

Pneumonia

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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**

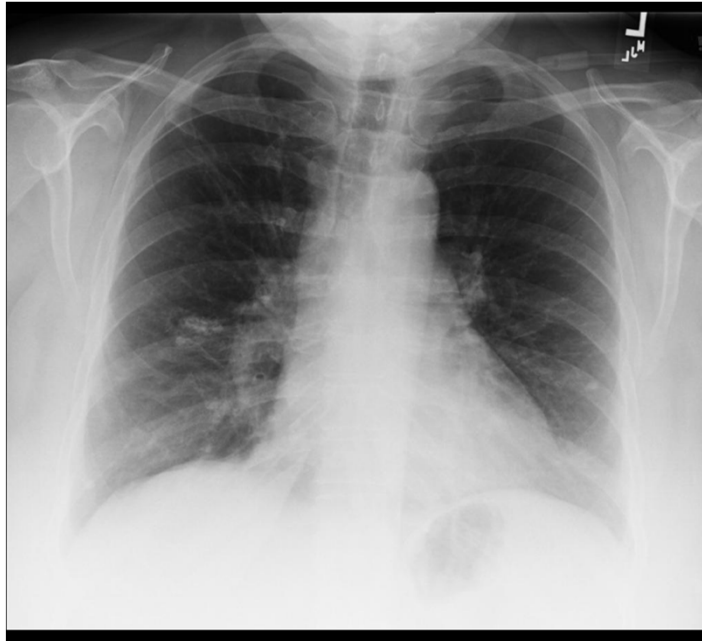
2005 IDSA/ATS HAP, VAP and HCAP Guidelines
Am J Respir Crit Care Med 2005; 171:388–416

Objectives-CAP

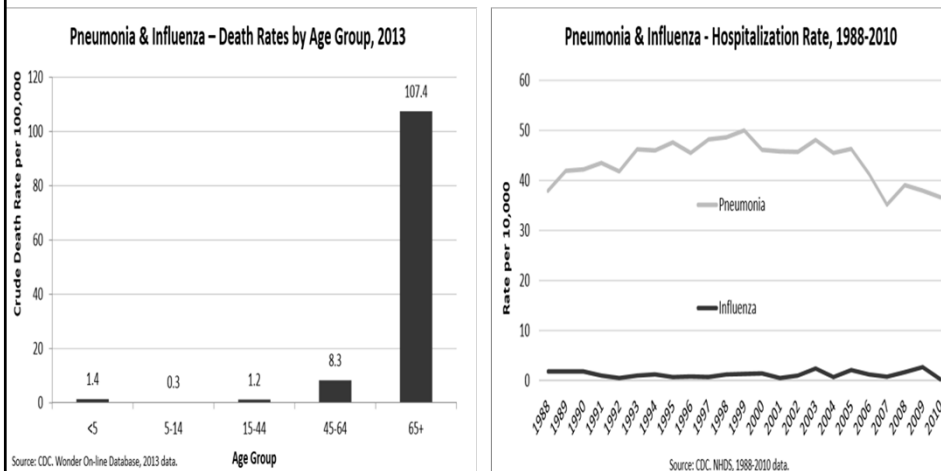
- **Epidemiology**
- **Review cases:**
 - **Diagnostic techniques**
 - **Risk stratification for site of care decisions**
 - **Use of biomarkers**
 - **Type and length of treatment**
- **Prevention**

