

Pneumonia: Captain of the Men of Death

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Disclosures

- No relevant financial disclosures

Objectives

- Explain the challenges of defining pneumonia
- Summarize the pathogenesis of and host response to pneumonia
- Demonstrate how to establish a clinical diagnosis of pneumonia
- Identify and classify causative agents of pneumonia
- Recognize common syndromes and complications of pneumonia
- Describe a general approach to treatment of pneumonia
- Utilize antimicrobial stewardship tools to manage pneumonia

Why Discuss Pneumonia

- Most common infectious cause of death globally
 - 3.8 million deaths in 2017
- Accounted for 15% of all deaths in children under 5 years old
- Most common infectious cause of admission in the US; 4th most common overall
- 30% of adults hospitalized for CAP in the US die within 1 year

What Is Pneumonia?

“Captain of the Men of Death”



One of the most widespread and fatal of all acute diseases, pneumonia has become the “Captain of the Men of Death,” to use the phrase applied by John Bunyan [(1628-1688), from *The Life and Death of Mr. Badman*] to consumption [tuberculosis].

THE PRINCIPLES AND PRACTICE OF MEDICINE, 165.

400 BC – Hippocrates Describes πνευμονία

- “A condition caused when the lung draws to its side blood, or salted mucus, without egesting them”
- “Its clinical manifestation was presented with intense and dry cough, shaking chills and high fever, chest and back pain, dyspnoea, and orthopnoea”
- “The patient could remain in the same condition for approximately two weeks, and then the pus could be spited out and the expectoration of the humours could appear”
- “When pneumonia is at its height, the case is beyond remedy if he is not purged”
- Other terms: pleurisy, peripneumonia, empyema, pulmonary phthisis, phymatiosis

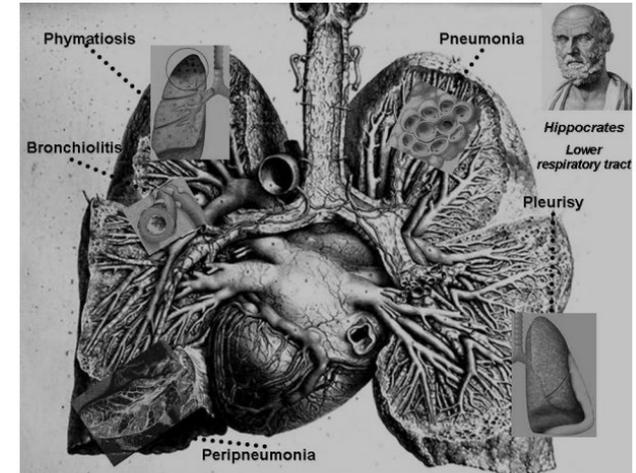


Figure 2: Pathology of the lower respiratory tract inside Corpus Hippocraticum. Lung anatomy, *Anatomie de l'homme*, Bourguery and Jacob, Guérin Editions, Paris 1862.

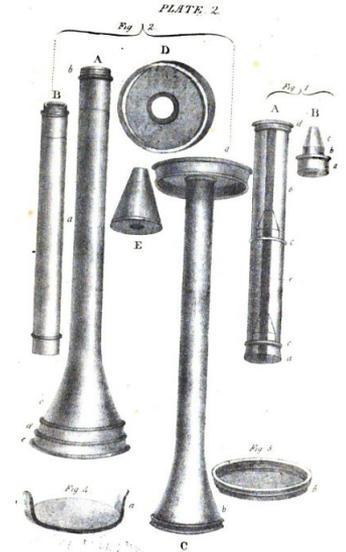
1821 – René Laënnec

Treatise on the Diseases of the Chest or Mediate Auscultation

- Published after discovery of the stethoscope in 1816
- Described pneumonia pathology and pathophysiologic characteristics

Duration of pneumonia, and of its different stages.—Acute pneumonia is one of those diseases, which, from the rapidity and brevity of their course, and the shortness of the period in which treatment can be beneficially applied, demand the utmost attention and vigilance on the part of the physician.

- Additional terms introduced: acute lobar pneumonia, primitive diffuse pneumonia, sthenic pneumonia, croupous pneumonia, acute asthenic exudative pneumonia, pulmonia, peripnumonia vera, simple legitimate pneumonia, pneumonic fever



1929 – Manual of the International List of Causes of Death

101. Pneumonia.

(a) lobar

This subtitle includes:

Acute congestive pneumonia
 hepatization of lung
 inflammation of lung
 interstitial pneumonia
 pleuropneumonia
 pneumonia
 pneumonitis
 pulmonitis
Alcoholic pneumonia
 pneumonitis
Apex pneumonia
Apical pneumonia
Bilateral lobar pneumonia
 pleuropneumonia
 pneumonia
Central pneumonia
Circumscribed pneumonia
Congestive pneumonia
Consolidation of lung
Croupous pneumonia
Diplococcus pneumonia
Double pleuropneumonia
 pneumonia
Epidemic pneumonia

Fibrinous pneumonia
Fulminant pneumonia
Hepatization of lung
Hypostatic lobar pneumonia
Infectious pneumonia
Intermittent pneumonia
Lobar bronchopneumonia
 pneumonia
Lung fever
Massive pneumonia
Migratory pneumonia
Organized pneumonia
Peripneumonia
Pleurolobar pneumonia
Pleuroperipneumonia
Pleuropneumonia
Pneumococcus pneumonia
Pneumonic fever
Pneumopleurisy
Pneumopleuritis
Solidification of lung
Spleno-pneumonia
True pneumonia
Unresolved pneumonia

(b) unspecified

This subtitle includes:

Adynamic pneumonia
Asthenic pneumonia
Cerebral pneumonia
Diffuse pneumonia
Fungoid pneumonia
Gangrenous pneumonia
Inflammation of chest
 lung
Latent pneumonia
Metastatic pneumonia
Pneumococemia
Pneumococcus infection (unqualified)

Pneumonia
Pneumonic congestion
Pneumonitis
Postoperative pneumonia
Progressive pneumonia
Pulmonitis
Senile pneumonia
Septic pleuropneumonia
 pneumonia
Suppurative pneumonia
Surgical pneumonia
Typhoid pneumonia

This title does not include: Pneumonia: caseous (31), or specific (31), or bacillary synonym of tuberculosis of the lungs (see title 31).—Catarrhal pneumonia (100).—Inte (107).—Pulmonary congestion (103).—Hypostatic pneumonia (103).—Pneumatosis (205)
Frequent complications: Suppurative pleurisy.—Pericarditis.

