The purpose of this document is to guide the appropriate treatment of adult patients presenting with pneumonia. Three 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.

Pathway A (non-ICU)  Pathway A (ICU)  Pathway B  Pathway C  Footnotes

**Pathway A: Community-Onset**
(No Risk Factors listed in Pathway B)

Patients presenting from the community without an risk factors for drug-resistant pathogens (includes patients admitted to the ICU for respiratory failure who do not meet Pathway B criteria)

**Pathway B: Community-Onset, Risk Factors**

Patients presenting with any of the following risk factors for drug-resistant pathogens OR unknown etiology of septic shock:
- History of infection or colonization with Pseudomonas spp., MRSA, or pathogens resistant to standard CAP therapy (ampicillin-sulbactam or ceftriaxone) within previous 12 months OR
- Severe community-acquired pneumonia (septic shock OR requiring mechanical ventilation OR high clinical concern for needing ICU care) AND Hospitalization for at least 48 hours AND use of any intravenous antibiotic, fluoroquinolone, or linezolid within previous 90 days OR
- Immunocompromised, defined as:
  - AIDS (CD4 <200)
  - Neutropenia (ANC <1000)
  - Kidney or liver or heart transplant recipient within previous 1 year
  - Solid organ transplant recipient treated for rejection within previous 6 months
  - Lung transplant recipient
  - Autologous stem cell transplant within previous 1 year or those with chronic GVHD
  - Autoimmune disorders on biologic agents (TNFa inhibitors, rituximab, etc.)

**Pathway C: Hospital-Onset**

- Hospital-acquired pneumonia (current hospitalization for ≥72 hours)
- Ventilator-associated pneumonia

For dosing, alternative treatment options, duration, and important comments Click here for Pathway A Recommendations

Empirc Treatment
Ampicillin-sulbactam + Azithromycin
*see treatment guidelines for appropriate use of ceftriaxone as an alternative agent