Pneumonia

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Epidemiology



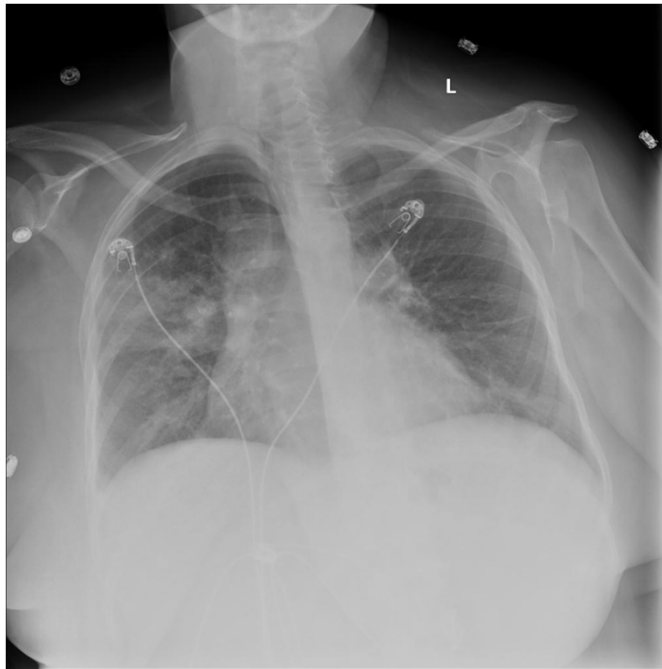
*American lung association epidemiology and statistics unit research and health education division.
November 2015*

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

- Risk of resistant organism
- Immunosuppression
- Abx in past 90 days
- Risk of atypical infection
- Risk of severe illness

Imaging

- CXR Required
- Identify complications of pneumonia
- Consider CT

Labs

- Basic labs
- Biomarkers
- Sputum culture
- Urinary antigens
- Rapid Diagnostic Viral PCR
- Blood cultures

Risk Stratification Tools

1,2,3,9

Pneumonia Severity Index

20 criteria

Heavily weights age and comorbidities

Sensitivity 79-95%

Specificity 44-70%

Curb 65

5 criteria

Convenient

Sensitivity 22-78%

Specificity 75-94%

PSI

Pneumonia Severity Index

Demographics

Age

Gender ☐ Male ☐ Female

Nursing Home Resident ☐ NO

Comorbid Illnesses

Neoplastic Disease ☐ NO

Liver Disease ☐ NO

Congestive Heart Failure ☐ NO

Cerebrovascular Disease ☐ NO

Renal Disease ☐ NO

Physical Examination

Altered Mental Status ☐ NO

Respiratory Rate $\geq 30/\text{min}$ ☐ NO

SBP $< 90\text{mmHg}$ ☐ NO

Temperature < 35 or $\geq 40^\circ\text{C}$ ☐ NO

Pulse $\geq 125/\text{min}$ ☐ NO

Lab & Radiographic Findings

Arterial pH < 7.35 ☐ NO

Urea $\geq 11\text{ mmol/L}$ ☐ NO

Na $< 130\text{ mmol/L}$ ☐ NO

Glucose $\geq 250\text{ mg/dL}$ ☐ NO

Hematocrit $< 30\%$ ☐ NO

PaO₂ $< 60\text{ mmHg}$ ☐ NO

Pleural Effusion ☐ NO

Score ...

