The purpose of this document is to guide the appropriate treatment of adult patients presenting with pneumonia. Two pathways with different empiric treatment regimens based on risk of infection with multidrug-resistant (MDR) pathogens (including MRSA, *Pseudomonas* spp., *Acinetobacter* spp., organisms not susceptible to beta-lactams (ceftriaxone or ampicillin-sulbactam) and/or fluoroquinolones (ciprofloxacin, levofloxacin)) are shown below. Of note, since the 2005 American Thoracic Society/Infectious Diseases Society of America guidelines first introduced recommendations for healthcare associated pneumonia (HCAP), several studies have been published that question the predictive value of HCAP criteria for patients infected with drug-resistant pneumonia. Multiple studies have reported various risk factors and proposed scoring tools but methodology varies widely and thus an optimal model has not yet been identified. Treatment recommendations below are based on disease severity and presence of additional risk factors for MDR pathogens. This will replace the previously defined HCAP criteria.

### Pathway A
Patients presenting from the community without any risk factors for drug-resistant pathogens (includes patients admitted to the ICU for respiratory failure without septic shock)

For dosing, alternative treatment options, duration, and important comments, see page X.

**Empiric Treatment**
- Ampicillin-sulbactam
- Azithromycin

*see treatment guidelines for appropriate use of ceftriaxone as an alternative agent

### Pathway B
Patients presenting with any of the following risk factors for drug-resistant pathogens:

**Healthcare Exposure:**
- Hospital-acquired pneumonia (current hospitalization for ≥72 hours)
- Ventilator-associated pneumonia
- Prior hospitalization for at least 48 hours within previous 90 days
- Current resident from long-term care facility, nursing home, extended care facility, skilled nursing facility with at least partial functional dependence in ADLs (transfer, feeding, bathing, dressing, toileting, and continence)

**Disease Severity:**
- Septic shock requiring ICU admission

**Antibiotic Exposure:**
- Fluoroquinolone, linezolid or any intravenous antibiotic use within previous 90 days

**Immunosuppression:**
- AIDS, neutropenia (ANC <1000), or active malignancy undergoing intravenous chemotherapy
- Kidney or liver or heart transplant recipient within previous 1 year in those who received induction with thymoglobulin
- Kidney or liver or heart transplant recipient within previous 6 months in those who did not receive induction with thymoglobulin
- Solid organ transplant recipient treated for rejection within previous 6 months
- Lung transplant recipient
- Autologous stem cell transplant within previous 6 months
- Allogeneic stem cell transplant within previous 1 year or those with chronic GVHD

**Other Conditions:**
- Current tube feeding
- History of infection or colonization with *Pseudomonas* spp., MRSA, or other MDR pathogens within previous 12 months
- Cystic fibrosis, chronic obstructive pulmonary disease (FEV1<35% predicted, multiple antibiotic prescriptions in last year, multiple hospital admissions in last year), or chronic bronchiectasis

**Utilization of procalcitonin (PCT) levels**
- Consider diagnosis of a viral respiratory tract infection in patients with a positive respiratory viral panel screening AND low repeated PCT levels (<0.25 mcg/L). Antibiotics are discouraged in these patients and should be discontinued.*
- Consider an alternative diagnosis in patients with low repeated PCT level (<0.25 mcg/L) as this level is not suggestive of a bacterial lower respiratory tract infection. *
- Patients with acute renal failure, massive trauma, major surgery, post-partum, acute GVHD, and cytokine stimulants may have false elevations in PCT levels. *

*Repeat 6-12 hours after 1st level if no antibiotics started
*See UMHS Procalcitonin Usage Guidelines for more information

For dosing, alternative treatment options, duration, and important comments, see page X.

