Updates in Management of Community Acquired Pneumonia

David Ming, MD
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Hilton Head, SC
Case #1

67 yo F previously healthy presents with fever, cough, dyspnea

Hemodynamically stable; 97% RA; RR 30

Normal mental status

Where should I treat (inpatient vs outpatient)?

What antibiotics should I prescribe?

What additional tests should I order?
Road Map

- Highlight the clinical features and presentation of community-acquired pneumonia (CAP)

- Assess the strengths and weaknesses of commonly used diagnostic testing modalities

- Describe common approaches to risk stratification for patients with CAP

- Evaluate treatment strategies for CAP

- Describe the shifting landscape in the management of healthcare-associated pneumonia (HCAP)
• Acute signs/symptoms of lower respiratory tract infection and new CXR infiltrate

• No “gold standard” definition exists

• No recent hospitalization or regular healthcare exposure
  – Stay tuned for more about HCAP

Lancet 2015;386:1097
NEJM 2014;371:1619
• CAP is **common**
  – >915,000 episodes of CAP annually in the US among adults >65 years
  – Leading cause of infectious disease death among adults >65 years

_Clin Infect Dis 2007;44:S27_  
_Ann Int Med Oct 6 2015;163(7):ITC1-17_
• CAP is **deadly**
  – 9\textsuperscript{th} leading cause of death in the US
  – 50,000 deaths in the US in 2010
  – 3.2 million deaths annually worldwide

NEJM 2014;370:543
CAP is **treatable**

– Antibiotics save lives

– Timely administration of antibiotics associated with reduced mortality (5-43%)
DIAGNOSIS
67 yo M with CHF (EF 40%) presents with cough and chest pressure.

Temp 100.2; 94% RA
Mild confusion

WBC 9K
Negative cardiac enzymes

What signs/symptoms support diagnosis of CAP?
Which of the following is the most useful single sign/symptom for diagnosis CAP?

a) Fever  
b) Egophany  
c) Leukocytosis  
d) Tachypnea  
e) Dullness to percussion
Which of the following is the most useful single sign/symptom for diagnosis CAP?

a) Fever
b) Egophany
c) Leukocytosis
d) Tachypnea
e) Dullness to percussion
Severity assessment
(clinical judgment supported by severity scores)

Low risk
- CURB-65=0, 1
  - PSI=I, II, III
  - Outpatient
  - Inpatient (admitted for social reasons)
  - Antibiotic
    - Monotherapy in patients without comorbidities or risk factors

Moderate risk
- CURB-65=2
  - PSI=IV, V
  - Inpatient, no ICU
  - Microbiological tests
  - Antibiotic
    - Combination antibiotics or quinolone

High risk
- CURB-65=3, 4
  - PSI=IV, V
  - Severe CAP criteria:
    - ≥3 minor, or ≥1 major criteria
  - Inpatient, ICU
  - Microbiological tests
  - Antibiotic
    - Combination antibiotics
    - (β-lactam plus macrolide*) or β-lactam plus quinolone

Lancet 2015;386:1097
Diagnosis

• In patients **without underlying heart/lung disease**:
  1. Evidence of infection (fever, chills, leukocytosis)
  2. Signs/symptoms localized to respiratory system
  3. New or changed infiltrate on radiography

*Slide courtesy of Stephen Telloni, MD*

*N Engl J Med 2014;370:543*
*N Engl J Med 2014;371:1619*
*Chest 2006;130:11-15.*
• Diagnosis particularly difficult in patients with underlying heart/lung disease and elderly
  – Confusion may be presenting symptom in elderly
  – Up to 30% may be afebrile (especially elderly)

• Atypical presentation complicates diagnosis and delays treatment

Chest 2006;130:11-15.
Slide courtesy of Stephen Telloni, MD
**Table 1. Differential Diagnosis of Community-Acquired Pneumonia.**

<table>
<thead>
<tr>
<th>Abnormal chest radiograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestive heart failure with associated viral syndrome to explain infectious symptoms</td>
</tr>
<tr>
<td>Aspiration pneumonitis</td>
</tr>
<tr>
<td>Pulmonary infarction</td>
</tr>
<tr>
<td>Acute exacerbation of pulmonary fibrosis</td>
</tr>
<tr>
<td>Acute exacerbation of bronchiectasis</td>
</tr>
<tr>
<td>Acute eosinophilic pneumonia</td>
</tr>
<tr>
<td>Hypersensitivity pneumonitis</td>
</tr>
<tr>
<td>Pulmonary vasculitis</td>
</tr>
<tr>
<td>Cocaine-induced lung injury (“crack lung”)</td>
</tr>
</tbody>
</table>

**Normal chest radiograph**

| Acute exacerbation of chronic obstructive pulmonary disease |
| Influenza |
| Acute bronchitis |
| Pertussis |
| Asthma with associated viral syndrome to explain infectious symptoms |
Fever and chills (sensitivity 50-80%)
Cough
Purulent sputum (sensitivity 50%)
Dyspnea (sensitivity 70%)
Pleuritic chest pain
Night sweats
Hemoptysis

