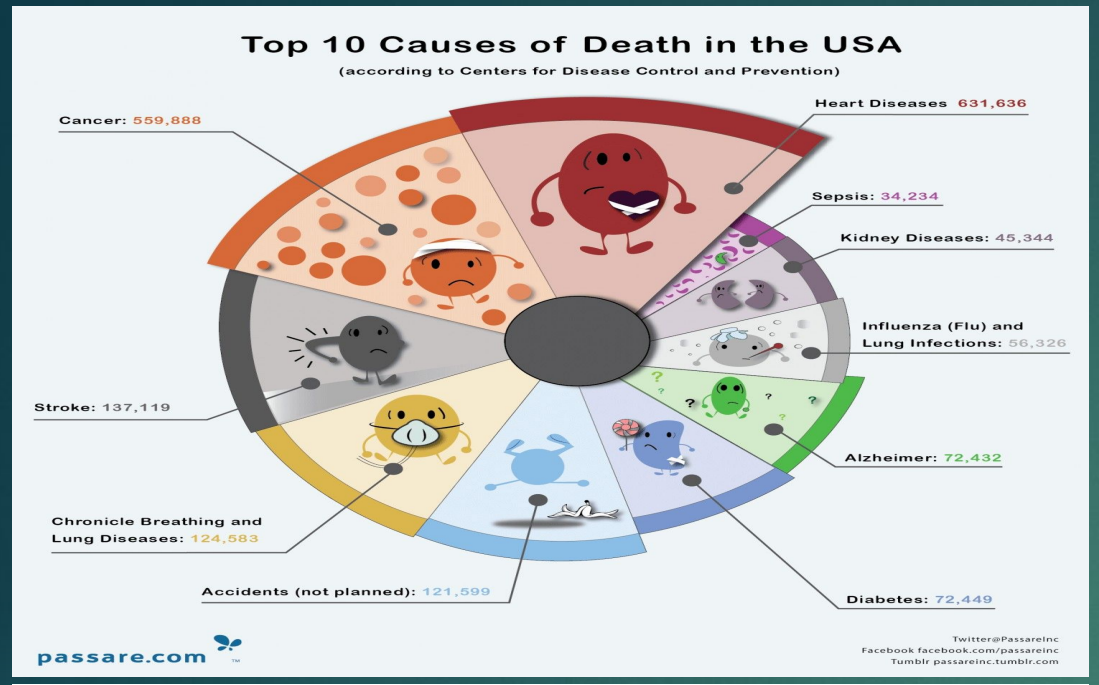
- HCAP???
- Atypical??
- Pneumonia based on organisms??

- Why it is important to know this classification??

Epidemiology

- Accounts for around 10% of all admissions to hospitals in the united states.

- A significant cause of morbidity and mortality in adults.


Top 10 Causes of Death in the USA
(according to Centers for Disease Control and Prevention)
Cancer: 559,888
Heart Diseases 631,636
Sepsis: 34,234
Kidney Diseases: 45,344
Influenza (Flu) and Lung Infections: 56,326
Stroke: 137,119
Alzheimer: 72,432
Chronicle Breathing and Lung Diseases: 124,583
Accidents (not planned): 121,599
Diabetes: 72,449
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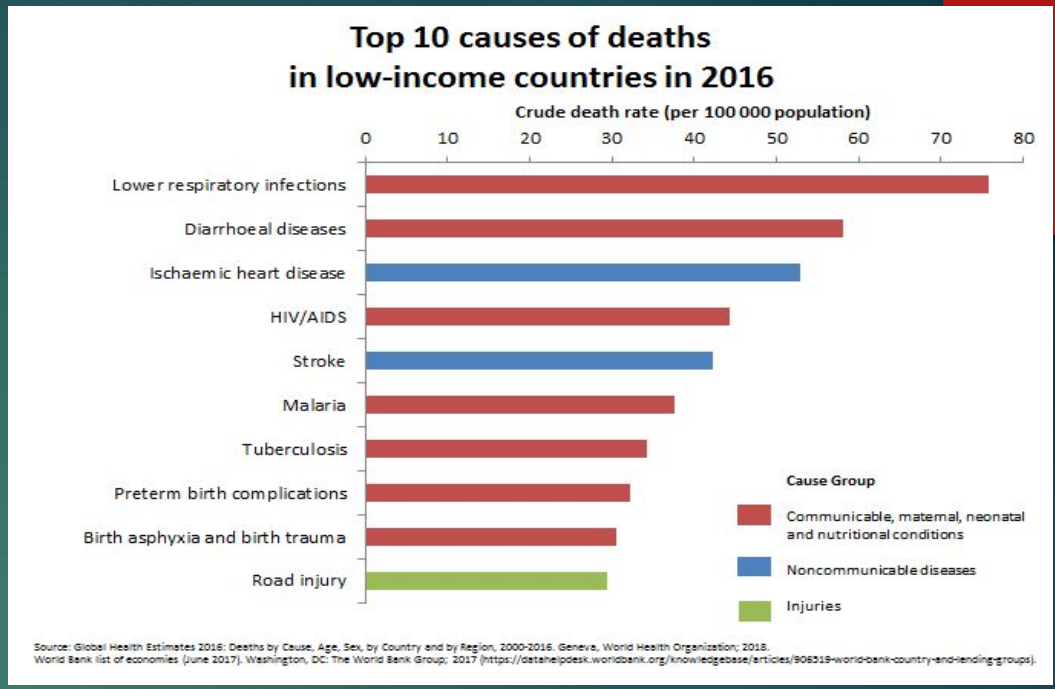
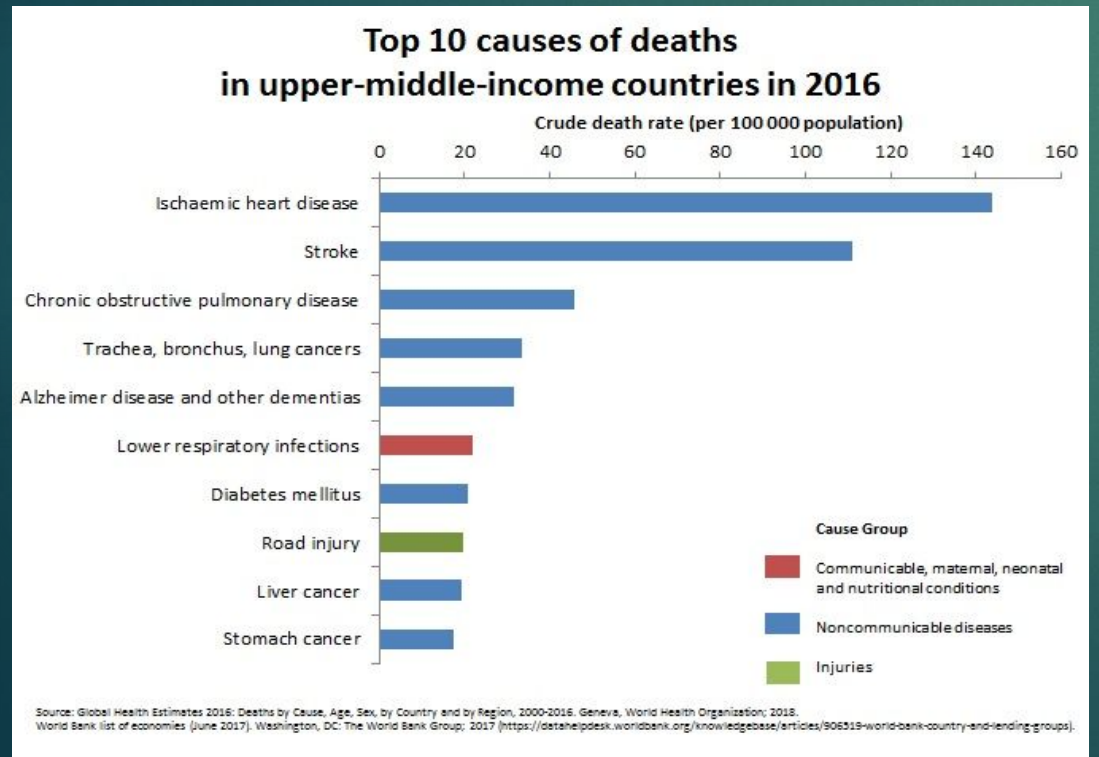

Top 10 causes of deaths
in low-income countries in 2016
Crude death rate (per 100 000 population)
0 10 20 30 40 50 60 70 80
Lower respiratory infections
Diarrhoeal diseases
Ischaemic heart disease
HIV/AIDS
Stroke
Malaria
Tuberculosis
Preterm birth complications
Birth asphyxia and birth trauma
Road injury
Cause Group
Communicable, maternal, neonatal and nutritional conditions
Noncommunicable diseases
Injuries
Source: Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. Geneva, World Health Organization; 2018.
World Bank list of economies (June 2017). Washington, DC: The World Bank Group; 2017 (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).