2016 – International Statistical Classification of Diseases and Related Health Problems, 10th Revision

ICD-10 Version:2016

Search pneumonia [Advanced Search] ICD-10

J09-J18 Influenza and pneumonia

- J12.0 Adenoviral pneumonia
- J12.2 Parainfluenza virus pneumonia
- J12.3 Human metapneumovirus pneumonia
- J12.8 Other viral pneumonia
- J12.9 Viral pneumonia, unspecified
- J13 Pneumonia due to Streptococcus pneumoniae
- J14 Pneumonia due to Haemophilus influenzae
- J15.0 Pneumonia due to Klebsiella pneumoniae
- J15.1 Pneumonia due to Pseudomonas
- J15.2 Pneumonia due to staphylococcus
- J15.4 Pneumonia due to other streptococci
- J15.5 Pneumonia due to Escherichia coli
- J15.6 Pneumonia due to other Gram-negative bacteria
- J15.7 Pneumonia due to Mycoplasma pneumoniae
- J15.8 Other bacterial pneumonia
- J15.9 Bacterial pneumonia, unspecified
- J16.0 Chlamydial pneumonia
- J17 Pneumonia in diseases classified elsewhere
 - J17.0 Pneumonia in bacterial diseases classified elsewhere
 - J17.1 Pneumonia in viral diseases classified elsewhere
 - J17.2 Pneumonia in mycoses
 - J17.3 Pneumonia in parasitic diseases
 - J17.8 Pneumonia in other diseases classified elsewhere
- J18 Pneumonia, organism unspecified
 - J18.0 Bronchopneumonia, unspecified
 - J18.1 Lobar pneumonia, unspecified
 - J18.2 Hypostatic pneumonia, unspecified
 - J18.8 Other pneumonia, organism unspecified
 - J18.9 Pneumonia, unspecified

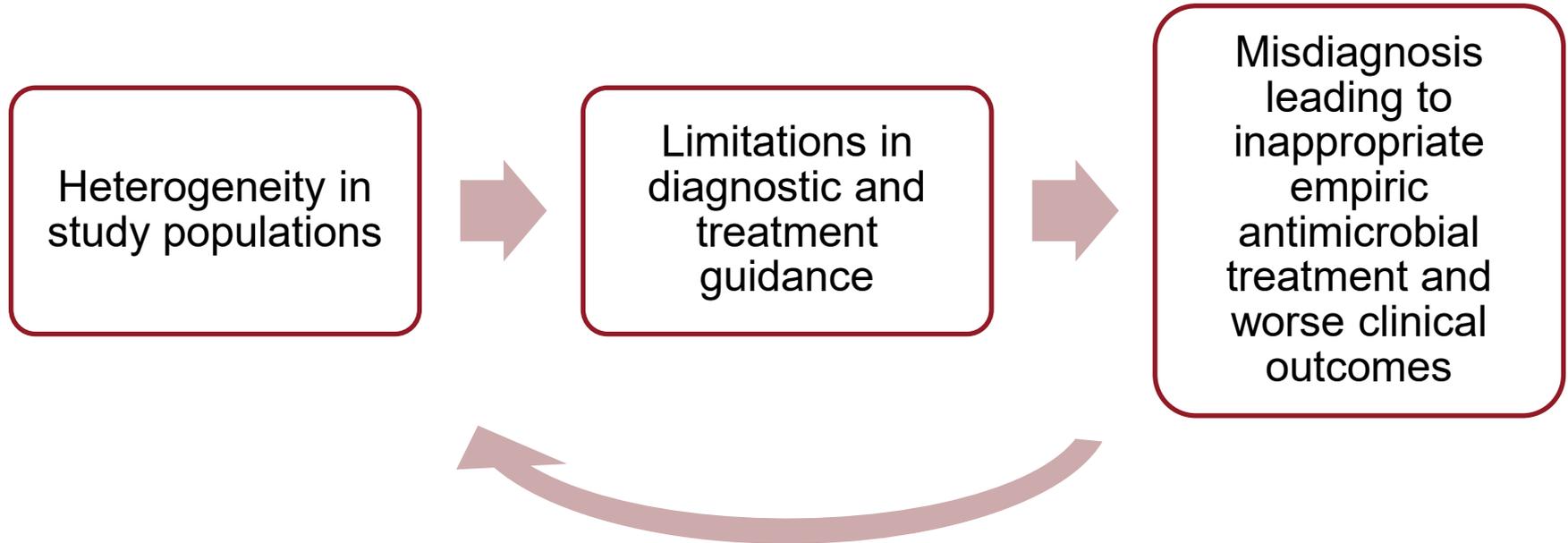
- A02.2 Localized salmonella infections
 - Salmonella: pneumonia
- A24.1 Acute and fulminating melioidosis
 - Melioidosis: pneumonia
- A54.8 Other gonococcal infections
 - Gonococcal: pneumonia
- B01.2 Varicella pneumonia
- B06.8 Rubella with other complications
 - Rubella: pneumonia
- J69.0 Pneumonitis due to food and vomit
 - Aspiration pneumonia (due to): NOS
- J69.1 Pneumonitis due to oils and essences
 - Lipid pneumonia
- J82 Pulmonary eosinophilia, not elsewhere classified
 - Löffler pneumonia
- J84.9 Interstitial pulmonary disease, unspecified
 - Interstitial pneumonia NOS
- P23 Congenital pneumonia
 - P23.1 Congenital pneumonia due to Chlamydia
 - P23.6 Congenital pneumonia due to other bacterial agents
 - P23.9 Congenital pneumonia, unspecified
- B05.2 Measles complicated by pneumonia
- B96.0 Mycoplasma pneumoniae [M. pneumoniae] as the cause of diseases classified to other chapters
- A40.3 Sepsis due to Streptococcus pneumoniae
- A70 Chlamydia psittaci infection
 - Ornithosis[with pneumonia A70+]
- B59 Pneumocystosis
 - Pneumonia due to: Pneumocystis carinii
- J84.1 Other interstitial pulmonary diseases with fibrosis
 - Usual interstitial pneumonia
- J85.1 Abscess of lung with pneumonia

... Results shown are incomplete. Please specify more

Various Current Definitions of Pneumonia

- Harrison: Infection of pulmonary parenchyma by various pathogens; not a single disease
- Mandell: Lower respiratory tract infection caused by various microbial agents
- WHO: In children < 5 years defined by cough and work of breathing
- NIH: Infection of the alveoli and surrounding tissue
- Google: Infection that inflames air sacs in one or both lungs, which may fill with fluid
- Wikipedia: Inflammatory condition of the lung primarily affecting the small air sacs known as alveoli