Atypical symptoms (especially in elderly)
  – Confusion, lethargy, weakness, falls, decreased PO intake, decompensation of chronic diseases
<table>
<thead>
<tr>
<th>Type of Finding</th>
<th>Positive Likelihood Ratio†</th>
<th>Negative Likelihood Ratio†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical history</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>1.7–2.1</td>
<td>0.6–0.7</td>
</tr>
<tr>
<td>Chills</td>
<td>1.3–1.7</td>
<td>0.7–0.9</td>
</tr>
<tr>
<td>Vital signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tachypnea‡</td>
<td>1.5–3.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Tachycardia§</td>
<td>1.6–2.3</td>
<td>0.5–0.7</td>
</tr>
<tr>
<td>Hyperthermia¶</td>
<td>1.4–4.4</td>
<td>0.6–0.8</td>
</tr>
<tr>
<td>Chest examination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dullness to percussion</td>
<td>2.2–4.3</td>
<td>0.8–0.9</td>
</tr>
<tr>
<td>Decreased breath sounds</td>
<td>2.3–2.5</td>
<td>0.6–0.8</td>
</tr>
<tr>
<td>Crackles</td>
<td>1.6–2.7</td>
<td>0.6–0.9</td>
</tr>
<tr>
<td>Rhonchi</td>
<td>1.4–1.5</td>
<td>0.8–0.9</td>
</tr>
<tr>
<td>Egophany</td>
<td>2.0–8.6</td>
<td>0.8–1.0</td>
</tr>
<tr>
<td>Laboratory findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukocytosis¶</td>
<td>1.9–3.7</td>
<td>0.3–0.6</td>
</tr>
</tbody>
</table>

No single/combo of history/exam diagnostic for CAP

Ann Int Med 2003;138(2):109
Diagnosis – History/Exam

- Baseline prevalence of CAP ~5%
- History/exam findings (single or combination) rarely raise probability of CAP to >50%
- More challenging if underlying heart/lung disease

![Graph showing the revised probability of CAP based on examination findings.](image-url)
• Not suggesting that exam/history are useless!

• Key questions:
  1. **What is** the value of physical examination?
     • History/exam refine clinical assessment before imaging
     • Absence of abnormalities implies low prob for CAP
     • CXR is not perfect

  2. If history/exam has limited accuracy, should **everyone** simply get a CXR?
     • CXR recommended to confirm CAP when diagnosis suspected
     • However, if you have a low treatment threshold and patient with mild illness, CXR may be avoided
Severity assessment
(clinical judgment supported by severity scores)

- **Low risk**
  - CURB-65=0, 1
  - PSI=I, II, III
  - **Outpatient**
  - **Inpatient** (admitted for social reasons)
  - **Antibiotic**
    - Monotherapy in patients without comorbidities or risk factors

- **Moderate risk**
  - CURB-65=2
  - PSI=IV, V
  - **Inpatient, no ICU**
  - **Antibiotic**
    - Combination antibiotics or quinolone

- **High risk**
  - CURB-65=3, 4
  - PSI=IV, V
  - **Severe CAP criteria:** ≥3 minor, or ≥1 major criteria
  - **Inpatient, ICU**
  - **Microbiological tests**
  - **Antibiotic**
    - Combination antibiotics (β-lactam plus macrolide* or β-lactam plus quinolone)
Two key questions for all patients with CAP

1. Hospital admission?
2. ICU care?
• Delayed care enhances patient risks (mortality)

• Physicians are inconsistent with how/where they treat CAP

• Hospital overuse for CAP care costly and risky
### Risk Stratification – PSI/PORT

#### Pneumonia Severity Index Step 2: Risk factors and assigned points

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic factors</strong></td>
<td></td>
</tr>
<tr>
<td>Age for a man</td>
<td>Age (in years)</td>
</tr>
<tr>
<td>Age for a woman</td>
<td>Age (in years) - 10</td>
</tr>
<tr>
<td>Nursing home resident</td>
<td>+10</td>
</tr>
<tr>
<td><strong>Coexisting illnesses</strong></td>
<td></td>
</tr>
<tr>
<td>Neoplastic disease (active)</td>
<td>+30</td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>+20</td>
</tr>
<tr>
<td>Heart failure</td>
<td>+10</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>+10</td>
</tr>
<tr>
<td>Chronic renal disease</td>
<td>+10</td>
</tr>
<tr>
<td><strong>Physical examination findings</strong></td>
<td></td>
</tr>
<tr>
<td>Altered mental status</td>
<td>+20</td>
</tr>
<tr>
<td>Respiratory rate ≥30/minute</td>
<td>+20</td>
</tr>
<tr>
<td>Systolic blood pressure &lt;90 mmHg</td>
<td>+20</td>
</tr>
<tr>
<td>Temperature &lt;35°C or ≥40°C</td>
<td>+15</td>
</tr>
<tr>
<td>Pulse ≥125 beats/minute</td>
<td>+10</td>
</tr>
<tr>
<td><strong>Laboratory and radiographic findings</strong></td>
<td></td>
</tr>
<tr>
<td>Arterial pH &lt;7.35</td>
<td>+30</td>
</tr>
<tr>
<td>Blood urea nitrogen ≥30 mg/dL (11 mmol/L)</td>
<td>+20</td>
</tr>
<tr>
<td>Sodium &lt;130 mmol/L</td>
<td>+20</td>
</tr>
<tr>
<td>Glucose ≥250 mg/dL (14 mmol/L)</td>
<td>+10</td>
</tr>
<tr>
<td>Hematocrit &lt;30 percent</td>
<td>+10</td>
</tr>
<tr>
<td>Partial pressure of arterial oxygen &lt;60 mmHg*</td>
<td>+10</td>
</tr>
<tr>
<td>Pleural effusion on chest radiograph</td>
<td>+10</td>
</tr>
</tbody>
</table>