CURB 65

CURB-65 Pneumonia Score

Confusion (AMT ≤ 8) ☐ NO

Urea $> 7\text{ mmol/L}$ ☐ NO

Resp. rate $\geq 30/\text{min}$ ☐ NO

SBP < 90 or DBP $\leq 60\text{ mmHg}$ ☐ NO

Age $\geq 65\text{ yr}$ ☐ NO

Score: 0

Mortality: 0.7 %

Causes of Community Acquired Pneumonia

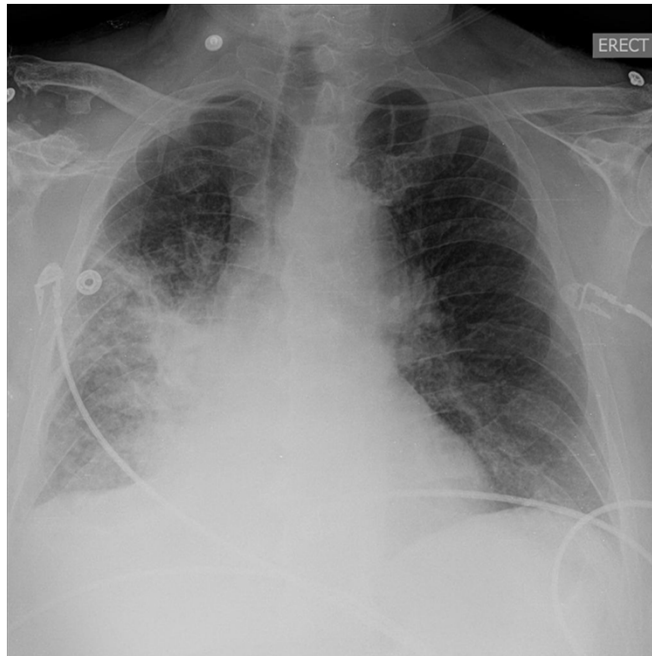
Bacterial		Viral	
Streptococcus Pneumoniae	27%	Influenza	18-33%
Haemophilus Influenza	12%	Rhinovirus	
Atypicals:		Coronavirus	
Mycoplasma	23%	Adenovirus	
Chlamydia		Parainfluenza	
Legionella		RSV	

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

Treatment

According to IDSA/ATS Guidelines

	Preferred	Alternative
<i>Outpatient, no comorbidities, low severity</i>	<i>Macrolide monotherapy</i>	<i>Doxycycline</i>
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

- Risk of resistant organism
- Immunosuppression
- Abx in past 90 days
- Risk of atypical infection
- Risk of severe illness

Imaging

- CXR Required
- Identify complications of pneumonia
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Labs

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- Rapid Diagnostic Viral PCR
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Modifying Factors That Increase The Risk For Infection With Specific Pathogens

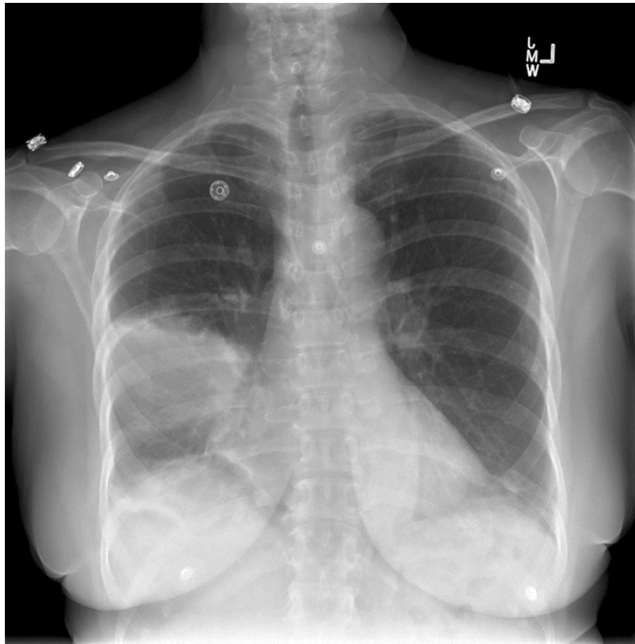
Organism	Risk Factor
Penicillin-resistant & drug-resistant pneumococci	Age > 65 years B-lactam therapy within the past 3 months Alcoholism Immune-suppressive illness Corticosteroids Multiple medical comorbid conditions Exposure to a child in a daycare center
Enteric gram negative bacteria	Residence in 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

In The Clinic: Community-Acquired Pneumonia - Ann Intern Med. 2015; 162(1):1-15

Treatment

According to IDSA/ATS Guidelines

	Preferred	Alternative
Outpatient, no comorbidities, low severity	Macrolide monotherapy	Doxycycline
Outpatient, comorbidities, or increased risk resistance	<i>β Lactam plus Macrolide</i>	<i>Respiratory Fluoroquinolone</i>
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. III 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

