Pneumonia

Jodi Grandominico , MD
Assistant Professor of Clinical Medicine
Department of Internal Medicine
Division of General Medicine and Geriatrics
The Ohio State University Wexner Medical Center

Pneumonia types

- CAP- limited or no contact with health care institutions or settings
- HAP: hospital-acquired pneumonia – occurs 48 hours or more after admission
- VAP: ventilator-associated pneumonia – develops more than 48 to 72 hours after endotracheal intubation
- HCAP: healthcare-associated pneumonia – occurs in non-hospitalized patient with extensive healthcare contact

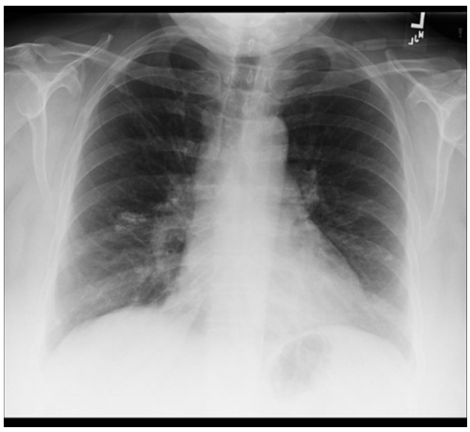
2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

Objectives-CAP

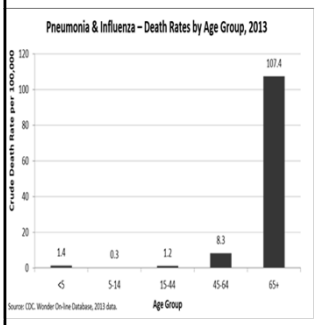
- Epidemiology
- Review cases:
  - Diagnostic techniques
  - Risk stratification for site of care decisions
  - Use of biomarkers
  - Type and length of treatment
- Prevention

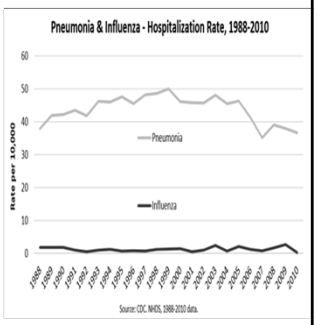
Pneumonia

Sarah Tapyrik, MD
Assistant Professor – Clinical
Division of Pulmonary, Allergy, Critical Care and Sleep Medicine
The Ohio State University Wexner Medical Center



Epidemiology





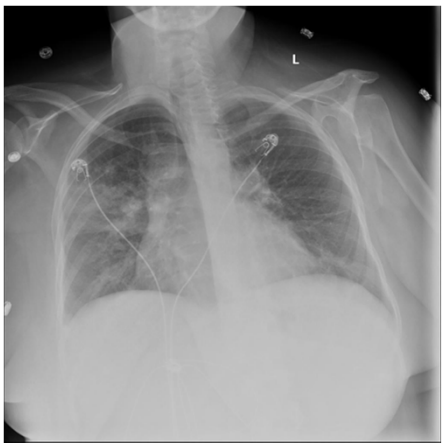
American lung association epidemiology and statistics unit research and health education division. November 2015

Who is at Risk?

- Children <5 yo
- Adults >65 yo
- Comorbid conditions:
  - CKD
  - CHF
  - DM
  - Chronic Liver Disease
  - COPD
- Immunosuppressed:
  - HIV
  - Cancer
  - Splenectomy
- Cigarette Smokers
- Alcoholics

Clinical Presentation

- Fever
- Chills
- Cough w/ purulent sputum
- Dyspnea
- Pleuritic pain
- Night sweats
- Weight loss
- Elderly and Immunocompromised
  - Confusion
  - Lethargy
  - Poor PO intake
  - Falls
  - Decompensation of chronic conditions



CASE #1

- **34 yo female with no pmhx 10 days of:**
  - **runny nose**
  - **Documented fevers**
  - **L sided pleuritic chest pain,**
  - **productive cough**
  - **Exam: RR 16, BP 110/70, T 101.6. mildly ill but alert with crackles at R base**