Lack of Consensus Definition Is Problematic



Proposed Approachs

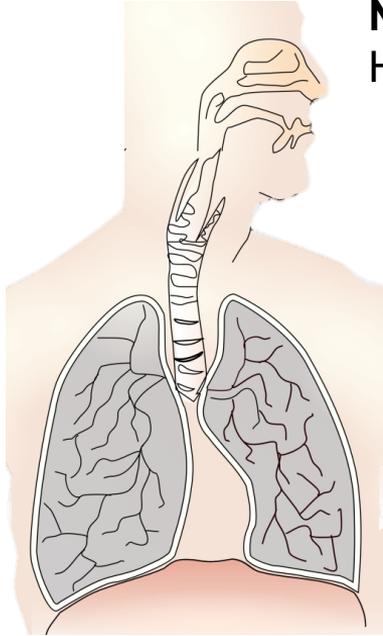
- Acute infection of the lung parenchyma by one or more pathogens, excluding bronchiolitis
- Incorporate clinical, radiographic, diagnostic, and/or biomarker measures
- Research should identify homogenous groups with respect to microbiology, severity, radiology, complications, age groups, and risk factors
- Consider vaccine probe study design

Pathophysiology of Pneumonia and Host Response

Pathogenesis of Pneumonia

- Mechanism
 - Defect in host defense
 - Highly virulent microorganism
 - Overwhelming inoculum
- Entry
 - Aspiration of upper airway microorganisms
 - Inhalation of aerosolized material
 - Metastatic seeding from the blood

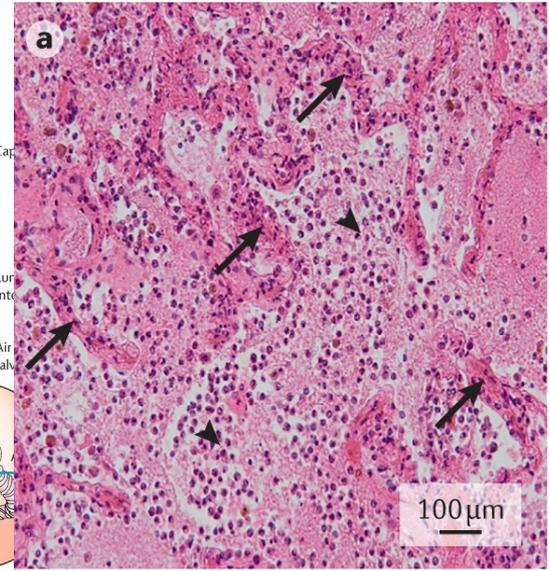
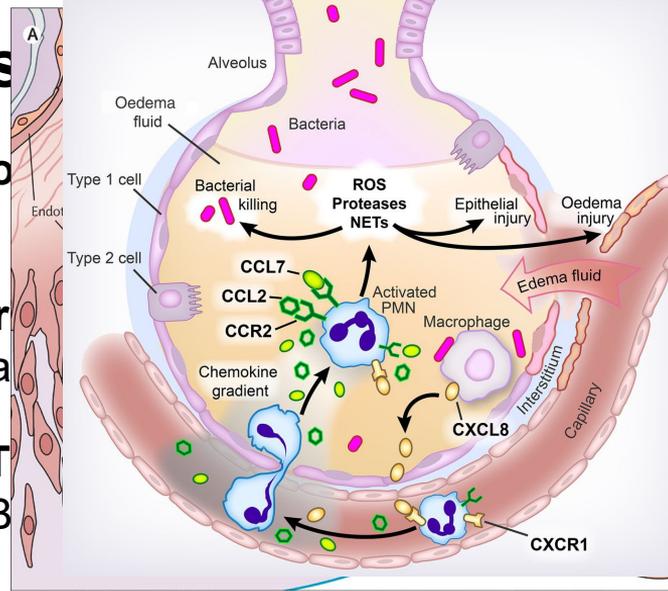
Host Defenses



Naso
Hair,

Or
Sa

T
B



Lower Respiratory Tract

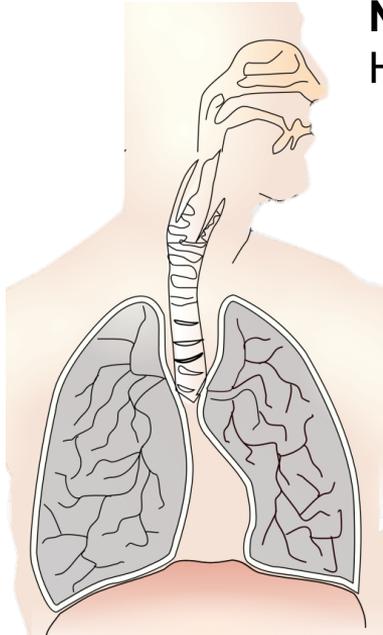
Alveolar lining, macrophages, neutrophils, dendritic cells, pattern recognition receptors

Stimulation of memory and effector T- and B-cells

Bacteria 0.5-2 μm not filtered

Impairment of Host Defenses

Altered Consciousness



Nasopharynx

Hair, turbinates, mucociliary apparatus, IgA

Oropharynx

~~Saliva, cough, complement, epiglottic reflex~~

Trachea and Bronchi

Branching, airway surface liquid, dendritic cells, immunoglobulins

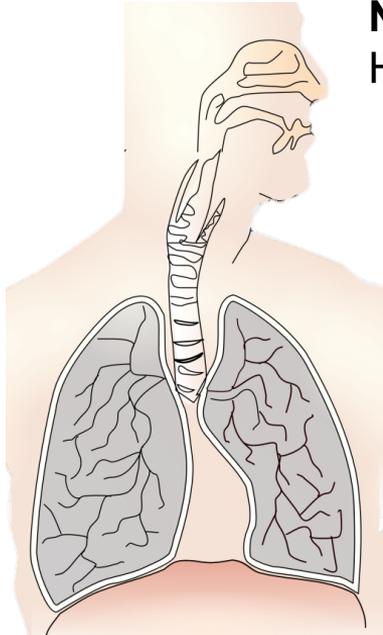
Lower Respiratory Tract

Alveolar lining, macrophages, neutrophils, dendritic cells, pattern recognition receptors