Top 10 causes of deaths
in upper-middle-income countries in 2016
Crude death rate (per 100 000 population)
0 20 40 60 80 100 120 140 160
Ischaemic heart disease
Stroke
Chronic obstructive pulmonary disease
Trachea, bronchus, lung cancers
Alzheimer disease and other dementias
Lower respiratory infections
Diabetes mellitus
Road injury
Liver cancer
Stomach cancer
Cause Group
Communicable, maternal, neonatal and nutritional conditions
Noncommunicable diseases
Injuries
Source: Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. Geneva, World Health Organization; 2018.
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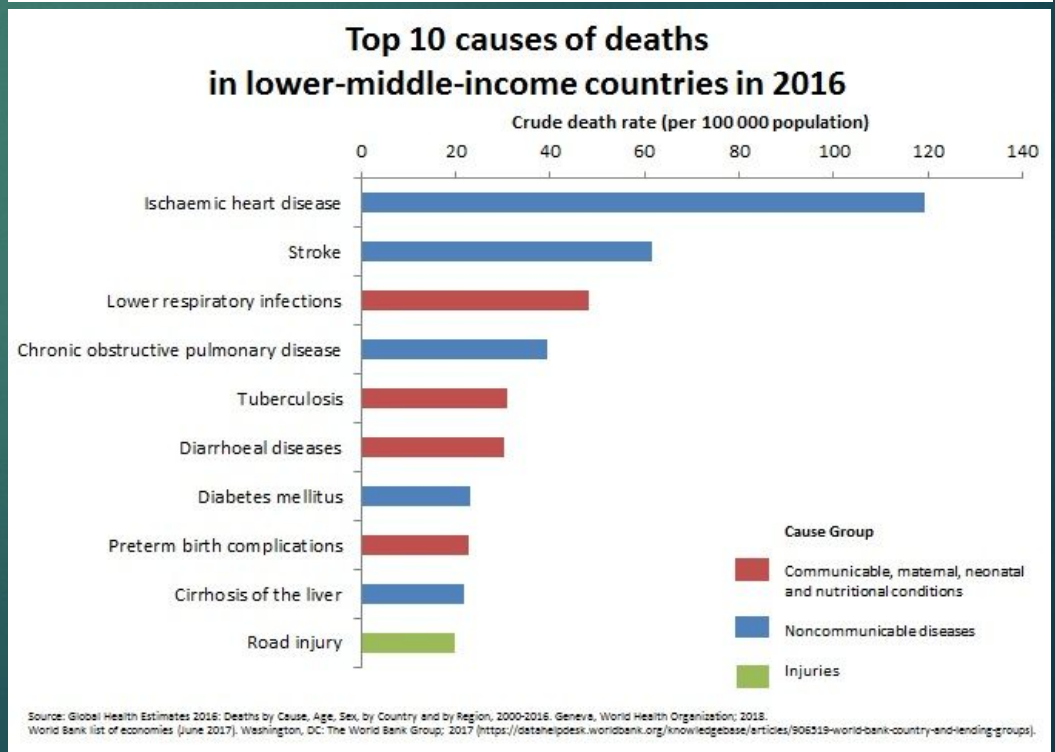
Top 10 causes of deaths
in lower-middle-income countries in 2016
Crude death rate (per 100 000 population)
0 20 40 60 80 100 120 140
Ischaemic heart disease
Stroke
Lower respiratory infections
Chronic obstructive pulmonary disease
Tuberculosis
Diarrhoeal diseases
Diabetes mellitus
Preterm birth complications
Cirrhosis of the liver
Road injury
Cause Group
Communicable, maternal, neonatal and nutritional conditions
Noncommunicable diseases
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Pathophysiology/Pathogenesis

Is the lower respiratory tract a sterile area???

Interactions between host and pathogens.

- **Inhalation**
- **Aspiration**
- **Hematogenous spread**
- **Direct extension from adjacent infected foci**
- Tuberculosis can spread contiguously from the lymph nodes to the pericardium or the lung, but this is only rarely a route of pneumonia formation

Microbiology

Mild to severe

1. *Mycoplasma pneumoniae* 2. *Streptococcus pneumoniae* 3. *Chlamydophila pneumoniae* 4. *Haemophilus influenzae* 5. Respiratory viruses	1. *Streptococcus pneumoniae* 2. *Mycoplasma pneumoniae* 3. *Chlamydophila pneumoniae* 4. *Haemophilus influenzae* 5. *Staphylococcus aureus* 6. Mixed infections 7. Enteric gram-negative bacilli 8. Aspiration (anaerobes) 9. Respiratory viruses 10. *Legionella* species	1. *Streptococcus pneumoniae* 2. Enteric gram-negative bacilli 3. *Staphylococcus aureus* 4. *Legionella* species 5. *Mycoplasma pneumoniae* 6. Respiratory viruses 7. *Pseudomonas aeruginosa* (relative frequency determined by the presence or absence of specific risk factors)

This is in the general population. In special patients groups like immunocpmpromised patients other pathogens can cause pneumonia (e.g. fungal infections, CMV, Atypical mycobacterium…etc)

History

- Pneumonia is characterized by the presence of fever, altered general well-being, and respiratory symptoms, such as cough (90%), sputum production (66%), dyspnea (66%), pleuritic pain (50%), and hemoptysis (15%).

- In older and immunocompromised patients, the signs and symptoms of pulmonary infection may be muted and overshadowed by nonspecific complaints, pneumonia may present with general weakness, decreased appetite, altered mental status, incontinence, or decompensation due to underlying disease.

- Pneumococcal pneumonia: "classic" history, such as that of the patient with pneumococcal infection who presents with sudden onset of rigor followed by pleuritic chest pain, dyspnea, and cough with rusty sputum.

- *Legionella* pneumonia may complain predominantly of diarrhea, fever, headache, confusion, and myalgia.

- *M. pneumoniae* infection, extrapulmonary manifestations such as myringitis, encephalitis, uveitis, iritis, and myocarditis may be present. However, only rarely does the clinical history clearly suggest a specific etiologic diagnosis.

- **Information obtained from the clinical history and physical examination is not sufficient to confirm the diagnosis of pneumonia. A definitive diagnosis requires the finding of a new opacity on the chest radiograph.**

- ***Typical Vs. Atypical syndromes*.**

- "Typical" characteristically caused by bacteria such as *S. pneumoniae, H. influenzae,* and *K. pneumoniae*. The initial presentation is frequently acute, with an intense chill. Productive cough is present, and the sputum is purulent or bloody. Physical examination reveals typical findings of pulmonary consolidation . Blood tests show leukocytosis with neutrophilia and the presence of band forms in most cases. Chest radiography shows lobar consolidation with air bronchograms.

- “Atypical pneumonia.” : gradual onset of fever, nonproductive cough, and a relatively normal white blood cell count in a patient without a readily demonstrable bacterial pathogen, systemic complaints are more prominent than the respiratory ones. The atypical syndrome is characteristic of infections by pathogens such as *M. pneumoniae, Chlamydophila*species, *C. burnetii,* and viruses.

- Neither the clinical symptoms nor the radiographic manifestations are sufficiently sensitive or specific to guide pathogen-directed antibiotic treatment against “typical” versus “atypical” microorganisms.