- Risk of resistant organism
- Immunosuppression
- Abx in past 90 days
- Risk of atypical infection
- Risk of severe illness

Imaging

- CXR Required
- Consider CT

Labs

- Basic labs
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Use of biomarkers 1,2,3,4, 11, 12

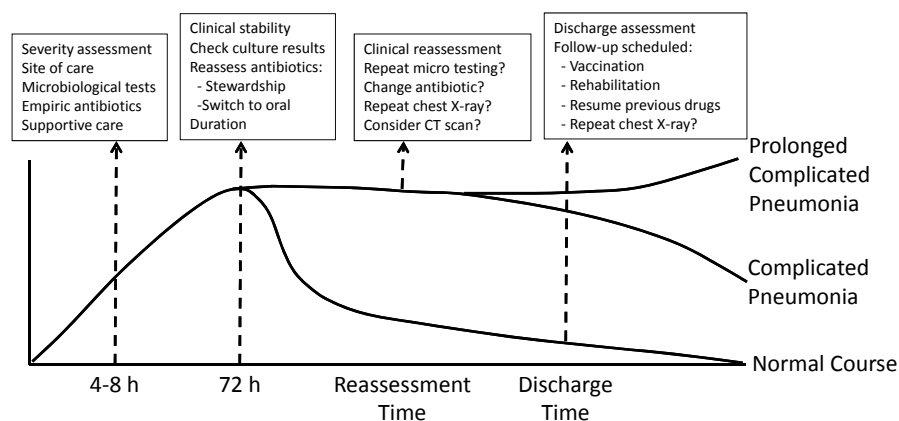
CRP	Pct	ProADM
Useful in primary care setting	Upregulated in response to bacterial infection	Non specific upregulation in severe illness
May reduce abx use	Guide antibiotic initiation	Useful adjunct to PSI and CURB 65 scores for mortality prediction
Antibiotics discouraged when crp <20	Length of treatment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

Treatment

According to IDSA/ATS Guidelines

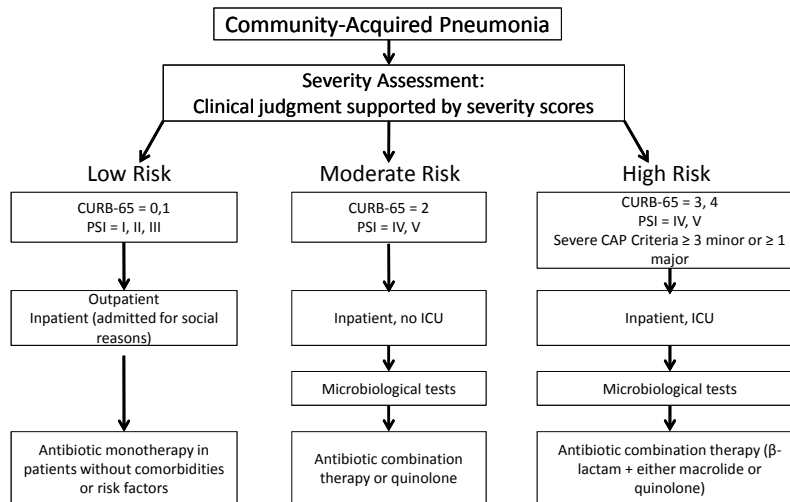
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Determining length of treatment^{1,3,5,6}