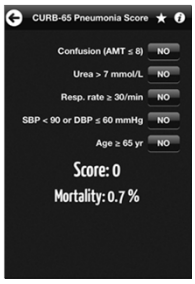
Work up

History physical	Imaging	Labs
• Risk of resistant organism • Immunosuppression • Abx in past 90 days • Risk of atypical infection • Risk of severe Illness	• CXR Required • Identify complications of pneumonia • Consider CT	• Basic labs • Biomarkers • Sputum culture • Urinary antigens • Rapid Diagnostic Viral PCR • Blood cultures

Risk Stratification Tools
1,2,3,9

Pneumonia Severity Index	Curb 65
20 criteria	5 criteria
Heavily weights age and comorbidities	Convenient
Sensitivity 79-95%	Sensitivity 22-78%
Specificity 44-70%	Specificity 75-94%

PSI **CURB 65**



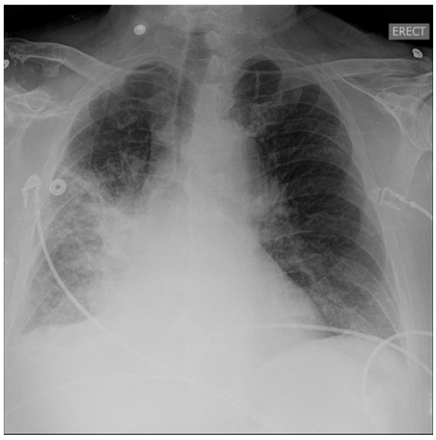
Causes of Community Acquired Pneumonia

Bacterial		Viral	
Streptococcus Pneumoniae	27%	Influenza	18-33%
Haemophilus Influenza	12%	Rhinovirus	
Atypicals:		Coronavirus	
Mycoplasma	23%	Adenovirus	
Chlamydia		Parainfluenza	
Legionella		RSV	

Community Acquired Pneumonia. *Lancet*. 2015; 386: 1097-1108.

Treatment

According to IDSA/ATS Guidelines		
	Preferred	Alternative
Outpatient, no comorbidities, low severity	***Macrolide monotherapy***	***Doxycycline***
Outpatient, comorbidities, or increased risk resistance	β Lactam plus Macrolide	Respiratory Fluoroquinolone
Inpatient, non ICU, moderate severity	β Lactam plus Macrolide	Respiratory Fluoroquinolone



Case #2

- **70 yo male with HTN, DM, mild systolic CHF, and COPD. Recently widowed with no family in the area.**
  - **productive cough**
  - **Fevers**
  - **Dyspnea**
  - **Exam: Appears mildly ill, alert and oriented, RR 22, temperature 102, and BP 120/80. He has bibasilar crackles, but no lower extremity edema.**

Work up

History physical	Imaging	Labs
• Risk of resistant organism • Immunosuppression • Abx in past 90 days • Risk of atypical infection • Risk of severe Illness	• CXR Required • Identify complications of pneumonia • Consider CT	• Basic labs • Biomarkers • Sputum culture • Urinary antigens • Rapid Diagnostic Viral PCR • Blood cultures

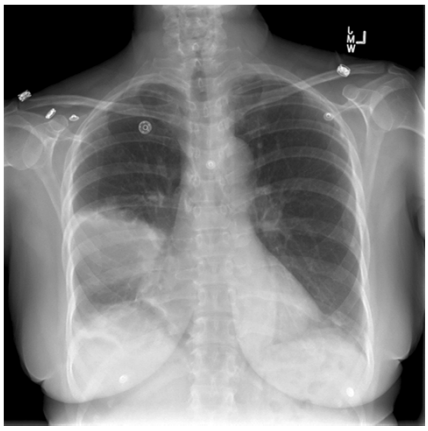
Modifying Factors That Increase The Risk For Infection With Specific Pathogens

Organism	Risk Factor
Penicillin-resistant & drug-resistant pneumococci	Age > 65 years B-lactam therapy within the past 3 months Alcoholism Immune-suppressive illness Corticosteroids Multiple medical comorbid conditions Exposure to a child in a daycare center
Enteric gram negative bacteria	Residence in a nursing home Underlying cardiopulmonary disease Multiple medical comorbid conditions Recent antibiotic therapy
Pseudomonas aeruginosa	Bronchiectasis Corticosteroid therapy Broad-spectrum antibiotic therapy > 7 days in the past month Malnutrition