- 20 items that stratify into 5 classes correlated with 30-day mortality risk
- Age and co-morbidities most heavily weighted


*Lancet 2015;386:1097*
**PSI class and mortality in the Pneumonia PORT validation cohort**

<table>
<thead>
<tr>
<th>Class</th>
<th>Points</th>
<th>Mortality (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No predictors</td>
<td>0.1</td>
</tr>
<tr>
<td>II</td>
<td>≤70</td>
<td>0.6</td>
</tr>
<tr>
<td>III</td>
<td>71 to 90</td>
<td>0.9</td>
</tr>
<tr>
<td>IV</td>
<td>91 to 130</td>
<td>9.3</td>
</tr>
<tr>
<td>V</td>
<td>&gt;130</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Advantages

- Well-validated for predicting mortality
- Use of PSI results in fewer admissions of patients with mild illness and no increase in adverse outcomes

Disadvantages

- Cumbersome to calculate; need EHR decision support
- Underestimates severity in young patients and those without chronic diseases
  - High PSI score in a young patient should be alarming
- Does not consider socioeconomic factors
  - Some low-risk patients may still need admission
- Class III is gray -- IP vs OP?
- Cannot predict risk for CAP complications or need for ICU

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
Adapted from slide by Stephen Telloni, MD
Risk Stratification – CURB-65

- 1 point for each criterion met
- More points correlates with higher mortality

<table>
<thead>
<tr>
<th>CURB-65 Score</th>
<th>30-Day Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.7%</td>
</tr>
<tr>
<td>1</td>
<td>2.1%</td>
</tr>
<tr>
<td>2</td>
<td>9.2%</td>
</tr>
<tr>
<td>3</td>
<td>14.5%</td>
</tr>
<tr>
<td>4</td>
<td>40%</td>
</tr>
<tr>
<td>5</td>
<td>57%</td>
</tr>
</tbody>
</table>

Confusion (based upon a specific mental test or new disorientation to person, place, or time)

**Urea** (blood urea nitrogen in the United States) >7 mmol/L (20 mg/dL)

Respiratory rate ≥30 breaths/minute

Blood pressure (systolic <90 mmHg or diastolic <60 mmHg)

Age ≥65 years

*Clin Infect Dis 2007;44:S27*
Advantages

• Easy to use and calculate

• Use associated with fewer admissions for mild without increase in adverse outcomes

Disadvantages

• Not as well validated as PSI

• Does not consider co-morbidities

• Does not consider socioeconomic factors
  • Some low-risk patients may still need admission

• CURB-65 score of 2 is gray – IP vs OP?

• Does not predict risk for CAP complications or need for ICU

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
Adapted from slide by Stephen Telloni, MD
Accuracy of Risk Stratification Scores

All scales with similar accuracy for predicting mortality
No one scale is clinically more useful than the other

---

Pooled test characteristics of high-risk categories of scales for predicting mortality in patients with community-acquired pneumonia*

<table>
<thead>
<tr>
<th>Scale†</th>
<th>Number of studies (n)</th>
<th>Sensitivity (95% CI)</th>
<th>Specificity (CI)</th>
<th>+LR</th>
<th>−LR</th>
<th>Diagnostic OR (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI</td>
<td>16 (16 519)</td>
<td>0.90 (0.87 to 0.92)</td>
<td>0.53 (0.46 to 0.59)</td>
<td>1.9</td>
<td>0.19</td>
<td>11 (8.3 to 14)</td>
</tr>
<tr>
<td>CURB-65</td>
<td>12 (11 199)</td>
<td>0.62 (0.54 to 0.70)</td>
<td>0.79 (0.75 to 0.83)</td>
<td>3.0</td>
<td>0.48</td>
<td>6.4 (5.1 to 8.1)</td>
</tr>
<tr>
<td>CRB-65</td>
<td>10 (8143)</td>
<td>0.33 (0.24 to 0.44)</td>
<td>0.92 (0.86 to 0.96)</td>
<td>4.1</td>
<td>0.73</td>
<td>6.0 (3.4 to 10)</td>
</tr>
<tr>
<td>CURB</td>
<td>5 (6237)</td>
<td>0.63 (0.49 to 0.76)</td>
<td>0.77 (0.68 to 0.83)</td>
<td>2.7</td>
<td>0.48</td>
<td>5.8 (4.6 to 7.2)</td>
</tr>
</tbody>
</table>

*Data from Ann Int Med 2011 Apr; ACP J Club;154(4)
## Site of Care for CAP - Summary