Stimulation of memory and effector T- and B-cells

Impairment of Host Defenses

Cigarette Smoke



Nasopharynx

Hair, turbinates, mucociliary apparatus, IgA

Oropharynx

Saliva, cough, complement, epiglottic reflex

Trachea and Bronchi

Branching, airway surface liquid, dendritic cells, immunoglobulins

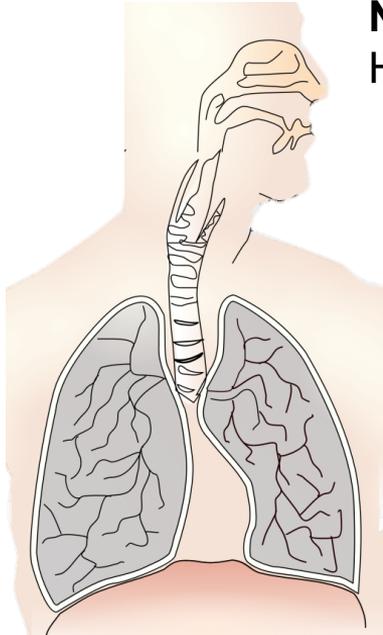
Lower Respiratory Tract

Alveolar lining, ~~macrophages~~, neutrophils, dendritic cells, pattern recognition receptors

~~Stimulation of memory and effector T- and B-cells~~

Impairment of Host Defenses

HIV Infection



Nasopharynx

Hair, turbinates, ~~mucociliary apparatus~~, ~~IgA~~

Increased pneumococcal
colonization

Oropharynx

Saliva, cough, complement, epiglottic reflex

Trachea and Bronchi

Branching, airway surface liquid, ~~dendritic cells~~, ~~immunoglobulins~~

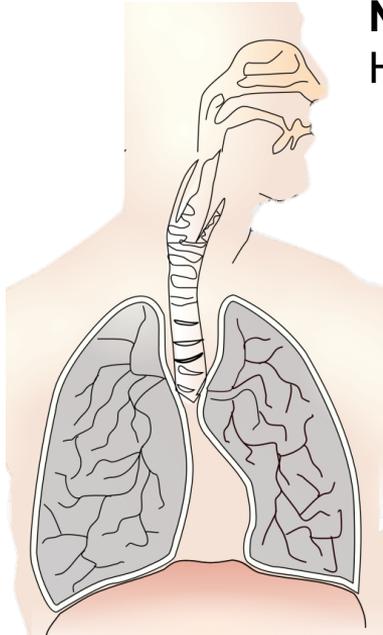
Lower Respiratory Tract

Alveolar lining, ~~macrophages~~, ~~neutrophils~~,
~~dendritic cells~~, pattern recognition receptors

~~Stimulation of
memory and effector
T- and B-cells~~

Impairment of Host Defenses

Cystic fibrosis



Nasopharynx

Hair, turbinates, ~~mucociliary apparatus~~, IgA

Oropharynx

Saliva, cough, complement, epiglottic reflex

Increased colonization
with pathogenic bacteria

Trachea and Bronchi

Branching, ~~airway surface liquid~~, dendritic cells, immunoglobulins

Lower Respiratory Tract

Alveolar lining, macrophages, **neutrophils**,
dendritic cells, pattern recognition receptors

Stimulation of
memory and effector
T- and B-cells

Other Factors Affecting Immunity

- Diabetes
- Transplant
- Malnutrition
- Lung cancer
- Heart failure
- Bronchial obstruction
- Prior pneumonia
- Immotile cilia syndrome
- Immunosuppressive medications
- Other medications
- Iatrogenic manipulation

Clinical Manifestations and Diagnostic Approach

Clinical Evaluation of Pneumonia

- History and exam may not reliably detect pneumonia
 - Sensitivity 47-69%
 - Specificity 58-75%
- High interobserver variation
- Dependent on prevalence

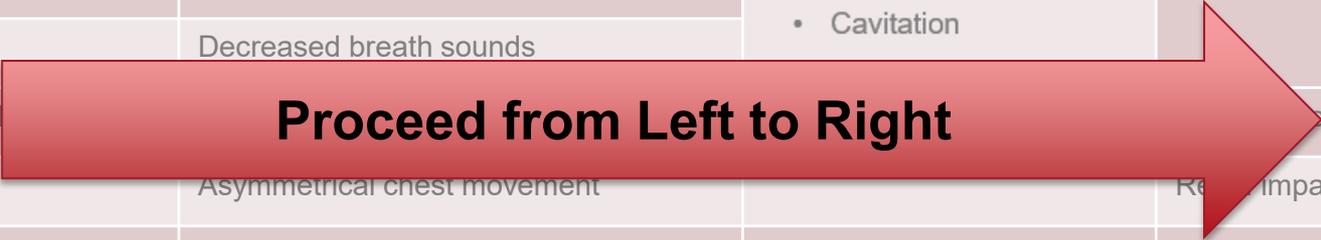
Findings Associated with Pneumonia

Table 2.—Likelihood Ratios for Pneumonia Given the Presence or Absence of Individual History Findings*

	Positive Likelihood Ratio†				Negative Likelihood Ratio‡			
	Diehr et al, ²⁶ 1984	Gennis et al, ²⁷ 1988	Singal et al, ²⁸ 1989	Heckerling et al, ²⁹ 1990	Diehr et al, ²⁶ 1984	Gennis et al, ²⁷ 1988	Singal et al, ²⁸ 1989	Heckerling et al, ²⁹ 1990
Respiratory symptoms								
Cough	...	NS	1.8	NS	...	NS	0.31	NS
Dyspnea	...	1.4	NS	NS	...	0.67	NS	NS
Sputum production	1.3	NS	...	NS	0.55	NS	...	NS
Nonrespiratory symptoms								
Fever	2.1	NS	...	1.7	0.71	NS	...	0.59
Chills	1.6	1.3	...	1.7	0.85	0.72	...	0.70
Night sweats	1.7	...	...	...	0.83	...	...	...
Myalgias	1.3	NS	...	...	0.58	NS	...	...
Sore throat	0.78	NS	...	...	1.6	NS	...	...
Rhinorrhea	0.78	NS	...	...	2.4	NS	...	...
Past medical history								
Asthma	...	...	...	0.10	...	...	...	3.8
Immunosuppression	...	...	...	2.2	...	...	...	0.85
Dementia	...	...	...	3.4	...	...	...	0.94

Suggested Approach

History	Exam	Imaging	Laboratory
Cough	Fever	Modality <ul style="list-style-type: none"> • Chest radiograph • CT scan • Ultrasound 	Positive respiratory gram stain and culture
Sputum production	Tachycardia		Positive blood culture
Dyspnea	Tachypnea		Urinary antigens
Chest pain	Hypoxia	Findings <ul style="list-style-type: none"> • Infiltrates • Pleural effusion • Cavitation 	Elevated inflammatory markers
Fever , sweats	Crackles		
Fatigue	Decreased breath sounds		
Altered mental status			Respiratory acidosis
Myalgia	Asymmetrical chest movement		Respiratory impairment
GI symptoms	Dullness to percussion		