Treatment

According to IDSA/ATS Guidelines

	Preferred	Alternative
Outpatient, no comorbidities, low severity	Macrolide monotherapy	Doxycycline
Outpatient, comorbidities, or increased risk resistance	***β Lactam plus Macrolide***	***Respiratory Fluoroquinolone***
Inpatient, non ICU, moderate severity	β Lactam plus Macrolide	Respiratory Fluoroquinolone



Case #3

- **74 yo female with DM, HTN, CAD, dementia, presents with 2 days of**
  - **confusion,**
  - **shortness of breath**
  - **lethargy.**
  - **Exam: BP is 110/70, RR 26, HR 105, temp 101. Ill appearing with bronchial breath sounds on Right**
  - **Labs show WBC of 14, but the rest are unremarkable.**
  - **CXR shows R sided infiltrate.**

Work up

History physical	Imaging	Labs
• Risk of resistant organism • Immunosuppression • Abx in past 90 days • Risk of atypical infection • Risk of severe Illness	• CXR Required • Consider CT	• Basic labs • Biomarkers • Sputum culture • Urinary antigens • Rapid Diagnostic Viral PCR • Blood cultures

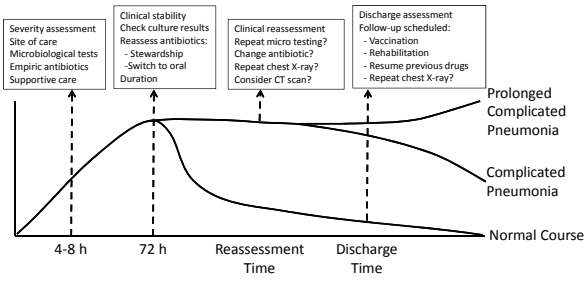
Use of biomarkers [1,2,3,4, 11, 12]

CRP	Pct	ProADM
Useful in primary care setting	Upregulated in response to bacterial infection	Non specific upregulation in severe illness
May reduce abx use	Guide antibiotic initiation	Useful adjunct to PSI and CURB 65 scores for mortality prediction
Antibiotics discouraged when crp <20	Length of treatment decisions	Better prognostic accuracy

Treatment

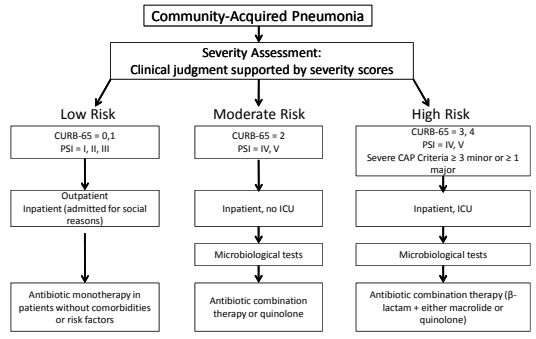
According to IDSA/ATS Guidelines		
	Preferred	Alternative
Outpatient, no comorbidities, low severity	Macrolide monotherapy	Doxycycline
Outpatient, comorbidities, or increased risk resistance	β Lactam plus Macrolide	Respiratory Fluoroquinolone
Inpatient, non ICU, moderate severity	***β Lactam plus Macrolide***	***Respiratory Fluoroquinolone***

Determining length of treatment[1,3,5,6]

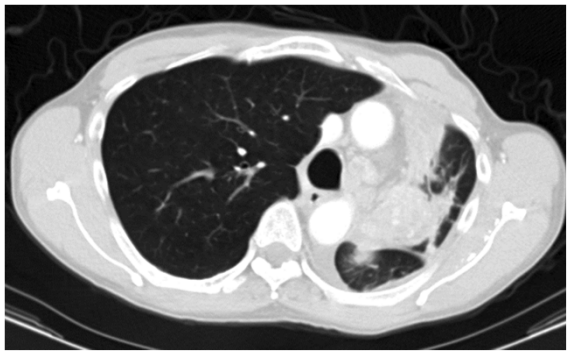


Community Acquired Pneumonia. *Lancet*. 2015; 386: 1097-1108

Treatment



Community Acquired Pneumonia. *Lancet*. 2015; 386: 1097-1108



Objectives – HAP, VAP, HCAP

- Definitions
- Epidemiology and Pathogenesis
- Risk Factors
- Pathogens and Culture Data
- Antibiotic recommendations
- Duration of treatment
- Complications of pneumonia