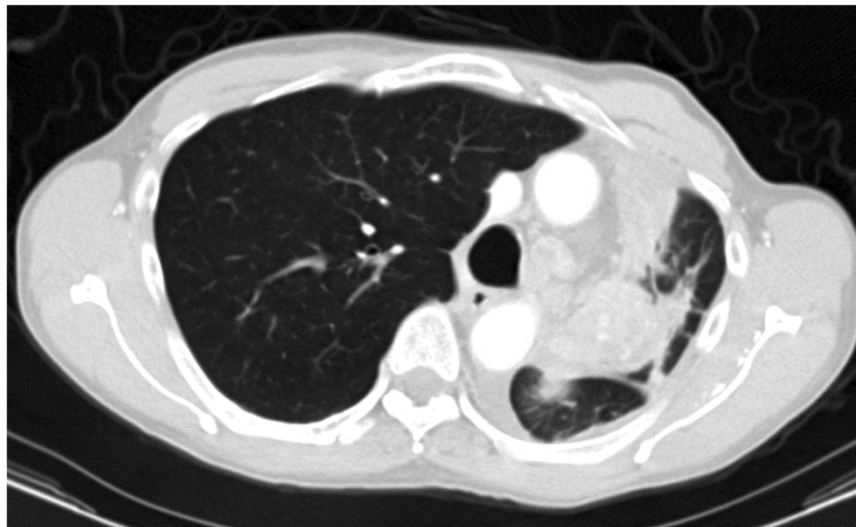


Community Acquired Pneumonia. *Lancet*. 2015; 386: 1097-1108

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

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2005 IDSA/ATS HAP, VAP and HCAP Guidelines
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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**

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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
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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**

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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 baumannii

Klebsiella pneumoniae

Escherichia coli

Methicillin Resistant Staphylococcus aureus (MRSA)

Enterobacter spp

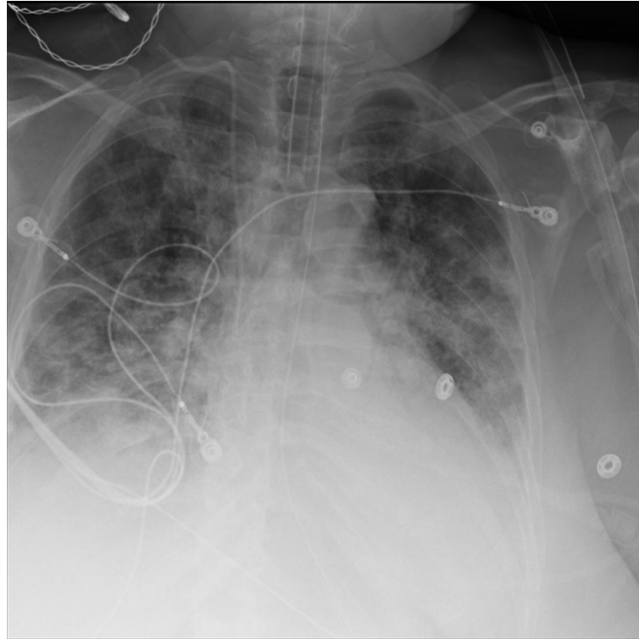
Proteus spp

Serratia marcescens

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**

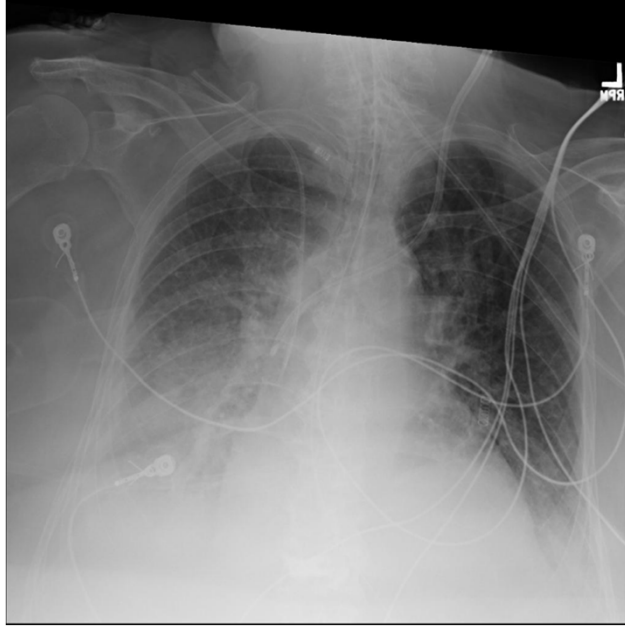
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HAP - cultures

