Pneumonia

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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

### Objectives-CAP

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

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The Ohio State University Wexner Medical Center
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

<table>
<thead>
<tr>
<th>History physical</th>
<th>Imaging</th>
<th>Labs</th>
</tr>
</thead>
</table>
| • Risk of resistant organism | • CXR Required | • Basic labs
| • Immunosuppression | • Identify complications of pneumonia | • Biomarkers
| • Abx in past 90 days | • Consider CT | • Sputum culture
| • Risk of atypical infection | | • Urinary antigens
| • Risk of severe illness | | • Rapid Diagnostic Viral PCR
| | | • Blood cultures

Risk Stratification Tools

<table>
<thead>
<tr>
<th>Pneumonia Severity Index</th>
<th>Curb 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 criteria</td>
<td>5 criteria</td>
</tr>
<tr>
<td>Heavily weights age and comorbidities</td>
<td>Convenient</td>
</tr>
<tr>
<td>Sensitivity 79-95%</td>
<td>Sensitivity 22-78%</td>
</tr>
<tr>
<td>Specificity 44-70%</td>
<td>Specificity 75-94%</td>
</tr>
</tbody>
</table>
Causes of Community Acquired Pneumonia

<table>
<thead>
<tr>
<th>Bacterial</th>
<th>Viral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streptococcus Pneumoniae</td>
<td>Influenza</td>
</tr>
<tr>
<td>27%</td>
<td>18-33%</td>
</tr>
<tr>
<td>Haemophilus Influenza</td>
<td>Rhinovirus</td>
</tr>
<tr>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Atypicals:</td>
<td>Coronavirus</td>
</tr>
<tr>
<td>Mycoplasma</td>
<td>Adenovirus</td>
</tr>
<tr>
<td>23%</td>
<td>Parainfluenza</td>
</tr>
<tr>
<td>Legionella</td>
<td>RSV</td>
</tr>
</tbody>
</table>


Treatment

<table>
<thead>
<tr>
<th>According to IDSA/ATS Guidelines</th>
<th>Preferred</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient, no comorbidities, low severity</td>
<td>Macrolide monotherapy</td>
<td>Doxycycline</td>
</tr>
<tr>
<td>Outpatient, comorbidities, or increased risk resistance</td>
<td>β Lactam plus Macrolide</td>
<td>Respiratory Fluoroquinolone</td>
</tr>
<tr>
<td>Inpatient, non ICU, moderate severity</td>
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</table>
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.

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<td>• CXR Required • Identify complications of pneumonia • Consider CT</td>
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Modifying Factors That Increase The Risk For Infection With Specific Pathogens

<table>
<thead>
<tr>
<th>Organism</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin-resistant &amp; drug-resistant pneumococci</td>
<td>Age &gt; 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</td>
</tr>
<tr>
<td>Enteric gram negative bacteria</td>
<td>Residence in a nursing home, Underlying cardiopulmonary disease, Multiple medical comorbid conditions, Recent antibiotic therapy</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Bronchiectasis, Corticosteroid therapy, Broad-spectrum antibiotic therapy &gt; 7 days in the past month, Malnutrition</td>
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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.

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Use of biomarkers

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

**According to IDSA/ATS Guidelines**

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**Treatment**

**Community Acquired Pneumonia**

**Severity Assessment:** Clinical judgment supported by severity scores

- **Low Risk**
  - CURB-65 = 0, PSI = I
  - Inpatient (admitted for social reasons)
  - Antibiotic monotherapy or patients without complications or risk factors

- **Moderate Risk**
  - CURB-65 = 1, PSI = II, III
  - Inpatient, no ICU
  - Microbiological tests
  - Antibiotic combination therapy or quinolone

- **High Risk**
  - CURB-65 = 2, PSI = IV, V
  - Severe CAP Criteria 2 major or 1 major
  - Inpatient, ICU
  - Microbiological tests
  - Antibiotic combination therapy (β-lactam + either macrolide or quinolone)

**Determining length of treatment**

1, 3, 5, 6

- **Severity assessment:** Initial care
  - Microbiological tests
  - Inpatient antibiotic prescription

- **Reassessment**
  - Clinical stability
  - Initial culture results
  - Change antibiotics
  - Reassess micro testing
  - Repeat chest X-ray
  - Repeat antibiotic?