<table>
<thead>
<tr>
<th>Risk Score</th>
<th>Outpatient</th>
<th>Inpatient Wards</th>
<th>ICU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Risk</strong></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>PSI I-II</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURB 0,1</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Moderate Risk</strong></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>PSI III-V</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURB 2</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High Risk</strong></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>PSI IV-V</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURB 3-5 and</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Meets severe CAP criteria</td>
<td></td>
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</tr>
</tbody>
</table>

*References*

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
Delayed ICU care associated with mortality

Graph showing the cumulative survival over time to death at 30 days for two groups: EICUA (Direct or <2d) and LICUA (> 2d).
• ~10% of CAP admissions need ICU
  – Variability between hospitals/ICUs

• CURB-65 and PSI have limited ability to identify patients likely to worsen and need ICU care

• ICU recommended if “severe CAP” present:
  – 1 major criteria or
  – ≥3 minor criteria

Table 4. Criteria for severe community-acquired pneumonia.

<table>
<thead>
<tr>
<th>Minor criteria&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory rate&lt;sup&gt;b&lt;/sup&gt;   ≥30 breaths/min</td>
</tr>
<tr>
<td>PaO&lt;sub&gt;2&lt;/sub&gt;/FiO&lt;sub&gt;2&lt;/sub&gt; ratio&lt;sup&gt;b&lt;/sup&gt; ≤250</td>
</tr>
<tr>
<td>Multilobar infiltrates</td>
</tr>
<tr>
<td>Confusion/disorientation</td>
</tr>
<tr>
<td>Uremia (BUN level, ≥20 mg/dL)</td>
</tr>
<tr>
<td>Leukopenia&lt;sup&gt;c&lt;/sup&gt; (WBC count, &lt;4000 cells/mm&lt;sup&gt;3&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Thrombocytopenia (platelet count, &lt;100,000 cells/mm&lt;sup&gt;3&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Hypothermia (core temperature, &lt;36°C)</td>
</tr>
<tr>
<td>Hypotension requiring aggressive fluid resuscitation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invasive mechanical ventilation</td>
</tr>
<tr>
<td>Septic shock with the need for vasopressors</td>
</tr>
</tbody>
</table>

Clin Infect Dis 2007;44:S27
• Risk stratification scales (CURB-65 or PSI) should be used to determine site of care

• Do not solely rely on PSI or CURB scoring
  – Scoring systems are adjuncts to clinical judgment that considers all factors (e.g., social)

• Use IDSA-ATS major/minor criteria to define severe CAP and consider ICU care
67 yo F previously healthy presents with fever, cough, dyspnea

Hemodynamically stable; 97% RA; RR 16

Normal mental status

Where should I treat (inpatient vs outpatient)?

a) Outpatient
b) Inpatient (non-ICU)
c) ICU
Clinical Vignette

67 yo F previously healthy presents with fever, cough, dyspnea

BP 88/50
97% RA; RR 32

Confused on exam
WBC 2.3K; Platelets 80
BUN 60; Cr 2.3 (usually normal)

Where should I treat (inpatient vs outpatient)?

a) Outpatient
b) Inpatient (non-ICU)
c) ICU

Lancet 2015;386:1097
67 yo F previously healthy presents with fever, cough, dyspnea

BP 100/72
97% RA; RR 32

Normal mental status on exam

Where should I treat (inpatient vs outpatient)?

a) Outpatient

b) Inpatient (non-ICU)

c) ICU
DIAGNOSTIC TESTING
Diagnostic Testing Options

- Blood culture
- Sputum culture
- Urine antigen testing
- Viral testing
- Inflammatory markers – CRP, procalcitonin
Microbiology

- Traditional most common bacterial pathogens
  - *S. pneumoniae*
  - Atypicals (*Mycoplasma, Legionella, Chlamydia*)
  - *Haemophilus influenzae*

- Viruses (esp influenza) often implicated (33%)

- Modern data highlights key role for viruses
  - Most common pathogens in pts admitted with CAP:
    - Rhinovirus (9%), Influenza (6%), *S. pneumoniae* (5%)

Lancet 2015;386:1097*
Bug isolated in only 38% of patients.

Viral prominence reflects effects of vaccination (*S. pneumoniae*) and insensitive bacterial diagnostic tests.
Diagnostic Testing

- Diagnostic testing rarely affects therapy
  - Most recommended antibiotics regimens effective for majority of patients

- Extensive testing most helpful in patients with HCAP or severe CAP
  - Higher rates of resistant/atypical CAP bacteria

Clin Infect Dis 2007;44:S27
Adapted from slide by Stephen Telloni, MD
Blood Cultures

- Low yield, even if obtained pre-abx (5-14%)
  - Most common bacteria is *S. pneumoniae*, which is presumed target for first-line abx anyways
  - Management rarely changes
  - Risk for false-positives and unnecessary abx (vancomycin)

- **Bottom Line:** routinely recommended only for:
  1. Severe CAP
  2. HCAP
  3. Non-severe CAP in patients with cirrhosis or asplenia

Clin Infect Dis 2007;44:S27
Adapted from slide by Stephen Telloni, MD
Sputum Culture