**Empiric Treatment**
- Piperacillin-tazobactam
- Tobramycin if admitted to ICU
- Vancomycin

+ Vancomycin

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^Repeat 6-12 hours after 1st level if no antibiotics started
^See UMHS Procalcitonin Usage Guidelines for more information
<table>
<thead>
<tr>
<th>Indication</th>
<th>Common Pathogens</th>
<th>Empiric Therapy</th>
<th>Duration of Therapy</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Inpatient community-acquired pneumonia</strong>&lt;br&gt;(Non-ICU patient)</td>
<td>Streptococcus pneumonia</td>
<td><strong>1st line:</strong>&lt;br&gt;- <em>Ampicillin-sulbactam</em> 3 g IV q6h (except if alcoholism with aspiration)&lt;br&gt;+ <em>Azithromycin</em> 500 mg IV/PO x1 day, then 250 mg q24h x4 days&lt;br&gt;- <em>PCN allergy without anaphylaxis, angioedema, or urticaria, or alcoholism with aspiration:</em>&lt;br&gt;- <em>Ceftriaxone</em> 1 g IV q24h&lt;br&gt;+ <em>Azithromycin</em> 500 mg IV/PO x1 day, then 250 mg q24h x4 days&lt;br&gt;- <em>Consider the addition of anaerobic coverage with metronidazole</em> 500 mg PO q8h if aspiration with risk of enteric GNRT, empyema, lung abscess, or cavitary lesion</td>
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<td></td>
<td>Haemophilus influenzae</td>
<td><strong>Severe PCN and cephalosporin allergy</strong>&lt;br&gt;(anaphylaxis, angioedema, hives):&lt;br&gt;- <em>Levofloxacin</em> 750 mg IV/PO q24h&lt;br&gt;- <em>Consider the addition of anaerobic coverage with metronidazole</em> 500 mg PO q8h if alcoholism with aspiration or aspiration with risk of empyema, lung abscess, or cavitary lesion</td>
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<td>Moraxella catarrhalis</td>
<td><strong>Aspiration pneumonia:</strong>&lt;br&gt;- <em>Ampicillin-sulbactam</em> 3 g IV q6h&lt;br&gt;- <em>Addition of vancomycin:</em>&lt;br&gt;Consider if high clinical suspicion for CA-MRSA (history of MRSA pneumonia or post-influenza pneumonia)</td>
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<td>Mycoplasma pneumoniae</td>
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<td>Legionella species</td>
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<td>Uncomplicated Pneumonia:</td>
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<td><strong>5 days</strong> for patients who defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation†&lt;br&gt;- Patients with delayed response should discontinue therapy 48-72 hours after defervesce and have no more than 1 sign of CAP instability† at time antibiotic discontinuation.&lt;br&gt;- Pneumonia with non-fermenting GNRs (e.g., Pseudomonas, Achromobacter, Acinetobacter, Stenotrophomonas) should receive 7 days of therapy</td>
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<td>Complicated Pneumonia:</td>
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<td><strong>Treat Staphylococcus aureus</strong> for a minimum duration of 7 days&lt;br&gt;- Patients with empyema, infected pleural effusions, and bacteremia secondary to pneumonia may require longer durations of therapy. Bacteremic pneumococcal pneumonia should be treated for a minimum of 10-14 days. ID consult is recommended for patients with bacteremia.</td>
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<td>†CAP clinical signs of instability (if different than patient baseline status):&lt;br&gt;1. HR ≥ 100 bpm&lt;br&gt;2. RR ≥ 24 breaths/min&lt;br&gt;3. SBP ≤ 90 mmHg&lt;br&gt;4. Arterial O₂ sat ≤ 90% or PaO₂ ≤ 60 mmHg on room air&lt;br&gt;5. Altered mental status</td>
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<td>• Appropriately tailor therapy based on respiratory culture results&lt;br&gt;• For culture negative pneumonia, transition to oral therapy when patient is afebrile with clinical improvement and hemodynamically stable for 48 hours:&lt;br&gt;1) <strong>1st line:</strong>&lt;br&gt;- <em>Ampicillin-clavulinate</em> 875 mg PO BID&lt;br&gt;+ <em>Azithromycin</em> (complete 5-day course of azithromycin)&lt;br&gt;- <em>PCN allergic, without anaphylaxis, angioedema, or urticaria:</em>&lt;br&gt;- <em>Cefuroxime</em> 500 mg PO BID&lt;br&gt;+ <em>Azithromycin</em> (complete 5-day course of azithromycin)&lt;br&gt;- <em>Severe PCN allergic patients who do not tolerate cephalosporins:</em>&lt;br&gt;- <em>Levofloxacin</em> 750 mg PO daily&lt;br&gt;• Adjust levofloxacin and ampicillin-sulbactam for renal dysfunction. Always give levofloxacin loading dose of 750 mg x1 dose&lt;br&gt;• Use <em>azithromycin</em> 500 mg q24h if high clinical suspicion for <em>Legionella</em>&lt;br&gt;• In setting of macrolide allergy can use <em>doxycycline</em> for atypical coverage in absence of <em>Legionella</em> concern&lt;br&gt;• See front page for tips on utilization of procalcitonin (PCT) levels</td>
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<td>patient)</td>
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<td><em>Vancomycin</em> (see UMHS standard dosing nomogram)</td>
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<td>• + <em>Aztreonam</em> 2 g IV q8h</td>
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**Uncomplicated Pneumonia:**
- **5-7 days** for patients who defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation
- Pneumonia with non-fermenting GNRs (e.g. Pseudomonas, Achromobacter, Acinetobacter, Stenotrophomonas) should receive 7 days of therapy