Clinical Diagnosis by Smartphone Algorithm

- Cohort of 322 hospitalized patients age > 12 years
- Excluded COPD, restrictive lung disease, contraindication to coughing

Patient-reported symptoms

- Fever in past week
- Acute or productive cough
- Age

+

Mathematical analysis of
5 cough-associated audio
segments

- ~86% positive and negative predictive agreement
- Severity and age group did not affect accuracy

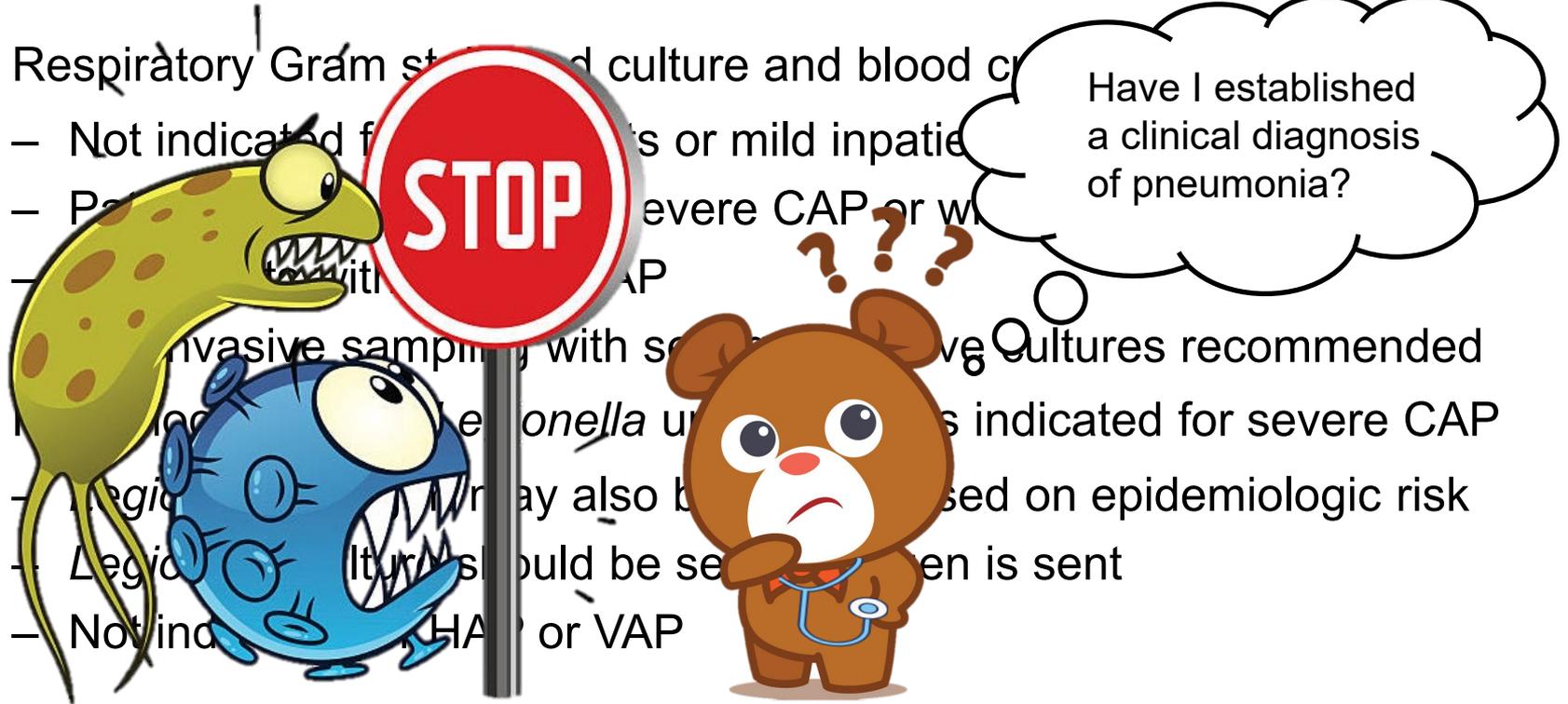
Pneumonia Mimics

- Pulmonary edema
- Pulmonary embolism
- Mucous plugging
- Aspiration pneumonitis
- Hypersensitivity pneumonitis
- Drug-induced pneumonitis
- Acute respiratory distress syndrome
- Diffuse alveolar hemorrhage
- Acute leukemia