TABLE 10. Possible Microbial Causes of Community-Acquired Pneumonia

Characteristics	Commonly Encountered Pathogens
Clinical Presentation	
Aspiration	Gram-negative enteric pathogens, oral anaerobes
Cough >2 weeks with whoop or posttussive vomiting	*Bordetella pertussis*
Lung cavity infiltrates	Community-associated methicillin-resistant *Staphylococcus aureus*, oral anaerobes, endemic fungal pathogens, *Mycobacterium tuberculosis*, atypical mycobacteria
Epidemiology or Risk Factor	
Alcoholism	*Streptococcus pneumoniae*, oral anaerobes, *Klebsiella pneumoniae*, *Acinetobacter* species, *M. tuberculosis*
COPD and/or smoking	*Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Legionella* species, *S. pneumoniae*, *Moraxella catarrhalis*, *Chlamydophila pneumoniae*
Exposure to bat or bird droppings	*Histoplasma capsulatum*
Exposure to birds	*Chlamydophila psittaci* (if poultry: avian influenza)
Exposure to rabbits	*Francisella tularensis*
Exposure to farm animals or parturient cats	*Coxiella burnetii*
Exposure to rodent excreta	Hantavirus
HIV infection (early)	*S. pneumoniae*, *H. influenzae*, *M. tuberculosis*
HIV infection (late)	*S. pneumoniae*, *H. influenzae*, *M. tuberculosis*, *Pneumocystis jirovecii*, *Cryptococcus* species, *Histoplasma* species, *Aspergillus* species, atypical mycobacteria (especially *Mycobacterium kansasii*), *P. aeruginosa*
Hotel or cruise ship stay in previous 2 weeks	*Legionella* species
Travel or residence in southwestern United States	*Coccidioides* species, hantavirus
Travel or residence in Southeast and East Asia	*Burkholderia pseudomallei*, avian influenza, severe acute respiratory syndrome–coronavirus (SARS-CoV)
Travel or residence in (or exposure to an ill traveler from) the Middle East	Middle East respiratory syndrome–coronavirus (MERS-CoV)
Influenza activity in community	Influenza, *S. pneumoniae*, *S. aureus*, *H. influenzae*
Injection drug use	*S. aureus*, anaerobes, *M. tuberculosis*, *S. pneumoniae*
Endobronchial obstruction	Anaerobes, *S. pneumoniae*, *H. influenzae*, *S. aureus*
Bronchiectasis or cystic fibrosis	*Burkholderia cepacia*, *P. aeruginosa*, *S. aureus*
Bioterrorism	*Bacillus anthracis*, *Yersinia pestis*, *Francisella tularensis*

Adapted with permission from Mandell LA, Wunderink RG, Anzueto A, et al; Infectious Diseases Society of America; American Thoracic Society. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis. 2007 Mar 1;44(suppl 2):S27-72. [PMID: 17278083] Copyright 2007, Oxford University Press.

Physical examination

- General
- Vital signs
- Hands
- H&N
- Chest
- Heart
- Abdomen
- LEs

- Expansion: reduced on the affected side.
- Vocal fremitus: increased on the affected side (in other chest disease this sign is of very little use!).
- Percussion: dull, but not stony dull.
- Breath sounds: bronchial.
- Additional sounds: medium, late or pan-inspiratory crackles as the pneumonia resolves.
- Vocal resonance: increased.
- Pleural rub: may be present

Disorder	Mediastinal displacement	Chest wall movement	Percussion note	Breath sounds	Added sounds
Consolidation	None	Reduced over affected area	Dull	Bronchial	Crackles
Collapse	Ipsilateral shift	Decreased over affected area	Dull	Absent or reduced	Absent
Pleural effusion	Heart displaced to opposite side (trachea displaced only if massive)	Reduced over affected area	Stony dull	Absent over fluid; may be bronchial at upper border	Absent; pleural rub may be found above effusion
Pneumothorax	Tracheal deviation to opposite side if under tension	Decreased over affected area	Resonant	Absent or greatly reduced	Absent
Bronchial asthma	None	Decreased symmetrically	Normal or decreased	Normal or reduced	Wheeze
Interstitial pulmonary fibrosis	None	Decreased symmetrically (minimal)	Normal unaffected by cough or posture	Normal	Fine, late or pan-inspiratory crackles over affected lobes

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Coarse crackles

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Bronchial breath sounds

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Pleural friction rub

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- ***Clues to the etiologic diagnosis may lie outside the respiratory tract.***

- Bradycardia in relation to the amount of fever (pulse should increase by 10 beats/min/°C of temperature elevation) has been associated with pneumonia due to Legionella, C. psittaci, Mycoplasma, or F. tularensis.

- M. pneumoniae infection may present with extrapulmonary manifestations including arthralgia, cervical lymphadenopathy, bullous myringitis, diarrhea, myalgia, myocarditis, hepatitis, nausea, pericarditis, and vomiting. Skin lesions of erythema multiforme or erythema nodosum suggest Mycoplasma infection (as well as tuberculosis and endemic fungal infection), whereas lesions of ecthyma gangrenosum are most often seen with P. aeruginosa infection.

- Finally, the examiner must look for the presence of complications such as pleural effusion, pericarditis, endocarditis, arthritis, and central nervous system involvement, which may necessitate further diagnostic procedures and, potentially, a change in therapy.

Laboratory Evaluation/basic labs

- CBC
- Blood Gas
- CRP
- ESR
- PCT
- KFT
- LFT

Laboratory Evaluation/Microbiologic eval.

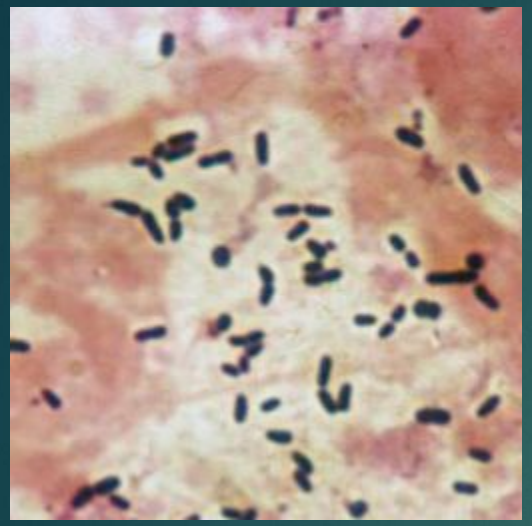
PATIENTS WHO DO NOT REQUIRE HOSPITALIZATION
None*
PATIENTS WHO REQUIRE HOSPITALIZATION
1. Two sets of blood cultures (obtained prior to antibiotics) 2. Gram stain and culture of a valid sputum sample 3. Urinary antigen test for detection of *Legionella pneumophila* (in endemic areas or during outbreaks) 4. Stain for acid-fast bacilli and culture of sputum (if tuberculosis is suggested by clinical history or radiologic findings) 5. Fungal stain and culture of sputum, and fungal serologies (if infection by an endemic mycosis is suggested by the clinical history or radiologic findings) 6. Sputum examination for *Pneumocystis jirovecii* (if suggested by clinical history or radiologic findings) 7. Nucleic acid amplification tests for *Mycoplasma pneumoniae, Chlamydophila pneumoniae, Chlamydophila psittaci, Coxiella burnetii, Legionella* species, and respiratory viruses (in endemic areas or during outbreaks) 8. Culture and microscopic evaluation of pleural fluid (if significant fluid is present)
ADDITIONAL TESTS FOR PATIENTS WHO REQUIRE TREATMENT IN AN ICU
1. Gram stain and culture of endotracheal aspirate or bronchoscopically obtained specimens using a protected specimen brush or BAL 2. Other procedures as for other hospitalized patients
BAL, bronchoalveolar lavage; ICU, intensive care unit.