• Variable yield dependent on sample quality
  – Best yield when collected pre-antibiotics

• **Bottom Line:** recommended if *productive cough and*
  – Severe CAP
  – HCAP
  – Non-severe CAP with underlying structural lung disease or severe COPD

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
Adapted from slide by Stephen Telloni, MD
Urinary Antigen Testing

- Advantages
  - Fast (<15 minutes)
  - Good accuracy
  - Allow detection of infection while receiving antibiotics

- Higher yield with more severe disease

- Pneumococcal urinary antigen
  - Sensitivity 70-90%
  - Specificity 97%

- Legionella urinary antigen
  - Sensitivity 74%
  - Specificity 98%

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
• **Bottom Line:**

  – Urine *S. pneumo* recommended for:
    1. Severe CAP
    2. HCAP

  – Urine *Legionella* recommended for:
    1. Severe CAP
    2. HCAP (only if patient resides in a nursing home)
    3. Non-severe CAP (*only if recent travel*)

*Clin Infect Dis 2007;44:S27*
*N Engl J Med 2014;370:543*
*Lancet 2015;386:1097*
Adapted from slide by Stephen Telloni, MD
Viral Testing

- Viruses are the most commonly isolated pathogens in hospitalized patients with CAP

- Viral testing difficult to interpret - ?causative vs predisposed patient to bacterial PNA

- Diagnosis of viral PNA, role of antivirals, and cost-effectiveness of routine expanded viral testing controversial

- **Bottom Line**: Focus on influenza testing for any patient with pneumonia during flu season.

Clin Infect Dis 2007;44:S27
Lancet 2015;386:1097
Adapted from slide by Stephen Telloni, MD
Inflammatory Markers

• **CRP**
  – Use associated with less antibiotic use and no difference in mortality
  – British NICE guidelines advise no abx in primary care if CRP <20 mg/L

• **Procalcitonin (PCT)**
  – Use associated with less abx use and unchanged mortality or treatment failure

• **Bottom Line:**
  Routine use of CRP and PCT not yet established but appears promising
## Diagnostic Testing – Summary

<table>
<thead>
<tr>
<th></th>
<th>Outpatient</th>
<th>Inpatient, low severity</th>
<th>Inpatient, no ICU, moderate severity</th>
<th>Inpatient, ICU, high severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sputum culture</td>
<td>None routinely</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Blood culture</td>
<td>None routinely</td>
<td>None routinely</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Legionella urinary antigen</td>
<td>None routinely</td>
<td>None routinely</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pneumococcal urinary antigen</td>
<td>None routinely</td>
<td>None routinely</td>
<td>None routinely</td>
<td>Yes</td>
</tr>
<tr>
<td>Invasive respiratory tract sample culture</td>
<td>None routinely</td>
<td>None routinely</td>
<td>None routinely</td>
<td>Yes</td>
</tr>
<tr>
<td>Others</td>
<td>None routinely</td>
<td>None routinely</td>
<td>None routinely</td>
<td>Yes*</td>
</tr>
</tbody>
</table>

*Lancet 2015;386:1097*
67 yo F previously healthy presents in mid-November with fever, cough, dyspnea

Hemodynamically stable; 97% RA; RR 16.

Normal mental status

What diagnostic testing should I order?

a) Blood culture
b) Sputum culture
c) Urine antigens
d) Influenza PCR
e) PCT or CRP
67 yo M with CHF (EF 40%) presents in July with cough and chest pressure.

Temp 100.2; 94% RA; RR 32
Mild confusion

WBC 9K
Negative cardiac enzymes

What diagnostic testing should I order?

a) Blood culture
b) Sputum culture
c) Urine antigens
d) Influenza PCR
e) PCT or CRP
f) A, B, and C
Imaging

• CXR
  – 75% accuracy for consolidation; 47% for effusions
  – PA views improve accuracy
  – Accuracy limited by body habitus, bedridden/portable views, underlying lung/heart disease, early illness course
  – Only moderate radiologist inter-observer agreement
    • Agreement lower for PNA (59%) than for non-PNA cases (94%)
  – **CXR still recommended to confirm suspected CAP**

• CT
  – Most accurate for consolidation and evaluation of lung parenchyma and mediastinum
  – Impractical, radiation exposure, high cost
  – Reserved for specific clinical situations (non-responding PNA, evaluate for abscess, exclude alternative dx)
TREATMENT
**Severity assessment**
( clinical judgment supported by severity scores)

- **Low risk**
  - CURB-65 = 0, 1
  - PSI = I, II, III
  - Outpatient
    - (admitted for social reasons)

- **Moderate risk**
  - CURB-65 = 2
  - PSI = IV, V
  - Inpatient, no ICU
    - Microbiological tests

- **High risk**
  - CURB-65 = 3, 4
  - PSI = IV, V
  - Severe CAP criteria:
    - ≥3 minor, or ≥1 major criteria
  - Inpatient, ICU
    - Microbiological tests

**Antibiotic**
- Monotherapy in patients without comorbidities or risk factors
- Combination antibiotics or quinolone
- Combination antibiotics (β-lactam plus macrolide* or β-lactam plus quinolone)