Pneumonia types

- CAP- limited or no contact with health care institutions or settings
- HAP: hospital-acquired pneumonia – occurs 48 hours or more after admission
- VAP: ventilator-associated pneumonia – develops more than 48 to 72 hours after endotracheal intubation
- HCAP: healthcare-associated pneumonia – occurs in non-hospitalized patient with extensive healthcare contact

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

HCAP: healthcare contact

- Intravenous (IV) therapy, wound care or IV chemotherapy within the prior 30 days
- Residence in an extended care facility
- Hospitalization in an acute care hospital for two or more days within the prior 90 days
- Hemodialysis clinic with the prior 30 days

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

HAP - Epidemiology

- 2nd most common nosocomial infection
- 5-15 cases per 1000 hospital admissions
- Increases hospital length of stay 7-9 days
- Cost of over $40,000 per patient

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

HAP – risk factors

- Mechanical ventilation (VAP). Pneumonia in 9-27% of vented patients
- Previous antibiotic treatment
- High gastric pH – secondary to stress ulcer prophylaxis
- Co-morbid medical conditions
- Poor functional status, recent surgery
- Recent respiratory viral infection

HAP - Pathogenesis

- Micro aspiration of bacteria that colonize oropharynx and upper airway
- Hematogenous spread
- Inhalation of bacteria containing aerosols

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

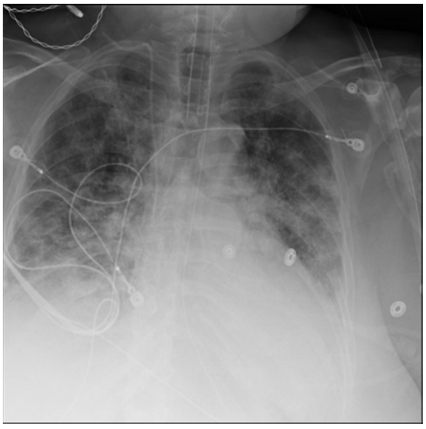
HAP - pathogens

- 70% of patients hospitalized 4 or more days have oropharyngeal colonization with gram-negative bacteria (GNB)
- GNB 55-85% of HAP infections
- Gram-positive cocci 20-40%
- Viral and fungal etiologies

HAP - pathogens

- **Distribution of pathogens variable**
- **Patient populations vary**
- **Local patterns of antimicrobial resistance**

Common HAP bacterial pathogens
Pseudomonas aeruginosa
Acinetobacter baumanii
Klebsiella pneumoniae
Escherichia coli
Methicillin Resistant Staphlyococcus aureus (MRSA)
Enterobacter spp
Proteus spp
Serratia marcescnes
Streptococcus pneumoniae
Haemophilus influenzae
Methicillin-sensitive Staphylococcus aureus (MSSA)



Diagnosis

- **No gold standard for diagnosis**
- **Combination of clinical, radiographic and culture data**
- **Fever, leukocytosis (or leukopenia), purulent sputum, hypoxia**

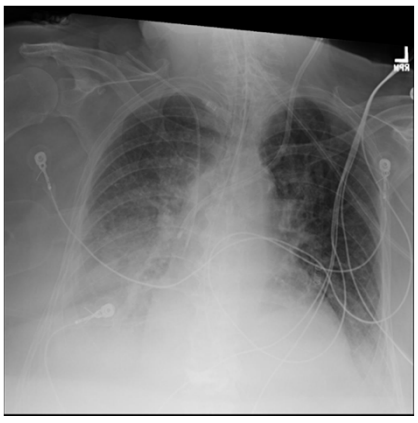
2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

HAP - cultures

- Expectorated sputum
- Induced sputum
- Tracheal aspirate
- "mini" BAL
- Bronchoscopy with BAL, brushing, biopsy

HAP – other data

- Blood cultures should be sent (rule in/out extra-pulmonary spread of infection)
- Thoracentesis if pleural effusion is present in cases of pneumonia