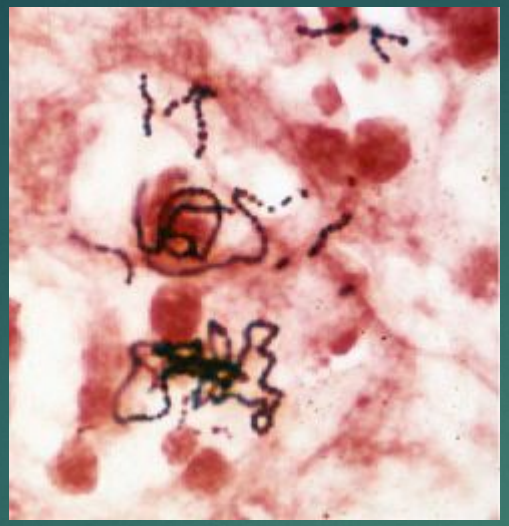
Clinical Indications for More Extensive Testing in Community-Acquired Pneumonia

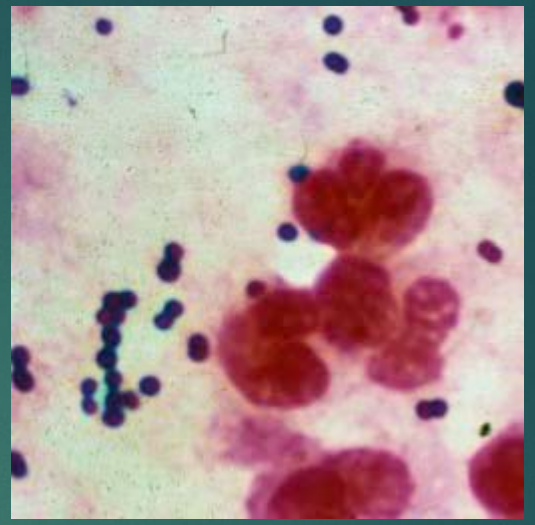
1. Intensive care unit admission
2. Failure of outpatient antibiotic therapy
3. Radiographic cavities
4. Leukopenia
5. Active alcohol abuse
6. Chronic severe liver disease
7. Severe obstructive/structural lung disease
8. Asplenia
9. Recent travel (within past 2 weeks)
10. Positive *Legionella* UAT result
11. Positive pneumococcal UAT result
12. Pleural effusion

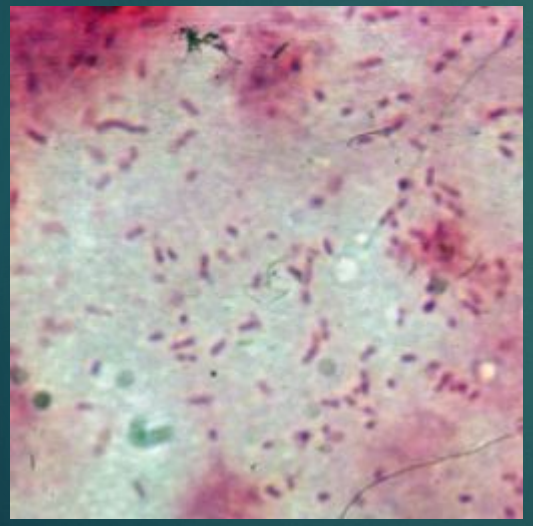
Laboratory Evaluation/Sputum Examination

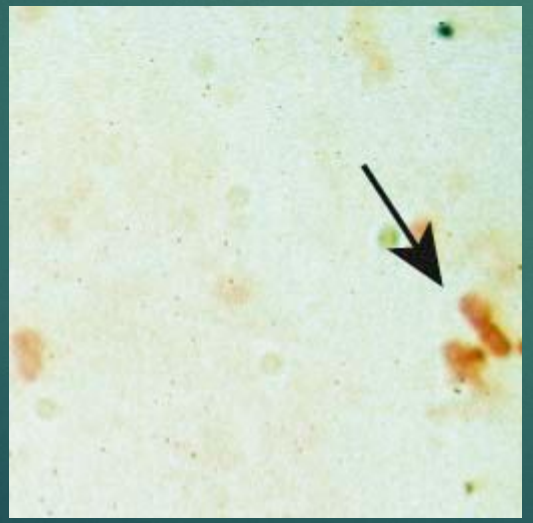
- Easy to do.
- A specimen with few or no squamous cells and many polymorphonuclear white blood cells (>25 cells/low-power field in a sample from a patient who is not
- The latest IDSA/ATS guidelines recommend obtaining a sputum sample for Gram stain and culture in hospitalized patients.
- In ventilated patients, the equivalent of sputum is the endotracheal aspirate.
- Some bacterial agents of pneumonia cannot be cultivated on conventional laboratory media. For example, *Legionella* requires buffered charcoal yeast extract agar for isolation, whereas recovery of *Chlamydophila* species and *C. burnetii* requires culture in mammalian cell lines.

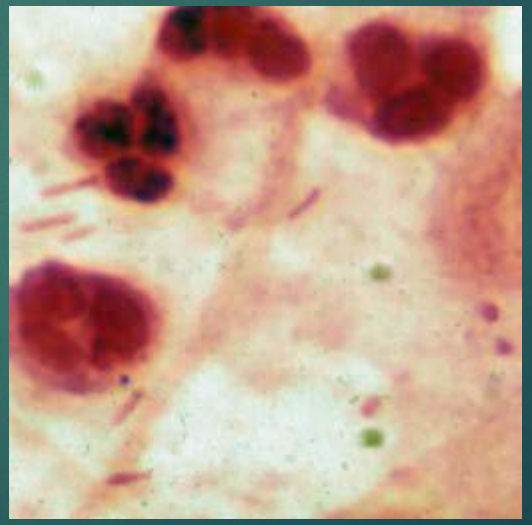












Laboratory Evaluation/Blood and Pleural Fluid Cultures

- The overall yield of blood cultures is less than 20% in patients hospitalized for CAP.
- The detected rate of bacteremia is lower in patients with mild CAP and higher in patients with severe CAP, especially those warranting ICU care. Prior antibiotic treatment decreases the yield of blood cultures.
- In up to 40% of CAP cases, a pleural effusion may be present. Although the specificity of pleural exudate cultures is very high, the sensitivity is low because of the low incidence of invasion of the pleura. Diagnostic thoracentesis should be performed when a significant pleural effusion is present.

Laboratory Evaluation/Antigen Detection

- Commercial assays can be used to detect capsular polysaccharide antigens of *S. pneumoniae* or *L. pneumophila* serogroup 1 in urine. The sensitivity of these tests is little affected by prior antibiotic treatment; indeed, results may remain positive several weeks after successful treatment. The degree of positivity for the *S. pneumoniae* urinary antigen test correlates with the *Pneumonia Severity Index* (PSI). The *S. pneumoniae* antigen test may also be applied on pleural fluid with a sensitivity and specificity of almost 100%.
- For *L. pneumophila* serogroup 1, the sensitivity is 60% to 80%, and the specificity is greater than 95%. Urinary antigen testing is currently the most helpful rapid test for the diagnosis of *Legionella* infections. The major limitation of urinary antigen tests is that currently available tests are intended to detect *L. pneumophila* serogroup 1 antigen only, although this is the most common cause of *Legionella* infection.
- Antigens for the many common respiratory viruses, influenza virus, respiratory syncytial virus, adenovirus, and parainfluenza viruses can be detected by direct immunofluorescence or by enzyme-linked immunoassay.

- **Serologic Evaluation**
- Before the development of nucleic acid amplification tests, serologic techniques were used to establish a microbiologic diagnosis for pneumonia caused by pathogens that cannot be readily cultured. Examples include common pathogens such as *M. pneumoniae, C. pneumoniae,* and *L. pneumophila,* and less common causes of pneumonia such as those caused by the agents of tularemia, brucellosis, and psittacosis, and certain viruses. Diagnosis usually requires that a convalescent specimen demonstrate a fourfold increase in *immunoglobulin* (Ig) *G* titer above that present in an acute specimen. These tests are not helpful in initial patient management but are of utility in defining the epidemiology of the pertinent infectious agents. Because IgM antibodies appear earlier than IgG antibodies, the detection of pathogen-specific IgM in serum has been used for the early serologic diagnosis of certain acute infections.