---

Lancet 2015;386:1097
• Traditional most common bacterial pathogens
  – S. pneumoniae
  – Atypicals (Mycoplasma, Legionella, Chlamydia
  – Haemophilus influenzae

• Modern studies highlight role for viruses
  – Most common pathogens in pts admitted with CAP: Rhinovirus (9%), Influenza (6%), S. pneumoniae (5%)

Lancet 2015;386:1097
<table>
<thead>
<tr>
<th></th>
<th>American (IDSA/ATS)³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preferred</td>
</tr>
<tr>
<td>Outpatient without</td>
<td>Macrolide</td>
</tr>
<tr>
<td>comorbidities; low severity</td>
<td></td>
</tr>
<tr>
<td>Outpatient with</td>
<td>β-lactam plus</td>
</tr>
<tr>
<td>comorbidities or high rate</td>
<td>macrolide</td>
</tr>
<tr>
<td>bacterial resistance</td>
<td></td>
</tr>
<tr>
<td>Inpatient not in ICU;</td>
<td>β-lactam* plus</td>
</tr>
<tr>
<td>moderate severity</td>
<td>macrolide</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Inpatient in ICU;</td>
<td>β-lactam± plus</td>
</tr>
<tr>
<td>high severity</td>
<td>macrolide</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lancet 2015;386:1097
Antibiotics - Outpatient

• Usually empiric abx and no diagnostic testing done

• Factors associated with higher risk for infection with drug-resistant *S. pneumoniae*
  – Recent abx exposure (past 3 months)
  – Co-morbidities
  – High regional rates of drug-resistant *S. pneumoniae*

• **Bottom Line:**
  – Healthy, no risk factors → macrolide or doxycycline
  – Co-morbidities, risk for drug resistant infection → respiratory fluoroquinolone (FQ) or β-lactam + macrolide

*Clin Infect Dis 2007;44:S27*  
*NEJM 2014;371:1619*
Antibiotics - Inpatient

• Factors to consider
  – Severity of illness (mild/moderate vs severe)
  – Site of care (ICU vs non-ICU)

• Most inpatients are at-risk for drug-resistant *S. pneumo* (e.g., co-morbidities), so macrolide monotherapy is rare

• ICU patients need combined abx and may be at risk for resistant/atypical infections (e.g., pseudomonas, MRSA)

• **Bottom Line:**
  – Inpatient, Non-ICU, Mild/Moderate CAP → β-lactam + macrolide or respiratory FQ
  – Inpatient, ICU, Severe CAP → β-lactam + macrolide or β-lactam + respiratory FQ
Recommende
d CAP
antibiotics are
associated with lower mortality

Adapted from slide by Stephen Telloni, MD
Antibiotics – Timing

- Antibiotics within 4-8 hours associated with lower mortality
  - Smaller studies found no difference

- Unintended consequences with efforts to shorten time to abx
  - C. diff, inappropriate abx use, CAP overdiagnosis, no impact on mortality

- Faster abx may be a marker of other beneficial care patterns

**Bottom Line:**
Prompt abx (<8 hours) at time of diagnosis should be part of an overall timely tx strategy

JAMA 2016;315(6):593
• 5-7 days for most patients

• Afebrile 48-72 hour and clinically stable

• Prolonged course not associated with better outcomes
67 yo F previously healthy presents with fever, cough, dyspnea

Hemodynamically stable; 97% RA; RR 16

Normal mental status

What antibiotic?

a) Doxycycline
b) Azithromycin
c) Cefixime
d) Moxifloxacin
e) A or B
f) A, B, or C
67 yo F previously healthy presents with fever, cough, dyspnea

BP 88/50
97% RA; RR 32

Confused on exam
WBC 2.3K; Platelets 80
BUN 60; Cr 2.3 (usually normal)

What antibiotic?

a) Ceftriaxone+azithro
b) Levofloxacin
c) Ceftriaxone+levo
d) Piperacillin/tazobactam + ciprofloxacin + vanc
e) Ertapenem+vanc
f) A or C
g) A, B, or C

Courtesy of Thomas Holland, MD
Clinical Vignette

67 yo F previously healthy presents with fever, cough, dyspnea

BP 100/72
97% RA; RR 32

Normal mental status on exam

What antibiotic?

a) Moxifloxacin
b) Azithromycin
c) Ceftriaxone + azithromycin
d) B and C
e) A or C

Courtesy of Thomas Holland, MD
Antibiotics – IV to PO Transition

• Transition to oral antibiotics if:
  – hemodynamically stable
  – clinically improving
  – able to eat/take oral meds

• Most (2/3) clinically stable within first 3 days

• A routine practice of continued observation in-hospital after transition to PO is unnecessary

Table 10. Criteria for clinical stability.