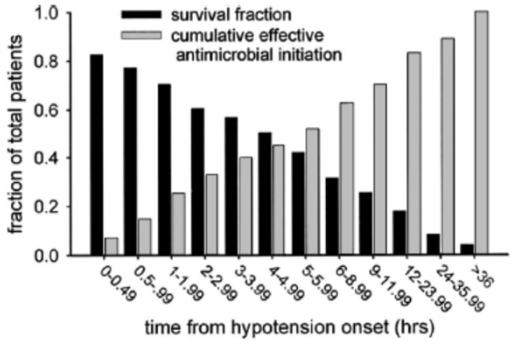


Early antibiotics are key!

- Every hour in delay of appropriate antibiotics = 7.6% lower survival
- Median time to appropriate antibiotics = 6 hours

Kumar et al. *Crit Care Med* 2006; 34: 1589-96

Effective Antimicrobial Therapy & Survival in Septic Shock



Kumar et al. *Crit Care Med* 2006; 34: 1589-96.

Empiric antibiotics

- Recommended basic of severity, risk of multi-drug resistant (MDR) pathogens and time of onset
- Empiric coverage while awaiting culture data
- Risk factors (hospitalizations, intubation, immunosuppression, etc) and local resistance patterns

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

Initial Empiric Antibiotics: Hospital Or Ventilator-Acquired With No Risks For Multi-Drug Resistance

Potential Pathogens	Recommended Antibiotic
• Streptococcus pneumoniae	• Ceftriaxone ***OR***
• Haemophilus influenzae	• Levofloxacin, moxifloxacin, or ciprofloxacin ***OR***
• Methicillin-sensitive Staph aureus	• Ampicillin/sulbactam ***OR***
• Antibiotic-sensitive enteric gram-negative bacilli:	• Ertapenem
– E. coli	
– K. pneumonaie	
– Enterobacter species	
– Proteus species	
– S. Marcescens	

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

Initial empiric therapy for hospital/ventilator/healthcare-associated pneumonia with late onset disease or risks for multidrug-resistance

Potential Pathogens

- **All previously mentioned pathogens**
- **Multidrug-resistant pathogens:**
  - **P. aeruginosa**
  - **K. pneumonia (ESBL positive)**
  - **Actinobacter species**
- **Methicillin-resistant Staph. Aureus**
- **Legionella pneumophila**

Combination Antibiotic Therapy

- **Anti-pseudomonal cephalosporin *OR* anti-pseudomonal carbepenem *OR* β-lactam/β-lactamase inhibitor**
- ***PLUS*: anti-pseudomonal fluoroquinolone *OR* aminoglycoside**
- **PLUS: linezolid *OR* vancomycin**

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

Initial intravenous adult doses of antibiotics for empiric therapy

Antibiotic	Dosage
Anti-pseudomonal cephalosporin	
Cefepime	1-2 g every 8-12 h
Ceftazidime	2 g every 8 h
Carbepenems	
Imipenem	500 mg every 6 h *or* 1 g every 8 hours
Meropenem	1 g every 8 h
B-lactam/B-lactamase inhibitor	
Piperacillin-tazobactam	4.5 g every 6 h
Aminoglycosides	
Gentamicin	7 mg/kg per day
Tobramycin	7 mg/kg per day
Amikacin	20 mg/kg per day
Anti-pseudomonal quinolone	
Levofloxacin	750 mg every day
Ciprofloxacin	400 mg every 8 h
Vancomycin	15 mg/kg every 12 h
Linezolid	600 mg every 12 h

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

What antibiotics?