**Complicated Pneumonia:**
- Treat *Staphylococcus aureus* for a minimum duration of 7 days
- Patients with empyema, infected pleural effusions, and bacteremia secondary to pneumonia may require longer durations of therapy. Bacteremic pneumococcal pneumonia should be treated for a minimum of 10-14 days. ID consult is recommended for patients with bacteremia.

**CAP clinical signs of instability** (if different than patient baseline status):
- HR ≥100 bpm
- RR ≥24 breaths/min
- SBP ≤90 mmHg
- Arterial O₂ sat ≤90% or pO₂ ≤ 60 mmHg on room air
- Altered mental status

**Comments**
- Appropriate tailor therapy based on respiratory culture results
- IV therapy for first 24 hours for ICU patients
- For culture negative pneumonia, transition to oral therapy when patient is afebrile with clinical improvement and hemodynamically stable for 48 hours:
  - 1<sup>st</sup> line: Amoxicillin-clavulanate 875 mg PO BID + Azithromycin (complete 5- day course of azithromycin)
  - PCN allergic: Cefuroxime 500 mg PO BID + Azithromycin (complete 5- day course of azithromycin)
  - Severe PCN allergic patients who do not tolerate cephalosporins: Levofloxacin 750 mg PO daily
  - Adjust levofloxacin, ampicillin/sulbactam, aztreonam, and piperacillin-tazobactam for renal dysfunction. Always give levofloxacin loading dose of 750 mg x 1 dose
- Use azithromycin 500 mg q24h if high clinical suspicion for *Legionella*
- See front page for tips on utilization of procalcitonin (PCT) levels
**Pathway B**