<table>
<thead>
<tr>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature ≤37.8°C</td>
</tr>
<tr>
<td>Heart rate ≤100 beats/min</td>
</tr>
<tr>
<td>Respiratory rate ≤24 breaths/min</td>
</tr>
<tr>
<td>Systolic blood pressure ≥90 mm Hg</td>
</tr>
<tr>
<td>Arterial oxygen saturation ≥90% or pO₂ ≥60 mm Hg on room air</td>
</tr>
<tr>
<td>Ability to maintain oral intake&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Normal mental status&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Clin Infect Dis 2007;44:S27
Steroids

• Not part of routine recommendations but evidence base growing
  – Small numbers and heterogeneity across studies

• Steroids associated with:
  – Shorter length of stay (1 day) and time to clinical stability (1.2 days)
  – Lower need for mechanical ventilation and lower risk for ARDS
  – Higher risk for hyperglycemia
  – No increase in risk for GI bleeding
  – No reduction in overall mortality

• Inpatients with severe CAP may be most likely to benefit
  – Highest risk for complications (mechanical ventilation, ARDS)
  – Suggestion of reduced mortality in this subgroup

• **Bottom Line**
  Steroids can be considered for inpatients with CAP. Give particular consideration to use in patients with severe CAP (ICU).
### Table 4. Reasons for a Lack of Response to Treatment of CAP.

<table>
<thead>
<tr>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct organism but inappropriate antibiotic choice or dose</td>
</tr>
<tr>
<td>Resistance of organism to selected antibiotic</td>
</tr>
<tr>
<td>Wrong dose (e.g., in a patient who is morbidly obese or has fluid overload)</td>
</tr>
<tr>
<td>Antibiotics not administered</td>
</tr>
<tr>
<td>Correct organism and correct antibiotic but infection is loculated (e.g., most commonly empyema)</td>
</tr>
<tr>
<td>Obstruction (e.g., lung cancer, foreign body)</td>
</tr>
<tr>
<td>Incorrect identification of causative organism</td>
</tr>
<tr>
<td>No identification of causative organism and empirical therapy directed toward wrong organism</td>
</tr>
<tr>
<td>Noninfectious cause</td>
</tr>
<tr>
<td>Drug-induced fever</td>
</tr>
<tr>
<td>Presence of an unrecognized, concurrent infection</td>
</tr>
</tbody>
</table>
LONG-TERM MANAGEMENT
Post-Discharge Outcomes

• Risks continue post-discharge
  – 30-day readmission rate = 18%
  – 30-day mortality rate = 10-12%

  – Mortality remains increased at 1 year and even up to 3-5 years (pneumococcal PNA)
  – Prolonged time to return to baseline (if ever)
Other Follow-Up Issues

• If stable course and recovery, no role for routine pre-/post-discharge follow-up CXR
  – Clinical resolution by 3 weeks but complete radiographic resolution can take >12 weeks

• Implement prevention strategies
  – Pneumococcus and influenza vaccines
  – Smoking cessation
  – Optimize management of co-morbidities
  – Aspiration evaluation (if recurrent PNA)
Figure 3: Acute and long-term assessment of community-acquired pneumonia
HEALTHCARE-ASSOCIATED PNEUMONIA
HCAP Criteria

• Develops outside the hospital
• Same pathogens associated with HAP/VAP (MRSA, multi-drug resistant GNR)
• Any one meets HCAP criteria

Table 2. Criteria for Health Care–Associated Pneumonia.

Original criteria*
Hospitalization for ≥2 days during the previous 90 days
Residence in a nursing home or extended-care facility
Long-term use of infusion therapy at home, including antibiotics
Hemodialysis during the previous 30 days
Home wound care
Family member with multidrug-resistant pathogen
Immunosuppressive disease or therapy†

HCAP Criteria

- Associated with:
  - Higher mortality and longer length of stay
  - Higher severity illness (PSI, CURB-65 scores)
  - More comorbid conditions
  - More MDR pathogens

### TABLE 4. OUTCOMES ACCORDING TO TYPE OF PNEUMONIA*

<table>
<thead>
<tr>
<th>Microbiologic and clinical outcomes</th>
<th>CAP (n = 887)</th>
<th>HCAP (n = 526)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multidrug-resistant pathogens</td>
<td>45/475 (9.5)</td>
<td>74/320 (23.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CAP drug-resistant pathogens†‡</td>
<td>38/442 (8.6)</td>
<td>81/304 (26.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Inappropriate initial antibiotic treatment‡§</td>
<td>69/442 (15.6)</td>
<td>99/305 (32.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mechanical ventilation¶</td>
<td>87 (9.8)</td>
<td>44 (8.4)</td>
<td>0.366</td>
</tr>
<tr>
<td>30-d mortality¶</td>
<td>62 (7.0)</td>
<td>107 (20.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>89 (10.0)</td>
<td>131 (24.9)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

“Triple therapy” broad-spectrum antibiotic recs:
- Antipseudomonal antibiotics (“double coverage”) and
- Anti-MRSA antibiotic
Limitations of HCAP Guidelines

- Extrapolation from non-HCAP literature
  - Criteria from study of healthcare-associated bacteremia
  - Abx regimens from HAP and VAP literature

- HCAP is clinically distinct from CAP, HAP, and VAP

- HCAP population is heterogeneous
  - Many with HCAP are not at high risk for MDR pathogens
  - Criteria do not accurately predict who will have MDR

- “One size fits all” approach has consequences
  - Overuse of broad spectrum antibiotics

Am J Resp Crit Care Med 2013;188:896
Undertreatment (Too narrow)