Laboratory Evaluation/Nucleic Acid Amplification Tests

- Culture procedures for viruses and fastidious bacteria, *M. pneumoniae, C. pneumoniae, L. pneumophila,* and *Bordetella pertussis,* which normally do not colonize in the human respiratory tract, are too insensitive and too slow to be helpful in guiding therapy. These pathogens should be detected by nucleic acid amplification tests; their sensitivity is generally superior to that of the traditional procedures and some are considered as the "gold standard."

- Real-time multiplex polymerase chain reaction assays detect respiratory viruses in both immunocompetent and immunosuppressed hosts.

Invasive Diagnostic Techniques

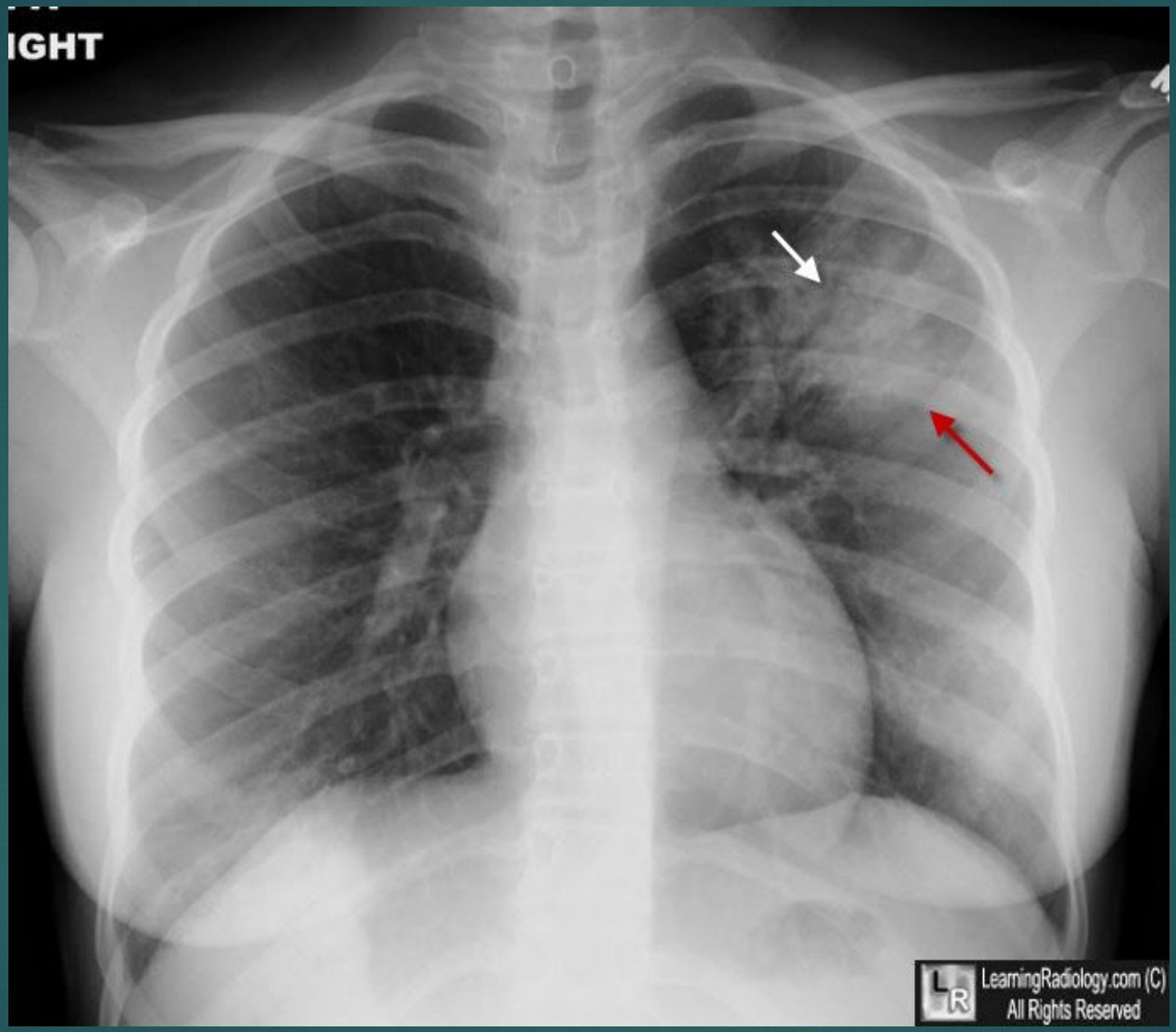
- Bronchoscopic Samples
- Transthoracic Lung Aspiration

Radiographic Evaluation

- Radiographic evaluation is necessary to establish the presence of pneumonia, because there is no combination of historical data, physical findings, or laboratory results that reliably confirms the diagnosis.

- The sensitivity of the chest radiograph is decreased in (1) patients with emphysema, bullae, or structural abnormalities of the lung, who may present with delayed or subtle radiographic changes; (2) obese patients, in whom it may be difficult to discern the existence of pneumonia; and (3) patients with very early infection, severe dehydration, or profound granulocytopenia.