The Ohio State University Wexner Medical Center and Ross Heart Hospital Inpatient Antibiogram, Calendar Year 2015

GRAM POSITIVE COCCI % SUSCEPTIBLE

	# Isolates	Penicillin G	Nafcillin	Ampicillin	Cefazolin	Clindamycin	Vancomycin	Trimethoprim/ sulfamethoxazole	Linezolid	Daptomycin
MIC breakpoints (ug/mL)		a	a	≤8	≤8	≤0.5	a	≤2/38	≤2	≤4
Staphylococcus aureus (MS)	512	25	100	NR	100	78	100	99	NR	NR
Staphylococcus aureus (MR)	548		0			50	100	93	NR	NR
Coagulase Negative Staphylococci	349	15	42	NR	42	49	100	59	NR	NR
Enterococcus faecalis (b, c)	805	100		100			95		NR	NR
Enterococcus faecalis (Vancomycin resistant) (b)	37	92		92			0		100	100
Enterococcus faecium (b, c)	262	8		8			26		NR	NR
Enterococcus faecium (Vancomycin resistant) (b)	194	1		1			0		98	97

Appropriate antibiotics

The Ohio State University Wexner Medical Center and Ross Heart Hospital Inpatient Antibiogram, Calendar Year 2015

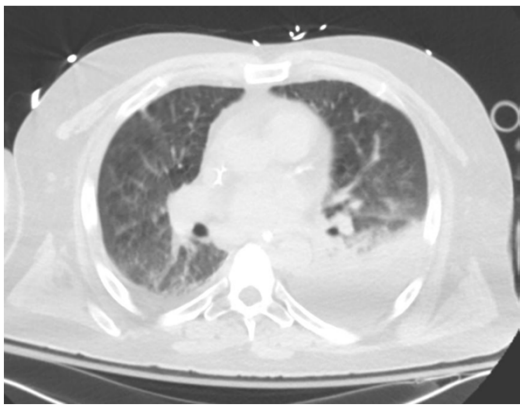
GRAM NEGATIVE RODS: NONFERMENTERS % SUSCEPTIBLE

	# Isolates	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Cefepime	Aztreonam	Doripenem	Ciprofloxacin	Gentamicin	Tobramycin	Amikacin
MIC breakpoints (ug/mL)		≤8/4	≤16/4	≤8	≤8	b	≤1	≤4	≤4	≤16
Pseudomonas aeruginosa (a)	466		83	82	74	90	74	83	90	95

Duration of antibiotic therapy

- Prolonged abx exposure causes MDR pathogens
- No difference in 8 vs 15 days for mortality, ICU LOS and recurrent infections
- Non-fermenting GNR need longer course
- Serial pro-calcitonin levels can help guide duration of therapy

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416



HAP Prevention strategies

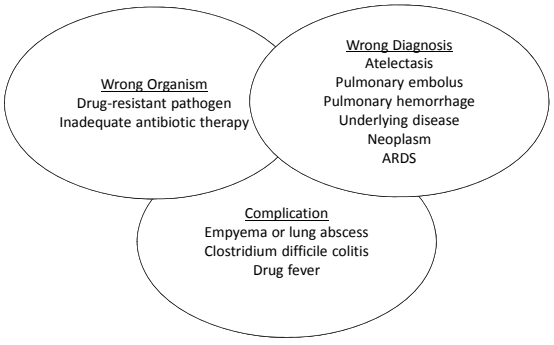
- Hand hygiene
- Standard precautions (gowns, gloves, masks)
- Semi upright or upright positioning
- Incentive spirometry

- Decrease oropharyngeal bacterial colonization
- Subglottic suctioning

HAP - summary

- Microbiology includes multi-drug (MDR) organisms
- Guidelines emphasize early, appropriate antibiotics, adequate dosing, broad empiric coverage with de-escalation based on culture data, clinical response, minimal effective duration of therapy

Assessment of Nonresponders



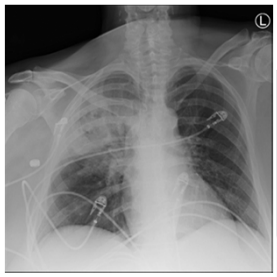
2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

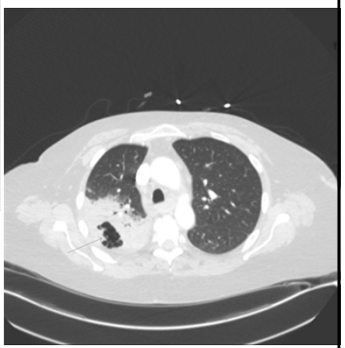
Complications

- **Pleural effusion**
- **Empyema**
- **Necrotizing pneumonia**
- **Cavitary pneumonia**
- **Lung abscess**
- **Bacteremia**
- **Pneumatocele**
- **Hyponatremia**