*Previous culture data should be used to guide empiric therapy.*

<table>
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</table>
| Patients with pneumonia presenting with risk factors for drug-resistant pathogens:  
**Healthcare Exposure:**  
- Hospital-acquired pneumonia (current hospitalization for ≥72 hours)  
- Ventilator-associated pneumonia  
- Prior hospitalization for at least 48 hours within previous 90 days  
- Current resident from long-term care facility, nursing home, extended care facility, skilled nursing facility with at least partial functional dependence in ADLs (transfer, feeding, bathing, dressing, toileting, and continence)  
**Disease Severity:**  
- Septic shock requiring ICU admission  
- Fluoroquinolone, linezolid or any intravenous antibiotic use within previous 90 days  
**Immunosuppression:**  
- AIDS, neutropenia (ANC <1000), or active malignancy undergoing intravenous chemotherapy  
- Kidney or liver transplant recipient within 1 year  
- Lung transplant recipient  
- Autologous stem cell transplant within 6 months  
- Allogeneic stem cell transplant within 1 year of transplant date or those with chronic GVHD  
**Other Conditions:**  
- Tube feeding  
- History of infection or colonization with *Pseudomonas spp.*, MRSA, or MRDA pathogens within 12 months  
- Cystic fibrosis, chronic obstructive pulmonary disease (FEV1 <35% predicted, multiple antibiotic prescriptions in last year, multiple hospital admissions in last year), or chronic bronchiectasis  
| Preferred:  
Piperacillin-tazobactam* 4.5 g IV q6h  
+ Vancomycin* IV if admitted to ICU  
| 7 days for uncomplicated pneumonia with rapid clinical response within 72 hours (including patients with *Pseudomonas*, *Stenotrophomonas*, *Acinetobacter*, or *Burkholderia*)  
|  
| PCN Allergy without Anaphylaxis, Angioedema, or Urticaria  
Cefepime* 2 g IV q8h  
+ Tobramycin* IV if admitted to ICU  
|  
| Severe PCN and cephalexolin allergy (anaphylaxis):  
Aztreonam* 2 g IV q8h  
+ Vancomycin* IV if admitted to ICU  
|  
| Linezolid may be used in patients with vancomycin allergy (not red man syndrome). See restriction criteria for appropriate empiric and definitive use of linezolid.  
If atypical pathogens are suspected, start azithromycin 500 mg IV x1 day followed by 250 mg IV/PO daily x4 days. Use azithromycin 500 mg q24h if high clinical suspicion for *Legionella*. Treatment duration may be longer for confirmed Legionella. In setting of macrolide allergy can use doxycycline for atypical coverage in non-ICU patients and in the absence of *Legionella* concern  
- Discontinue vancomycin after 48-72 hours if no positive respiratory cultures for MRSA and consider earlier discontinuation if no evidence of colonization (MRSA nasal swab) if clinically stable UNLESS using for gram-positive coverage in patients receiving aztreonam.  
- Antibiotic therapy is not generally recommended for patients with ventilator-associated tracheobronchitis (defined as fever with no other recognizable cause, with new or increased sputum production, positive endotracheal aspirate culture, and no radiographic evidence of pneumonia).  
- Definitive therapy should be tailored to culture results and may lead to dose adjustments. Oral antibiotics should be considered in clinically stable patients. In clinically stable patients in whom appropriate respiratory cultures were obtained are negative, deescalate antibiotic therapy to CAP treatment.  
  - 1st line:  
  - Amoxicillin-clavulanate 875 mg PO BID  
  - PCN allergic, without anaphylaxis, angioedema, or urticaria:  
  - Cefuroxime 500 mg PO BID  
  - Severe PCN allergic patients who do not tolerate cephalexolin:  
  - Levofloxacin 750 mg PO daily  
  - In patients with VAP or in those with inadequate cultures, physician discretion is advised.  
  - See front page for tips on utilization of procalcitonin (PCT) levels  
|  
* Dose may need to be adjusted for renal dysfunction  
** For ADULTS: Dose per vancomycin nomogram with trough goal 10-15

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**Antimicrobial Subcommittee Approval:** 04/2019  
**Originated:** Unknown  
**P&T Approval:** 07/2019  
**Last Revised:** 04/2019

The recommendations in this guide are meant to serve as treatment guidelines for use at Michigan Medicine facilities. If you are an individual experiencing a medical emergency, call 911 immediately. These guidelines should not replace a provider’s professional medical advice based on clinical judgment, or be used in lieu of an Infectious Diseases consultation when necessary. As a result of ongoing research, practice guidelines may from time to time change. The authors of these guidelines have made all attempts to ensure the accuracy based on current information, however, due to ongoing research, users of these guidelines are strongly encouraged to confirm the information contained within them through an independent source.

If obtained from a source other than med.umich.edu/asp, please visit the webpage for the most up-to-date document.