- *Computed tomography* (CT) of the chest provides a more sensitive means of detecting minor radiographic abnormalities.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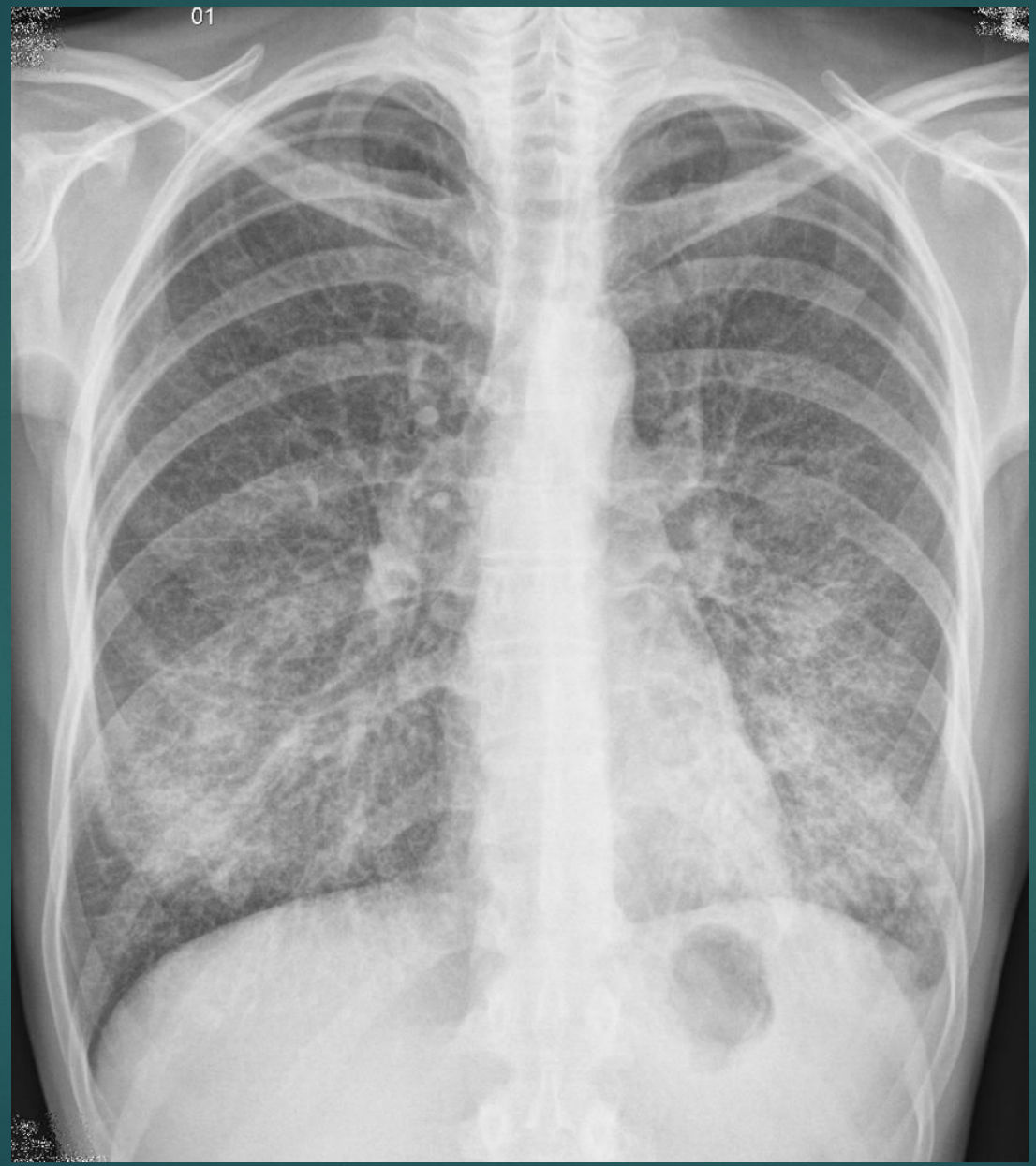
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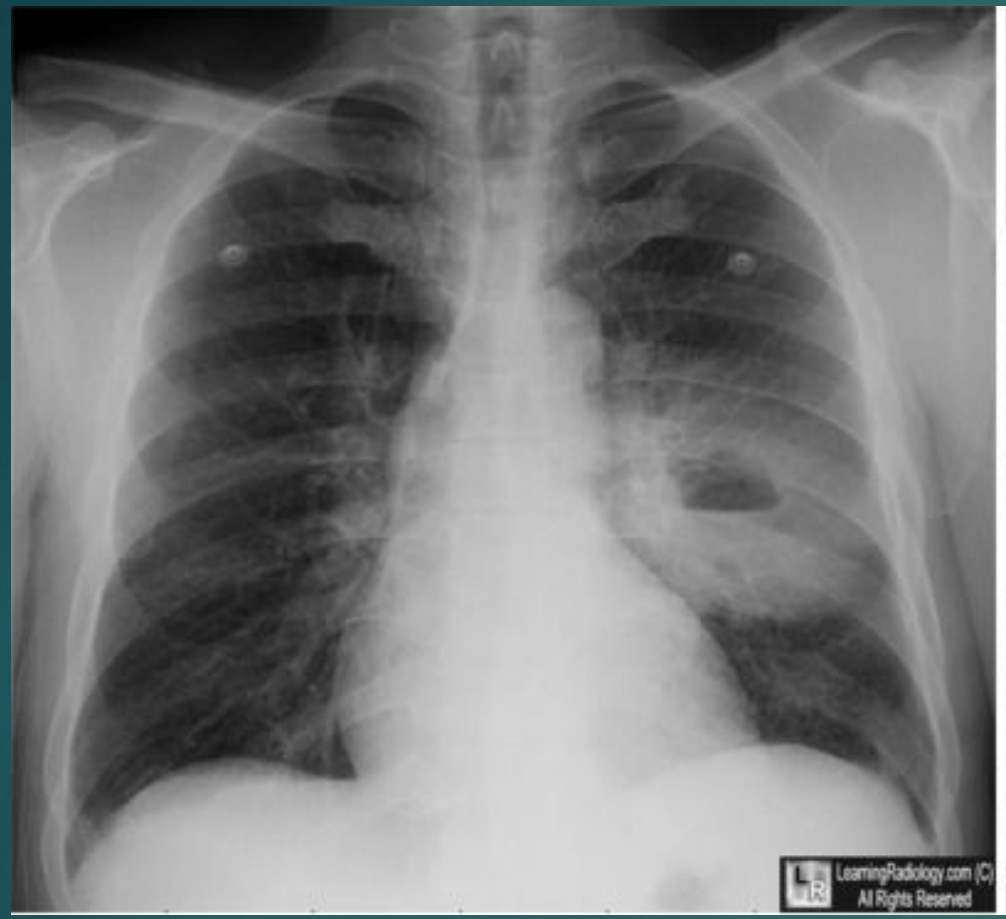
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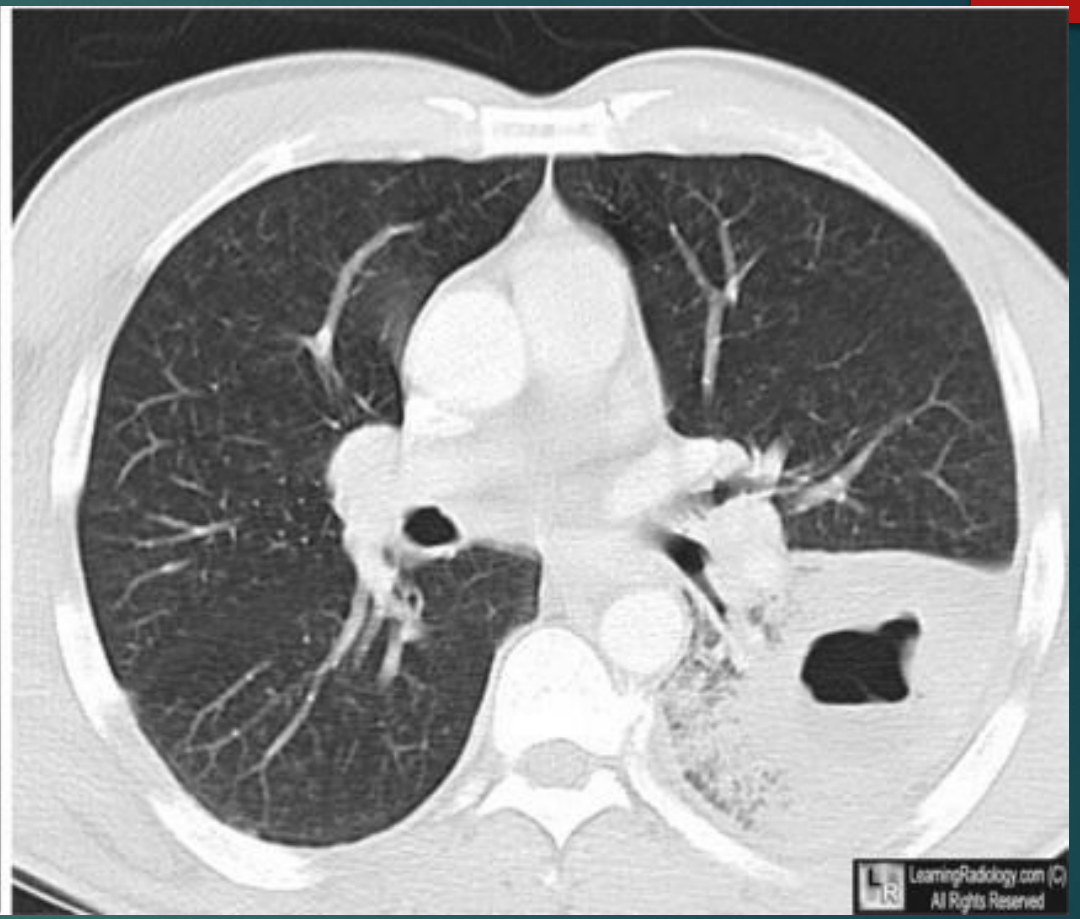
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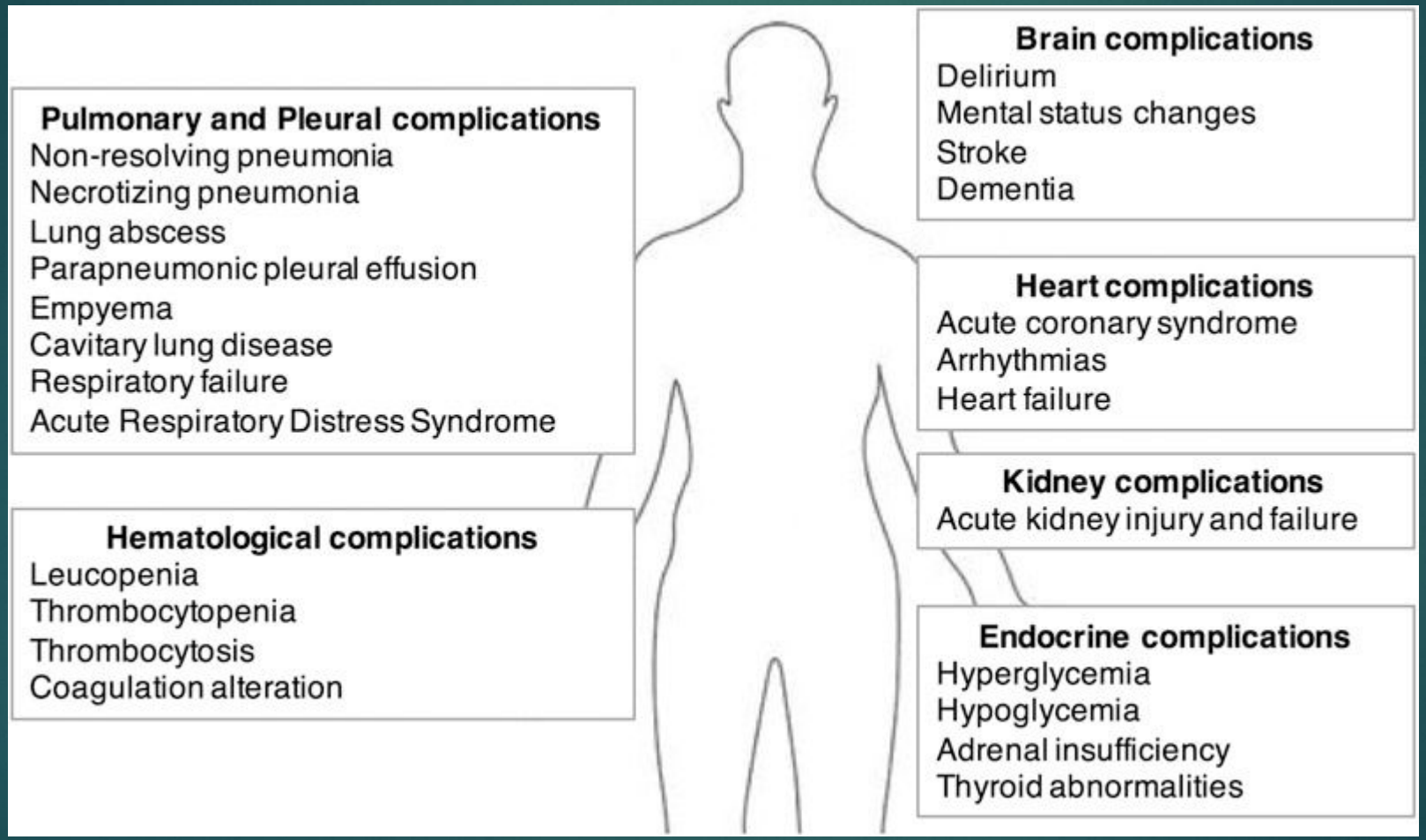
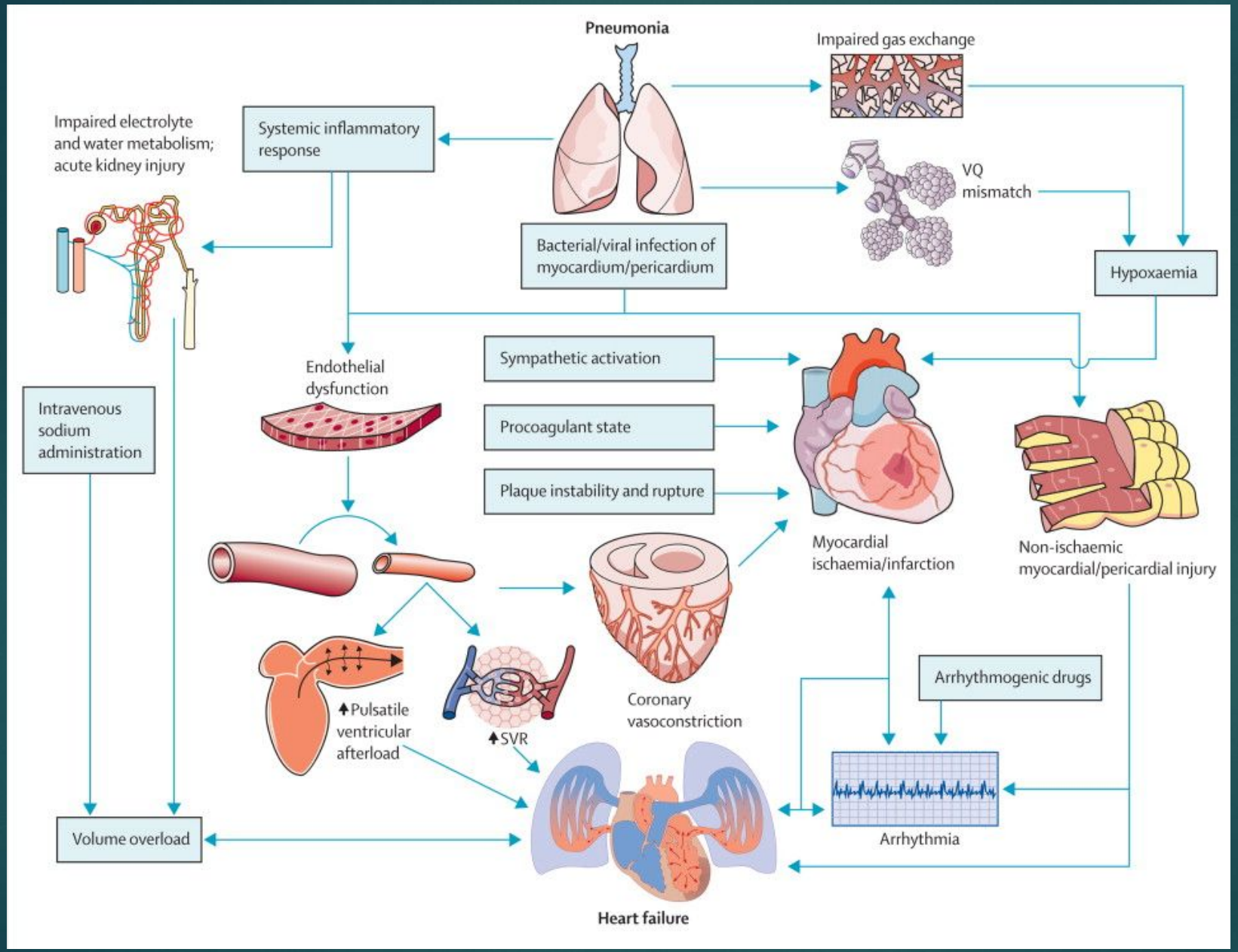
Differential Diagnosis