Microbiologic Diagnostic Methods

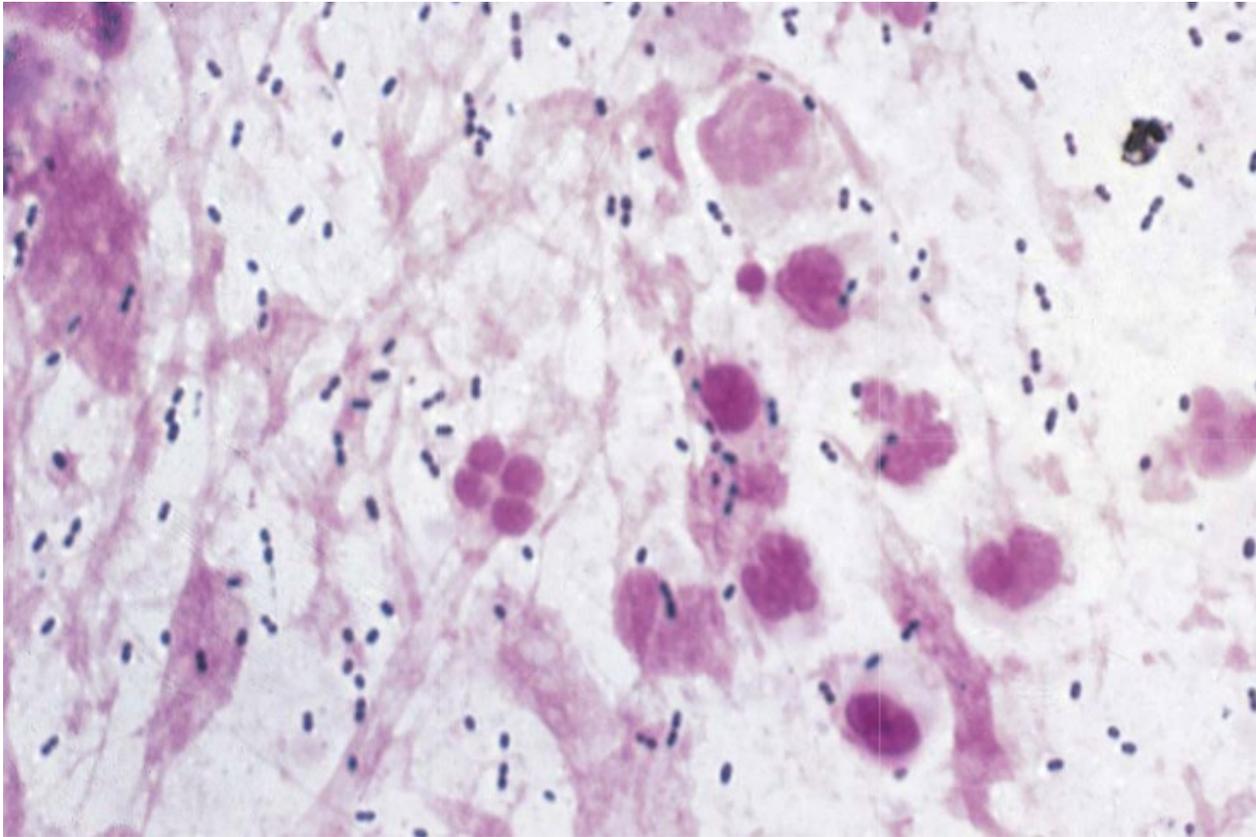
Diagnostic Testing Recommendations

- Respiratory Gram stain and culture and blood culture
 - Not indicated for outpatients or mild inpatients
 - Preferred for severe CAP or with risk factors for CAP
 - Invasive sampling with sputum or bronchoalveolar lavage cultures recommended
- Legionella
 - Legionella pneumoniae indicated for severe CAP
 - Legionella may also be considered based on epidemiologic risk
 - Legionella cultures should be sent when is sent
 - Not indicated for HAP or VAP

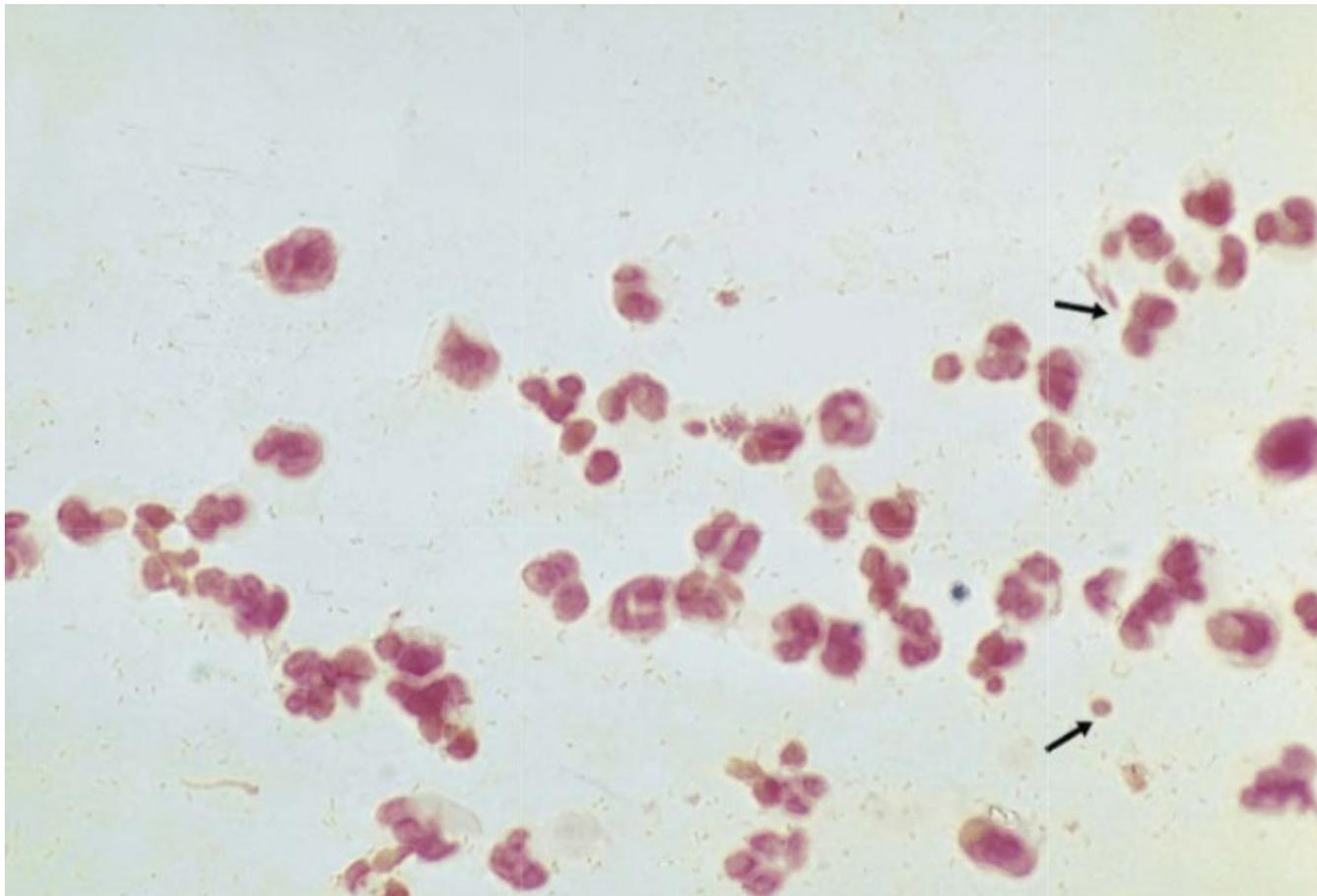


Sputum Specimens and Gram Stain

- 40-60% of hospitalized patients cannot produce sputum
- 40-60% of collected samples have oropharyngeal contamination
- Good-quality specimen Gram stain results are specific, not sensitive
 - 60-69% sensitive and 87-91% specific for *S. pneumoniae*
 - 76-78% sensitive and 96-97% specific for *H. influenzae*
 - Bacterial pathogens identified in 73% of good-quality specimens
- Cannot detect atypical pathogens
- Antibiotics prior to sampling drastically reduces diagnostic yield



Expectorated sputum with gram-positive, lancet-shaped diplococci from a patient with pneumococcal pneumonia Mandell 8th Ed 2015