- **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**

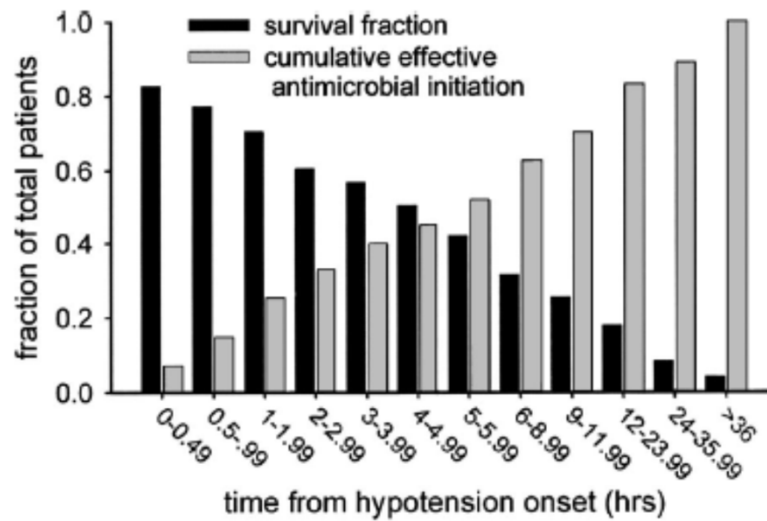


Early antibiotics are key!

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

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

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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 carbapenem OR β -lactam/ β -lactamase inhibitor
- PLUS: anti-pseudomonal fluoroquinolone OR aminoglycoside
- PLUS: linezolid OR vancomycin

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Initial intravenous adult doses of antibiotics for empiric therapy

Antibiotic	Dosage
Anti-pseudomonal cephalosporin Cefepime Ceftazidime	1-2 g every 8-12 h 2 g every 8 h
Carbapenems Imipenem Meropenem	500 mg every 6 h <u>or</u> 1 g every 8 hours 1 g every 8 h
B-lactam/B-lactamase inhibitor Piperacillin-tazobactam	4.5 g every 6 h
Aminoglycosides Gentamicin Tobramycin Amikacin	7 mg/kg per day 7 mg/kg per day 20 mg/kg per day
Anti-pseudomonal quinolone Levofloxacin Ciprofloxacin	750 mg every day 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
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What antibiotics?

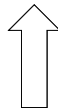
The Ohio State University Wexner Medical Center and Ross Heart Hospital Inpatient Antibigram, Calendar Year 2015

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

Appropriate antibiotics

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

GRAM NEGATIVE RODS: NONFERMENTERS % SUSCEPTIBLE										
	# Isolates	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Cefepime	Aztreonam	Doripenem	Ciprofloxacin	Gentamicin	Tobramycin	Amikacin
MIC breakpoints (µg/mL)		≤8/4	≤16/4	≤8	≤8	b	≤1	≤4	≤4	≤16
<i>Pseudomonas aeruginosa</i> (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
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HAP Prevention strategies

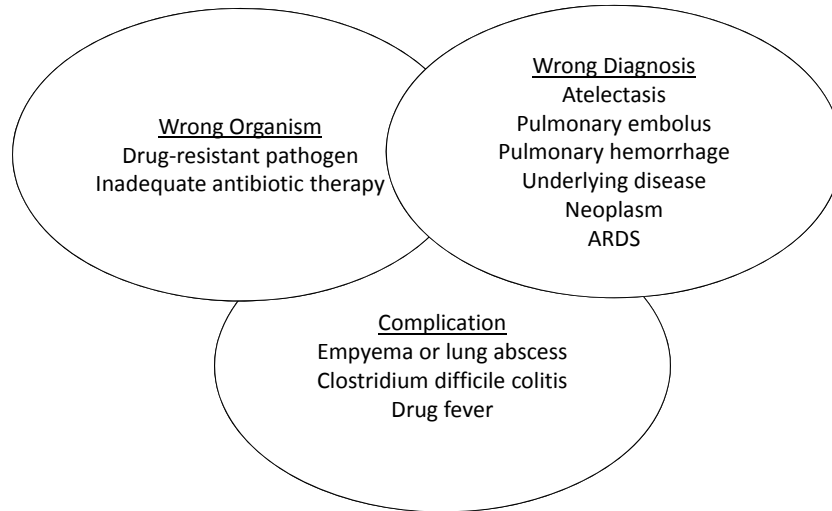
- **Hand hygiene**
- **Standard precautions (gowns, gloves, masks)**
- **Semi upright or upright positioning**
- **Incentive spirometry**