- **Discharge assessment**
  - Follow-up scheduled
  - Microbiological tests
  - Normal chest X-ray
  - Repeat antibiotic? (CXR)
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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- HCAP: healthcare-associated pneumonia – occurs in non-hospitalized patient with extensive healthcare contact

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

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
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

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

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<th>Common HAP bacterial pathogens</th>
</tr>
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<tbody>
<tr>
<td>Pseudomonas aeruginosa</td>
</tr>
<tr>
<td>Acinetobacter baumanii</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
</tr>
<tr>
<td>Escherichia coli</td>
</tr>
<tr>
<td>Methicillin Resistant Staphylococcus aureus (MRSA)</td>
</tr>
<tr>
<td>Enterobacter spp</td>
</tr>
<tr>
<td>Proteus spp</td>
</tr>
<tr>
<td>Serratia marcescnes</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
</tr>
<tr>
<td>Haemophilus influenzae</td>
</tr>
<tr>
<td>Methicillin-sensitive Staphylococcus aureus (MSSA)</td>
</tr>
</tbody>
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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
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
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

Potential Pathogens
- Streptococcus pneumoniae
- Haemophilus influenzae
- Methicillin-sensitive Staph aureus
- Antibiotic-sensitive enteric gram-negative bacilli:
  - E. coli
  - K. pneumoniae
  - Enterobacter species
  - Proteus species
- S. Marcescens

Recommended Antibiotic
- Ceftriaxone OR
- Levofloxacin, moxifloxacin, or ciprofloxacin OR
- Ampicillin/sulbactam OR
- Ertapenem

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

2005 IDSA/ATS HAP, VAP and HCAP Guidelines
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

2005 IDSA/ATS HAP, VAP and HCAP Guidelines

Initial intravenous adult doses of antibiotics for empiric therapy

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-pseudomonal cephalosporin</td>
<td>1-2 g every 8-12 h</td>
</tr>
<tr>
<td>Cefepime</td>
<td>2 g every 8 h</td>
</tr>
<tr>
<td>Carabepenem</td>
<td>500 mg every 6 h OR 1 g every 8 h</td>
</tr>
<tr>
<td>Imipenem</td>
<td>1 g every 8 h</td>
</tr>
<tr>
<td>Meropenem</td>
<td>4.5 g every 6 h</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td></td>
</tr>
<tr>
<td>Gentamicin</td>
<td>7 mg/kg per day</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>7 mg/kg per day</td>
</tr>
<tr>
<td>Amikacin</td>
<td>20 mg/kg per day</td>
</tr>
<tr>
<td>Anti-pseudomonal quinolone</td>
<td></td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>750 mg every day</td>
</tr>
<tr>
<td>Ciprofloxacine</td>
<td>400 mg every 8 h</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>15 mg/kg every 12 h</td>
</tr>
<tr>
<td>Linezolid</td>
<td>600 mg every 12 h</td>
</tr>
</tbody>
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2005 IDSA/ATS HAP, VAP and HCAP Guidelines

What antibiotics?

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<thead>
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2005 IDSA/ATS HAP, VAP and HCAP Guidelines

Appropriate antibiotics
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

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

Wrong Diagnosis
- Atelectasis
- Pulmonary embolus
- Pulmonary hemorrhage
- Underlying disease
- Neoplasm
- ARDS

Complication
- Empyema or lung abscess
- Clostridium difficile colitis
- Drug fever

Wrong Organism
- Drug-resistant pathogen
- Inadequate antibiotic therapy

2005 IDSA/ATS HAP, VAP and HCAP Guidelines

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:**

<table>
<thead>
<tr>
<th>No health conditions or risks:</th>
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<tbody>
<tr>
<td>- Age 65: PCV13</td>
</tr>
<tr>
<td>- After 1 year: PPSV23</td>
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<table>
<thead>
<tr>
<th>Chronic health condition*, smoker, or long-term care facility:</th>
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<tbody>
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<td>- After 1 year: PCV13</td>
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<td>- After 5 years: PPSV23</td>
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<th>Immunocompromising condition or asplenia:</th>
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*CHF, chronic lung disease, chronic liver disease, alcoholism, diabetes

**References**


## References