Overtreatment (Too broad)
Updated Approach to HCAP

Table 2. Criteria for Health Care–Associated Pneumonia.
Pneumonia-specific criteria:
Hospitalization for ≥2 days during the previous 90 days
Antibiotic use during the previous 90 days
Nonambulatory status
Tube feedings
Immunocompromised status
Use of gastric acid suppressive agents

- Only similarities with original HCAP criteria are hospitalization in past 90 days and immunosuppression

Am J Respir Crit Care Med 2013;188(8):985
• More criteria present, higher risk for MDR pathogens
• Highest accuracy at ≥3 risk factors
• 36% of HCAP have 0-1 risk factors (low risk for MDR)

Am J Respir Crit Care Med 2013;188(8):985
• CA-MRSA in absence of other HCAP risk factors requires thinking about MRSA separately from other MDRs
• Cut-point for MRSA appears to be ≥2 HCAP risk factors

Table 1. Independent risk factors for pneumonia secondary to community-acquired pneumonia drug-resistant pathogens and methicillin-resistant Staphylococcus aureus specifically

<table>
<thead>
<tr>
<th>CAP-DRP</th>
<th>MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalization ≥ 2 d in previous 90 d</td>
<td>Hospitalization ≥ 2 d in previous 90 d</td>
</tr>
<tr>
<td>Use of antibiotics in previous 90 d</td>
<td>Use of antibiotics in previous 90 d</td>
</tr>
<tr>
<td>Immunosuppression</td>
<td>Chronic hemodialysis in previous 30 d*</td>
</tr>
<tr>
<td>Nonambulatory status</td>
<td>Prior MRSA colonization*</td>
</tr>
<tr>
<td>Tube feedings</td>
<td>Congestive heart failure*</td>
</tr>
<tr>
<td>Gastric acid suppression</td>
<td>Gastric acid suppression</td>
</tr>
</tbody>
</table>

Am J Resp Crit Care Med 2013;188:896
HCAP Controversies - Summary

• Original HCAP criteria are too broad, do not predict MDR risk very well, and lead to antibiotic overuse

• Physicians not following original HCAP guidelines anyways and patients overall have similar outcomes
  – Suggests heterogeneous HCAP population with subset at lower risk for MDRs
  – Lower risk HCAP patients may not need recommended broad spectrum empiric antibiotics

• Recent data provides a more nuanced approach to HCAP management
  – Stratifies patients by number of risk factors for MDRs
Clinical Bottom Line

1. Assess MDR risk in all pts with HCAP

2. Treat low risk HCAP (0-1) with CAP abx

3. Reserve broad spec abx for ≥3 RF

4. Think about MRSA and assess MRSA RFs if ≥2 MDR risk factors present

5. Instead of looking for reason for broad abx, look for safe opportunities for narrow CAP abx
Case #4

58 yo F hospitalized 1 month ago for mechanical fall with femur fracture.

Been living at a rehab facility since last admission. Now ambulatory.

Now admitted after presenting with fever, cough, dyspnea.

What empiric antibiotic?

a) Moxifloxacin
b) Ceftriaxone + azithromycin
c) Piperacillin/tazobactam + ciprofloxacin + vancomycin
d) A or B
e) A or C

Courtesy of Thomas Holland, MD
58 yo F hospitalized 1 month ago for LLE cellulitis. Treated with cephalexin and resolved. Has a history of ESRD on hemodialysis.

Now admitted after presenting with fever, cough, dyspnea.

**What empiric antibiotic?**

a) Moxifloxacin  
b) Ceftriaxone + azithromycin  
c) Vancomycin  
d) A and C  
e) B and C  
f) D or E
58 yo F hospitalized 1 month ago for mechanical fall with femur fracture. Complex admission that led to G-tube placement.

Been living at a rehab facility since last admission. Remains non-ambulatory and tube-fed.

Now admitted after presenting with fever, cough, dyspnea. BP 90/60; HR 110; RR 28

What empiric antibiotic?

- a) Moxifloxacin
- b) Ceftriaxone + azithromycin
- c) Piperacillin/tazobactam + vancomycin
- d) vancomycin
- e) B or D

Courtesy of Thomas Holland, MD
Road Map

• Highlight the clinical features and presentation of community-acquired pneumonia (CAP)

• Assess the strengths and weaknesses of commonly used diagnostic testing modalities

• Describe common approaches to risk stratification for patients with CAP

• Evaluate treatment strategies for CAP

• Describe the shifting landscape in the management of healthcare-associated pneumonia (HCAP)
Take Home Points

• Diagnosis of CAP requires compatible clinical signs/symptoms and a new CXR infiltrate
  – Diagnosis can be challenging

• Use CURB-65 or PSI scoring for risk stratification and triage/site of care decision-making

• Outpatient CAP can be treated with narrow-spectrum monotherapy (macrolide or doxycycline)

• Inpatient, non-ICU CAP can be treated with respiratory FQ or beta-lactam+macrolide

• HCAP management is changing
  – Assess all patients with HCAP for risk factors for MDR pathogens
  – Typical CAP antibiotics appropriate for low risk HCAP
  – Reserve broad spectrum antibiotics for higher risk HCAP