Expectorated sputum with gram-negative coccobacillary forms (arrows) from a patient with *Haemophilus influenzae* pneumonia

Sputum Culture

- Poor sensitivity
- Sensitivity decreases with prior exposure to antibiotics
 - Common CAP pathogens are more fastidious
 - Rare pathogens representing common colonizers are easily isolated

Translation:

- Staph aureus and gram-negative bacilli in respiratory specimens often represent colonization

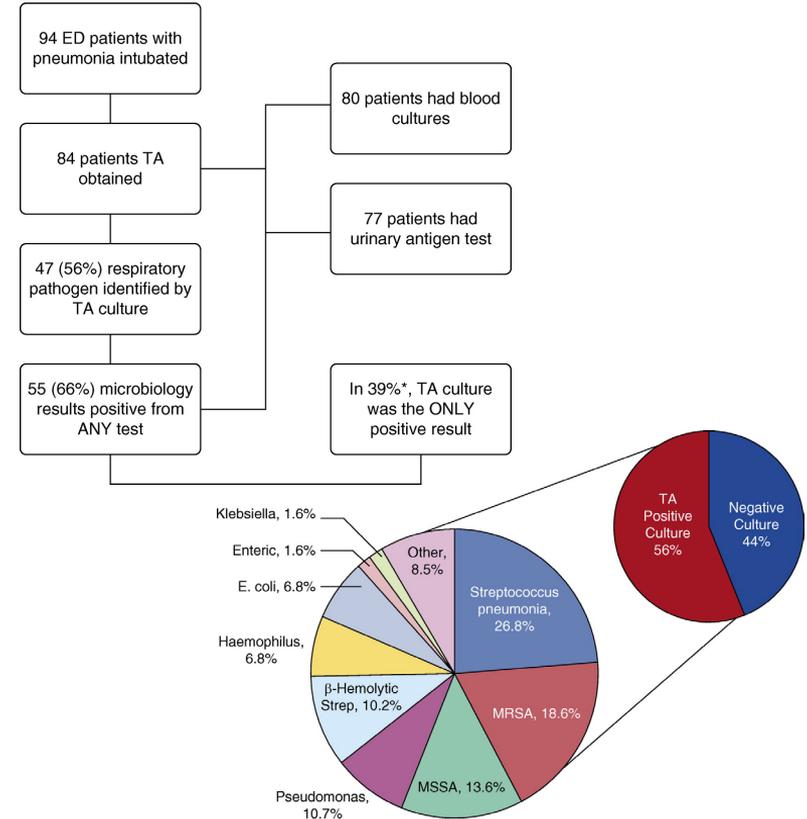
GNB examples:
Pseudomonas spp.
 ESBL-producing GNB

- Failure to grow is strong evidence against their presence

Blood cultures (<i>n</i> = 3369)	<i>n</i>	Bacterial Detections (%)
Before antibiotics	2679	139 (5.2)
>0–1 hours after antibiotics	163	8 (4.9)
>1–4 hours after antibiotics	176	5 (2.8)
>4–15 hours after antibiotics	176	1 (0.6)
>15 hours after antibiotics	175	3 (1.7)
ET/Sputum Cultures (<i>n</i> = 378)		
Before antibiotics	36	18 (50.0)
>0–5 hours after antibiotics	98	46 (46.9)
>5–10 hours after antibiotics	76	23 (30.3)
>10–20 hours after antibiotics	86	17 (19.8)

Endotracheal Aspirate

- Non-invasive sampling method for mechanically ventilated patients
- Subject to similar contamination issues as sputum
- High contamination rate may be improved by sampling within 24 hours of intubation



Invasive Sampling

- Includes bronchoalveolar lavage and protected specimen brush
- Sensitivity and specificity generally higher
- Not indicated for routine workup of pneumonia
- Potential indications:
 - Immunocompromised hosts
 - Suspicion for fungal or mycobacterial disease
 - Persistent process not responsive to antibiotics
- Biopsy uncommonly performed for infectious workup

Blood cultures

- Positive rate ~5-15% may not change management for mild disease
- More useful for severe disease or concern for resistance
 - May be able to deescalate broader spectrum therapy
 - May suggest an alternate diagnosis
 - Implications for morbidity and mortality

Pneumococcal and *L. pneumophila* Urine Antigen Tests

- 66-100% sensitive and 94-100% specific
- Do not appear to be affected by prior exposure to antibiotics
- *L. pneumophila* antigen only detects serogroup 1
- Indications
 - Recommended for severe CAP
 - Benefits less clearly defined for mild disease
- May be an underutilized antimicrobial stewardship tool

Additional Diagnostic Methods

- PCR tests
 - Nasal screen for MRSA
 - Viruses
 - Multiplex PCR
 - Pneumocystis
- Biomarkers
 - CRP and procalcitonin
 - Fungal biomarkers
- Serology
- Cryptococcal antigen
- Pleural fluid analysis

Imaging studies represent a major component of diagnostic testing

Pneumonia Syndromes

Major Causative Agents of Acute Pneumonia

CAP – Typical	CAP – Atypical	CAP with MDR Risk	HAP/VAP
<i>S. pneumoniae</i>	Viruses: influenza, adenovirus, HMPV, RSV, parainfluenza, rhinovirus, coronavirus	<i>S. aureus</i>	<i>S. aureus</i>
<i>H. influenzae</i>		<i>P. aeruginosa</i>	Gram-negative bacilli: <i>P. aeruginosa</i> , <i>Klebsiella</i> spp., <i>E. coli</i> , <i>Enterobacter</i> spp., <i>A. baumannii</i> ± ESBL or CRE
<i>Klebsiella</i> spp.	Gram-negative bacilli ± ESBL or CRE		
<i>M. catarrhalis</i>	<i>C. pneumoniae</i>		
Group A <i>Streptococcus</i>	<i>L. pneumophila</i>	Pneumonia with Additional Risk Factors	
		Zoonotic: tularemia, Q fever, psittacosis, pasteurella	Immunocompromised: TB, pneumocystis, CMV
		Travel: endemic mycoses, melioidosis, epidemic viruses, paragonimus, other parasites	Environment: anthrax, brucellosis, plague, hantavirus, leptospirosis

Community-Acquired Pneumonia

- Classic presentation:
 - Sudden onset of fever/chills
 - Followed by pleuritic chest pain
 - Older populations may have atypical symptoms
- Most common causative agents
 - Outpatients: *S. pneumoniae*, viruses
 - Inpatients: *S. pneumoniae*
 - *S. pneumoniae* prevalence increased likely due to vaccination
- Risk factors for MRSA or *P. aeruginosa*
 - Prior identification in culture
 - Hospitalization and antibiotic administration in last 90 days