- **Decrease oropharyngeal bacterial colonization**
- **Subglottic suctioning**

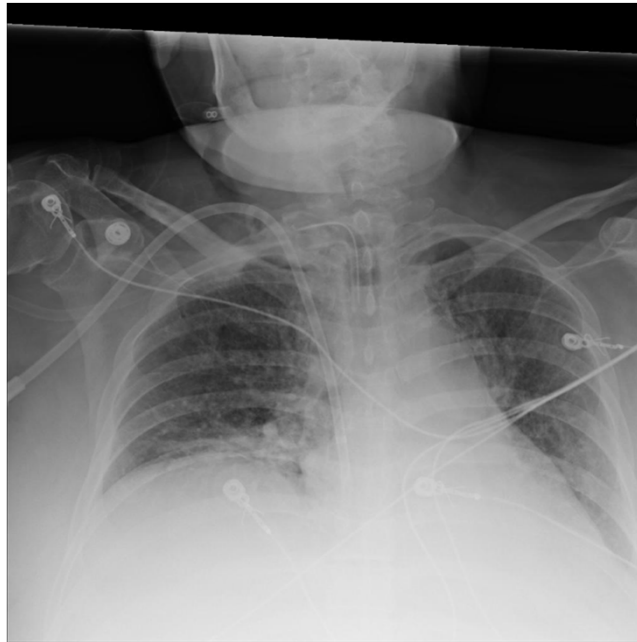
HAP - summary

- **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
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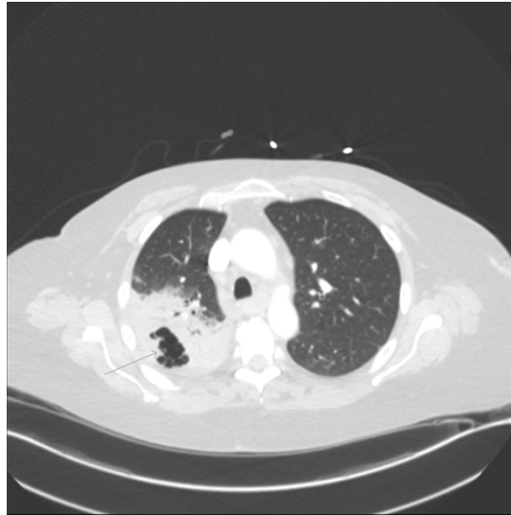
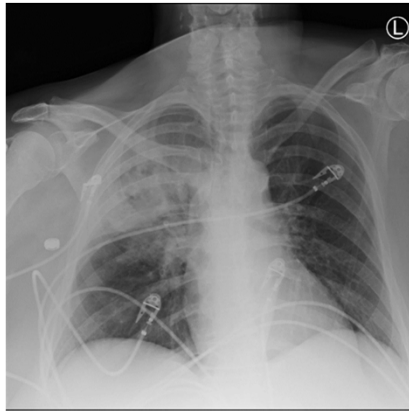
Complications

- **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**

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- 13. Kumar, et al. Duration of hypotension before inititiation of effective antimicrobial therapy is the critical determinate of survival in human septic shock. *Crit Care Med* 2006;34(6):1589-1595