Empirc Treatment
Cefepime (+tobramycin if admitted to ICU) + Vancomycin

Empirc Treatment
Cefepime (+tobramycin if admitted to ICU) + Vancomycin

Utilization of procalcitonin (PCT) levels

- Consider diagnosis of a viral respiratory tract infection in patients with a low PCT level (<0.25 mcg/l). Antibiotics are discouraged in these patients and should be discontinued.
- Patients with AKI/CKD, 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 and clinical suspicion for bacterial pneumonia persists
See UMHS Procalcitonin Usage Guidelines for more information
<table>
<thead>
<tr>
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<th>Empiric Therapy</th>
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<th>Comments</th>
</tr>
</thead>
</table>
| Inpatient community-acquired pneumonia, no risk factors (Non-ICU patient) | Streptococcus pneumonia, Haemophilus influenzae, Moraxella catarrhalis, Mycoplasma pneumoniae, Chlamydia pneumoniae, Legionella species | Uncomplicated/Aspiration Pneumonia:  
- 5 days for patients who defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation  
- 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.  
Complicated Pneumonia:  
- 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 7-14 days. ID consult is recommended for patients with bacteremia.  
Pathogen-Specific Considerations:  
- Uncomplicated pneumonia with non-fermenting GNRs (e.g., Pseudomonas, Acinetobacter, Acinetobacter, Stenotrophomonas) or Staphylococcus aureus should receive 7 days of therapy if defervesces within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation.  
- Delayed response will likely require longer durations.  
**+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  
- Appropriately tailor therapy based on respiratory culture results.  
- Anaerobic coverage is not necessary for patients with pneumonia following an aspiration event. Only those with empyema or lung abscess should receive empiric anaerobic coverage.  
- For culture negative pneumonia, transition to oral therapy when patient is afibrile with clinical improvement and hemodynamically stable for 48 hours:  
  - 1st line:  
    - **Amoxicillin-clavulanate** 875 mg BID  
    + **Azithromycin** (complete 5-day course of azithromycin)  
  - Low/medium risk PCN allergy:  
    - **Cefuroxime** 500 mg BID plus azithromycin (complete 5-day course of azithromycin)  
  - High risk PCN or cephalosporin allergy:  
    - **Levofloxacin** 750 mg PO q24h  
  - Adjust levofloxacin and ampicillin-sulbactam for renal dysfunction. Always give levofloxacin loading dose of 750 mg x1 dose  
  - Use **azithromycin** 500 mg q24 h if documented or high clinical suspicion for Legionella (can pursue further diagnostic testing → respiratory legionella PCR)  
  - In setting of macrolide allergy can use doxycycline for atypical coverage in absence of Legionella concern.  
  - In patients with documented Mycoplasma, use of doxycycline should be preferred for treatment due to concern for macrolide resistance.  
  - Antibiotic coverage of atypical organisms can be discontinued if the respiratory panel (RPAN) and urine antigens are negative.  
  - See front page for tips on utilization of procalcitonin (PCT) levels. | | |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Inpatient community-acquired</td>
<td>Streptococcus pneumonia</td>
<td>Preferred: <em>Amoxicillin-sulbactam</em> 3 g IV q6h + <em>Azithromycin</em> 500 mg IV q24h x5 days</td>
<td>Uncomplicated/Aspiration Pneumonia:</td>
<td>• Appropriately tailor therapy based on respiratory culture results.</td>
</tr>
<tr>
<td>pneumonia, no risk factors</td>
<td><em>Haemophilus influenzae</em></td>
<td>Low/medium risk PCN allergy: <em>Ceftriaxone</em> 2 g IV q24h + <em>Azithromycin</em> 500 mg IV q24h x5 days</td>
<td>• 5 days for patients who defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation †</td>
<td>• Anaerobic coverage is not necessary for patients with pneumonia following an aspiration event. Only those with empyema or lung abscess should receive empiric anaerobic coverage.</td>
</tr>
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<td>(ICU patient)</td>
<td><em>Moraxella catarrhalis</em></td>
<td>Consider the addition of anaerobic coverage with <em>metronidazole</em> 500 mg IV q8h if empyema or lung abscess present</td>
<td>• 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.</td>
<td>• IV therapy for first 24 hours for ICU patients</td>
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<td><em>Mycoplasma pneumoniae</em></td>
<td><em>High risk PCN and cephalosporin allergy:</em> <em>Vancomycin</em>** IV (see nomogram) + <em>Aztreonam</em> 2 g IV q8h + <em>Azithromycin</em> 500 mg IV q24h x5 days</td>
<td>Complicated Pneumonia:</td>
<td>• 1st line: <em>Amoxicillin-clavulanate</em> 875 mg BID + <em>Azithromycin</em> (complete 5-day course of azithromycin)</td>
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<td><em>Chlamydia pneumoniae</em></td>
<td>Consider the addition of anaerobic coverage with <em>metronidazole</em> 500 mg IV q8h if empyema or lung abscess present</td>
<td>• 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 7-14 days. ID consult is recommended for patients with bacteremia.</td>
<td>• Low/medium risk PCN allergy: <em>Cefuroxime</em> 500 mg BID plus azithromycin (complete 5-day course of azithromycin)</td>
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<td><em>Legionella species</em></td>
<td><em>Addition of vancomycin</em> Consider if high clinical suspicion for CA-MRSA (prior isolation of MRSA from respiratory culture in past 12 months or post-influenza pneumonia)</td>
<td>Pathogen-Specific Considerations:</td>
<td>• High risk PCN or cephalosporin allergy: <em>Levofloxacin</em> 750 mg PO q24h</td>
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<td>• Uncomplicated pneumonia with non-fermenting GNRs (e.g., Pseudomonas, Acromobacter, Acinetobacter, Stenotrophomonas) or <em>Staphylococcus aureus</em> should receive 7 days of therapy if defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation †</td>
<td>• Adjust levofloxacin, ampicillin-sulbactam, aztreonam, and piperacillin-tazobactam for renal dysfunction. Always give levofloxacin loading dose of 750 mg x1 dose</td>
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<td>• Delayed response will likely require longer durations.</td>
<td>• Use <em>azithromycin</em> 500 mg q24 h if documented or high clinical suspicion for <em>Legionella</em> (can pursue further diagnostic testing → respiratory legionella PCR)</td>
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<td>• In setting of macrolide allergy can use doxycycline for atypical coverage in absence of <em>Legionella</em> concern.</td>
<td>• In patients with documented Mycoplasma, use of doxycycline should be preferred for treatment due to concern for macrolide resistance.</td>
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<td>• Antibiotic coverage of atypical organisms can be discontinued if the respiratory panel (RPAN) and urine antigens are negative.</td>
<td>• See front page for tips on utilization of procalcitonin (PCT) levels</td>
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### Pathway B
(Previous culture data should be used to guide empiric therapy)