Pulmonary edema
Pulmonary infarction
Acute respiratory distress syndrome
Pulmonary hemorrhage
Lung cancer or metastatic cancer
Atelectasis
Radiation pneumonitis
Drug reactions involving the lung
Extrinsic allergic alveolitis
Pulmonary vasculitis
Pulmonary eosinophilia
Organizing pneumonia

Complications




Pneumonia
Impaired gas exchange
Impaired electrolyte and water metabolism; acute kidney injury
Systemic inflammatory response
VQ mismatch
Bacterial/viral infection of myocardium/pericardium
Hypoxaemia
Endothelial dysfunction
Sympathetic activation
Intravenous sodium administration
Procoagulant state
Plaque instability and rupture
Myocardial ischaemia/infarction
Non-ischaemic myocardial/pericardial injury
Pulsatile ventricular afterload
SVR
Coronary vasoconstriction
Arrhythmogenic drugs
Volume overload
Arrhythmia
Heart failure

Treatment

- Risk stratify patients.
- Antibiotics.
- Treat complications

CURB-65	Clinical Feature	Points
C	Confusion	1
U	Urea > 7 mmol/L	1
R	RR ≥ 30	1
B	SBP ≤ 90 mm Hg OR DBP ≤ 60 mm Hg	1
65	Age > 65	1