There is no
HCAP

Hospital-Acquired and Ventilator-Associated Pneumonia

- Definitions
 - HAP refers to pneumonia occurring ≥ 48 hours after admission
 - VAP refers to pneumonia occurring ≥ 48 hours after intubation
- Accounts for the largest proportion of all HAIs in the US at 28%
- VAP occurs in 9-40% of intubated patients
- Associated with higher attributable mortality rate, prolonged hospitalization and mechanical ventilation, increased costs of care

Aspiration Pneumonia

- Distinct from chemical pneumonitis and obstruction
- Historically thought that anaerobes had a dominate role
- More recent studies show similar flora to non-aspiration pneumonia
- Oral anaerobes and streptococci generally covered by standard coverage

Translation:

- Do not add anaerobic coverage to standard CAP or HAP/VAP treatment for suspected aspiration pneumonia
- Maintain coverage based on setting and other risk factors

Complications of Pneumonia

- Parapneumonic pleural effusion and empyema
- Lung abscess
- Bronchiectasis
- Bronchopleural fistula
- Chronic infection

Oral health plays a major role in development of complications related to pneumonia

Acute Pathogens Causing Chronic Infection

Pathogens

- *S. aureus*
- *P. aeruginosa*
- Streptococci
- Anaerobes
- *H. influenzae*
- *K. pneumoniae*
- *Burkholderia pseudomallei*

Risk Factors

- Diabetes
- Thoracic malignancy
- Chronic alcohol use
- COPD
- Chronic ventilation
- Recurrent aspiration

Major Causative Agents of Chronic Pneumonia

Immunocompetent Host	Immunocompromised Host	Geographic
Nontuberculous Mycobacteria	All immunocompetent host pathogens esp. tuberculosis, cryptococcus, nocardiosis	Endemic mycoses: talaromyces, paracoccidioides, emergomycosis
Tuberculosis		
Cryptocococcus	Mold: aspergillus, scedosporidium, mucormycosis	Parasites: echinococcus, filariasis, paragonimus
Endemic mycoses: histoplasma, blastomyces, coccidioides, sporothrix	HIV: pneumocystis, rhodococcus	
Actinomycosis	Nocardiosis	

Principles of Pneumonia Treatment

Approach to Antimicrobial Treatment

Coverage Required	Preferred Agents	Alternative Agents
Typical	ceftriaxone, amoxicillin, amoxicillin-clavulanate, ampicillin-sulbactam	levofloxacin
Atypical	azithromycin, doxycycline	levofloxacin
MRSA	vancomycin	linezolid, ceftaroline
Pseudomonas	cefepime, piperacillin-tazobactam	meropenem, levofloxacin
HAP/VAP with MDRO risk factors	Add amikacin	Add tobramycin
ESBL	ertapenem	meropenem, levofloxacin
Influenza	oseltamivir	peramivir
Mold	voriconazole, micafungin	amphotericin

Duration of Treatment

- Most CAP adequately treated with 5 days
 - Only 3 days high-dose azithromycin required
 - Stop treatment if normal vitals, normal mentation, able to eat
- Most HAP/VAP adequately treated with 7 days
- Potential indications for prolonged treatment
 - Complications of bacterial pneumonia
 - Immunocompromised status
 - Chronic or non-bacterial pneumonia
- Consider complications or alternate pathogen if no response

Pneumonia Prevention and Resources

Pneumococcal Vaccination

	Routine	High-Risk Groups
Pediatrics	PCV13 4-dose series	PPSV23 1-2 doses
Adults 19-64 years	Not indicated	PPSV23 single dose
		PCV13 single dose PPSV23 2 doses
Adults ≥ 65 years	PPSV23 single dose	PCV13 single dose

Routine PCV13 vaccination of adults ≥ 65 years no longer required

Other Preventative Strategies

- Inpatient strategies
 - Hand hygiene
 - Oral hygiene
 - Semirecumbent position
 - Lung expansion
 - Early mobilization
- Health maintenance
 - Dental care
 - Smoking cessation
 - Chronic disease management

UH Antimicrobial Stewardship Tools for Pneumonia

- CAP and HAP/VAP guidelines
 - Antimicrobial stewardship website on DWP
 - UH Provider App
 - Antimicrobial stewardship pocket guide
- Inpatient and ED pneumonia order set
- Upcoming MRSA PCR screening program
- Pneumonia discharge bundle

Additional Resources

- Mackenzie G. The definition and classification of pneumonia. *Pneumonia (Nathan)*. 2016;8:14.
- Torres, A., Cilloniz, C., Niederman, M.S. *et al*. Pneumonia. *Nat Rev Dis Primers* 7, 25 (2021).
- Metlay JP, Kapoor WN, Fine MJ. Does This Patient Have Community-Acquired Pneumonia? Diagnosing Pneumonia by History and Physical Examination. *JAMA*. 1997;278(17):1440–1445.
- CAP Guidelines: Metlay JP, Waterer GW, Long AC, et al. Diagnosis and Treatment of Adults with Community-acquired Pneumonia. An Official Clinical Practice Guideline of the American Thoracic Society and Infectious Diseases Society of America. *Am J Respir Crit Care Med*. 2019;200(7):e45-67.
- HAP/VAP Guidelines: Kalil AC, Metersky ML, Klompas M, et al. Management of Adults With Hospital-acquired and Ventilator-associated Pneumonia: 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society. *Clin Infect Dis*. 2016;63(5):e61-e111.
- Vaccines: Advisory Committee on Immunization Practices Child and Adolescent Immunization Schedule and Adult Immunization Schedule, 2021

Summary and Main Points

- There is a lack of confidence regarding the
- The pathogenesis of pneumonia may be
- overwhelming inoculation
- Pneumonia is a common
- Semiquantitative
- to determining a microbiologic etiology
- The causative agent of pneumonia is
- drives choice of treatment
- Acute pneumonia is associated with
- acute pneumonia requires prompt treatment
- Strategies for pneumonia prevention and antimicrobial stewardship resources are available



- There is no HCAP
- Anaerobic coverage is not needed for aspiration
- Failure to grow *S. aureus* and GNB is strong evidence against their presence

Have I established a clinical diagnosis of pneumonia? factors, which complications of

Thank You!



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ANTIBIOTICS
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SMART USE, BEST CARE

**U.S. ANTIBIOTIC
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November 15-19, 2021

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