- **65 yo man, 2 weeks of progressive shortness of breath, subjective fevers at home, purulent sputum.**
- **Presented to ED**

- 52 yo woman, asthma, OSA, morbid obesity
- 5-6 days of worsening dyspnea on exertion and non-productive cough.
- Recently diagnosed with pneumonia, only took 4 days of antibiotics
- Exam: appears tired and weak, 76% on RA after walking, 96% RA at rest, lung exam with rhonchi on the right. Vitals stable
- Labs within normal limits





An ounce of prevention[1, 2]…

- Tobacco Cessation
  - Smoking is a risk factor for bacteremia
- Influenza Vaccination
  - influenza vaccination reduces pneumonia and mortality by 30-50%
  - Reduces all cause mortality by 27-54%
- Pneumonia Vaccination
  - PCV-13
  - PPS-23

Pneumococcal Vaccine Schedule:

- No health conditions or risks:
  - Age 65: PCV13
  - After 1 year: PPSV23
- Chronic health condition*, smoker, or long-term care facility:
  - PPSV23
  - After 1 year: PCV13
  - After 5 years: PPSV23

*CHF, chronic lung disease, chronic liver disease, alcoholism, diabetes

Pneumococcal Vaccine Schedule:

- Immunocompromising condition or asplenia:
  - PCV13
  - After 8 weeks: PPSV23
  - After 5 years: PPSV23
- Cerebrospinal fluid leak or cochlear implant:
  - PPSV13
  - After 8 weeks: PPSV23
  - After 5 years: PPSV23

References

- 1. Mandell LA, Wunderink RG, Anzueto A, et al. Infectious Diseases Society of America/American Thoracic Society Consensus Guidelines on the Management of Community Acquired Pneumonia in Adults. *CID*. 2007; 44:S27-72.
- 2. Niederman, MS. In The Clinic Community Acquired Pneumonia. *Ann Intern Med*. 2015; ITC:1-15.
- 3.Prina E, Ranzani OT, Torres A. Community Acquired Pneumonia. *Lancet*. 2015; 386: 1097-1108.

References

- 4. Torres A, Ramirez P, Montull B, Menendez R. Biomarkers and Community Acquired Pneumonia: Tailoring Management with Biological Data. *Semin Respir Crit Care Med*. 2012;33:266-271.
- 5. Lee JS, Giesler DL, Gellad WF, Fine MJ. Antibiotic therapy for Adults Hospitalized with Community Acquired Pneumonia, A Systematic Review. *JAMA*. 2016: 315(6)593-602.
- 6. Aliberti S, Giuliani F, Ramirez J, Blasi F, the Duration Study Group. How to choose the duration of antibiotic therapy in patients with pneumonia. *Curr Opin Infect Dis*. 2015; 28:177-184.

References

- 7. Blum CA, Nigro N, Brief M, et al. Adjunct prednisone therapy for patients with community acquired pneumonia: a multicenter double blind, randomised, placebo-controlled trial. *Lancet*. 2015; 385: 1511-1518.
- 8. American Lung Association. Trends in Pneumonia and Influenza Morbidity and Mortality; 2015.
- 9. Loke Y, CS, Niruban A, Myint PK. Value of seerity scales in predicting mortality from community acquired pneumonia: systematic review and meta-analysis. *Thorax*. 2010;65:884-890.
- 10. Liu JI, Xu F, Zhou H, et al. Expanded Curb-65: a new score system predicts severity of community-acquired pneumonia with superior efficiency. *Scientific Reports*. March 2016; 6:22911.

References

- 11. Schuetz P, Litke A, Albrich WC, Mueller B. Blood biomarkers for personalized treatment and patient management decisions in community acquired pneumonia. *Curr Opin Infect Dis*. 2013; 26:159-167.
- 12. Guidelines for the Management of Adults with Hospital-acquired, Ventilator-associated, and Healthcare-associated Pneumonia. *Am J Resp Crit Care Med* 2005;171:388-416
- 13. Kumar, et al. Duration of hypotension before inititian of effective antimicrobial therapy is the critical determinate of survival in human septic shock. *Crit Care Med* 2006;34(6):1589-1595