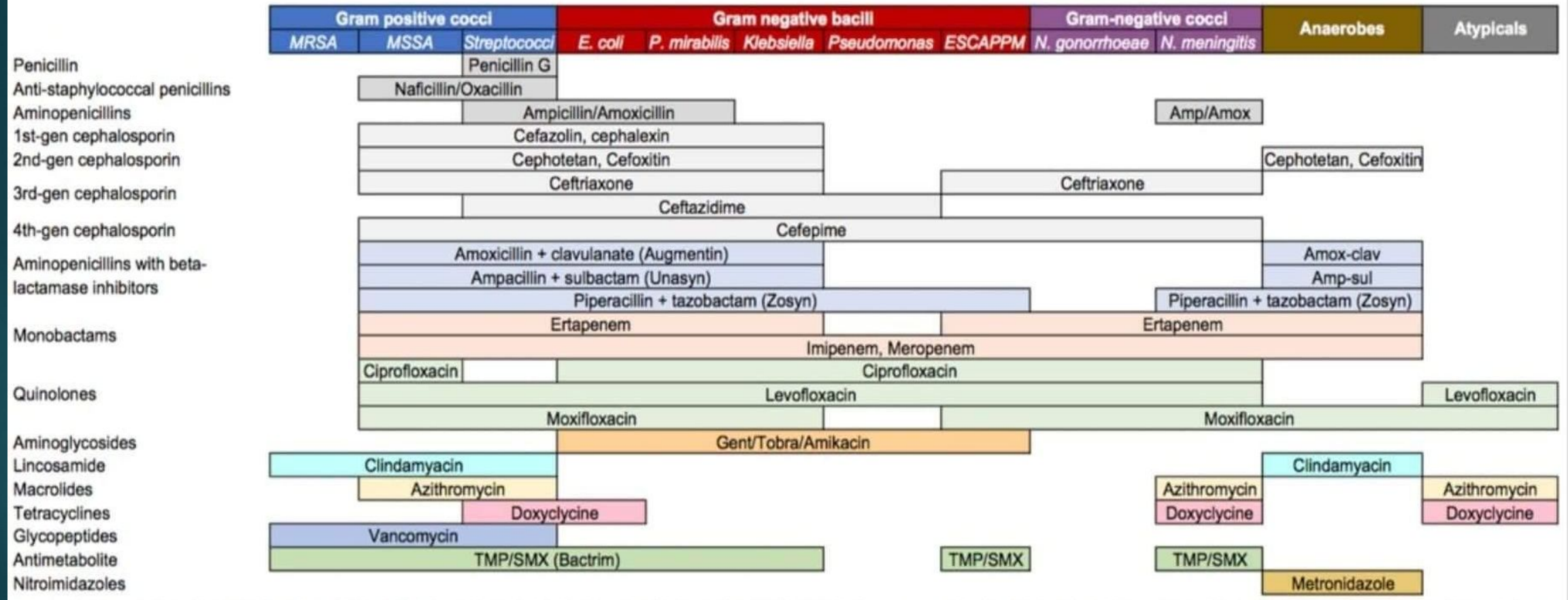
CURB-65 Score	Risk group	30-day mortality	Management
0 -1	1	1.5%	Low risk, consider home treatment
2	2	9.2%	Probably admission vs close outpatient management
3-5	3	22%	Admission, manage as severe

TABLE 12. Antibiotic Therapy for Community-Acquired Pneumonia in Outpatients

Risk Factors	Treatment
Previously healthy and no risk factor(s) for drug-resistant *Streptococcus pneumoniae*	Macrolide (azithromycin, clarithromycin, or erythromycin) or doxycycline
Risk factor(s) for drug-resistant *S. pneumoniae* or underlying comorbidities[a]	Respiratory fluoroquinolone (moxifloxacin, gemifloxacin, or levofloxacin) or β-lactam[b] plus a macrolide or doxycycline

TABLE 13. Empiric Antibiotic Therapy for Community-Acquired Pneumonia in Inpatients

Inpatient Setting	Treatment
Medical ward	β-lactam[a] plus a macrolide or doxycycline; *or* respiratory fluoroquinolone (moxifloxacin, gemifloxacin, or levofloxacin)
ICU	β-lactam[b] plus either azithromycin or a fluoroquinolone[c]; if penicillin allergic, a respiratory fluoroquinolone[d] plus aztreonam[e]
If risk factor(s) for *Pseudomonas aeruginosa* or gram-negative rods on sputum Gram stain	Antipseudomonal β-lactam with pneumococcal coverage (cefepime, imipenem, meropenem, or piperacillin-tazobactam) plus ciprofloxacin or levofloxacin (750 mg); *or* antipseudomonal β-lactam with pneumococcal coverage plus an aminoglycoside plus azithromycin; *or* antipseudomonal[e] β-lactam with pneumococcal coverage plus an aminoglycoside plus a respiratory fluoroquinolone
If risk factor(s) for CA-MRSA, cavitary infiltrates, or compatible sputum Gram stain	Add vancomycin or linezolid to β-lactam[b] plus either azithromycin or a fluoroquinolone[c]



See github.com/aetherist/antibiogram for details. For educational purposes only. TMP/SMX = Trimethoprim-sulfamethoxazole, MRSA = Methicillin-resistant Staphylococcus aureus, MSSA = Methicillin-sensitive Staphylococcus aureus, ESCAPPM = Enterobacter spp., Serratia spp., Citrobacter freundii, Aeromonas spp., Proteus spp., Providencia spp. and Morganella morganii.

Causes of Nonresponding Pneumonia

INFECTIOUS
1. Resistant microorganisms 2. Community-acquired pneumonia (e.g., *Streptococcus pneumoniae, Staphylococcus aureus* 3. Nosocomial pneumonia (e.g., *Acinetobacter*, methicillin-resistant *Staphylococcus aureus, Pseudomonas aeruginosa*) 4. Uncommon microorganisms (e.g., *Mycobacterium tuberculosis*, *Nocardia* spp., fungi, *Pneumocystis jirovecii*) 5. Complications of pneumonia 6. Empyema 7. Abscess or necrotizing pneumonia 8. Metastatic infection
NONINFECTIOUS
1. Neoplasms 2. Pulmonary hemorrhage 3. Pulmonary embolism 4. Sarcoidosis 5. Eosinophilic pneumonia 6. Pulmonary edema 7. Acute respiratory distress syndrome 8. Organizing pneumonia 9. Drug-induced pulmonary disease 10. Pulmonary vasculitis

Prevention of Pneumonia

- **Vaccines**

Prevention of pneumonia may be achieved by administering the influenza and pneumococcal vaccines.

- Smoking cessation.

Recommendations for Administration of Influenza Vaccine*

- Inactivated vaccine: All persons aged 6 months and older including pregnant women
- Live attenuated vaccine: Healthy, nonpregnant women aged 2 to 49 years without high-risk medical conditions

Risk Group	PCV13 Recommended	PPSV23 Recommended	PPSV23 Revaccination 5 Years after First Dose
Immunocompetent	1. Cerebrospinal fluid leak 2. Cochlear implant	1. Chronic heart diseases† 2. Chronic lung diseases‡ 3. Diabetes mellitus 4. Chronic liver diseases 5. Cerebrospinal fluid leak 6. Cochlear implant 7. Alcohol 8. Smoking	
Asplenia	1. Sickle cell disease/ hemoglobinopathy 2. Congenital or acquired asplenia	1. Sickle cell disease/ hemoglobinopathy 2. Congenital or acquired asplenia	1. Sickle cell disease/ hemoglobinopathy 2. Congenital or acquired asplenia
Immunocompromised	1. HIV 2. Congenital or acquired immunodeficiency 3. Chronic renal failure 4. Leukemia/lymphoma 5. Generalized malignancy 6. Solid organ transplant 7. Multiple myeloma 8. Iatrogenic immunosuppression§	1. HIV 2. Congenital or acquired immunodeficiency 3. Chronic renal failure 4. Leukemia/lymphoma 5. Generalized malignancy 6. Solid organ transplant 7. Multiple myeloma 8. Iatrogenic immunosuppression	1. HIV 2. Congenital or acquired immunodeficiency 3. Chronic renal failure 4. Leukemia/lymphoma 5. Generalized malignancy 6. Solid organ transplant 7. Multiple myeloma 8. Iatrogenic immunosuppression

QUESTIONS?