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<tr>
<td>Patients presenting with any of the following risk factors for drug-resistant pathogens OR unknown etiology of septic shock: &lt;br&gt;• History of infection or colonization with Pseudomonas spp., MRSA, or other MDR gram-negative pathogens (resistant to ampicillin-sulbactam or ceftriaxone) within previous 12 months &lt;br&gt;OR &lt;br&gt;• In patients with severe community-acquired pneumonia (septic shock OR requiring mechanical ventilation OR high clinical concern for needing ICU level care), <strong>AND</strong> Hospitalization for at least 48 hours <strong>AND</strong> use of any intravenous antibiotic, fluoroquinolone, or linezolid within previous 90 days &lt;br&gt;OR &lt;br&gt;• Immunocompromised, defined as: &lt;br&gt;  ○ AIDS (CD4 &lt;200)  &lt;br&gt;  ○ Neutropenia (ANC &lt;1000)  &lt;br&gt;  ○ Kidney or liver or heart transplant recipient within previous 1 year  &lt;br&gt;  ○ Solid organ transplant recipient treated for rejection within previous 6 months  &lt;br&gt;  ○ Lung transplant recipient  &lt;br&gt;  ○ Allogeneic stem cell transplant within previous 1 year or those with chronic GVHD  &lt;br&gt;  ○ Autoimmune disorders on biologic agents (TNFα inhibitors, rituximab, etc.)</td>
<td><strong>Preferred:</strong> &lt;br&gt;Cefepime* 2 g IV q8h &lt;br&gt;(+ Tobramycin* IV if admitted to ICU) &lt;br&gt;+ Vancomycin** IV (see nomogram) &lt;br&gt;NOTE: If patient has a history of Pseudomonas or MDR gram-negative pathogen ONLY, empiric vancomycin use is not necessary. If MRSA history ONLY, use of cefepime is not necessary (preferred regimen would be ampicillin-sulbactam + vancomycin).</td>
<td><strong>Uncomplicated/Aspiration Pneumonia:</strong> &lt;br&gt;• 5 days 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.</td>
<td>If atypical pathogens are suspected, start <strong>azithromycin</strong> 500 mg IV x1 day, followed by 250 mg IV/PO daily x4 days. Use <strong>azithromycin</strong> 500 mg q24h if high clinical suspicion for <em>Legionella</em>. Treatment duration may be longer for confirmed <em>Legionella</em>. In setting of macrolide allergy can use <strong>doxycycline</strong> for atypical coverage in non-ICU patients and in the absence of <em>Legionella</em> concern. In patients with documented or high clinical suspicion for <em>Mycoplasma</em>, use of <strong>levofloxacin</strong>* should be preferred for treatment due to concern for macrolide resistance. &lt;br&gt;<strong>Definitive therapy should be tailored to culture results.</strong> In patients with negative respiratory cultures who are clinically stable after 48 hours, deescalate antibiotic therapy to CAP treatment. Oral antibiotics should be considered in clinically stable patients.</td>
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<td>Low/medium risk cephalosporin allergy: &lt;br&gt;Meropenem* 2 g IV q8h &lt;br&gt;(+ Tobramycin* IV if admitted to ICU) &lt;br&gt;+ Vancomycin** IV (see nomogram)</td>
<td>Consider the addition of anaerobic coverage with metronidazole 500 mg IV q8h if empyema or lung abscess present</td>
<td><strong>Complicated Pneumonia:</strong> &lt;br&gt;• Patients with empyema, infected pleural effusions, and bacteremia secondary to pneumonia should receive longer durations of therapy. Bacteremic pneumococcal pneumonia should be treated for a minimum of 7-14 days. ID consult is recommended for patients with bacteremia.</td>
<td>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).  <strong>Definitive therapy should be tailored to culture results.</strong> In patients with negative respiratory cultures who are clinically stable after 48 hours, deescalate antibiotic therapy to CAP treatment. Oral antibiotics should be considered in clinically stable patients.</td>
</tr>
<tr>
<td><strong>Pathogen-Specific Considerations:</strong> &lt;br&gt;• Uncomplicated pneumonia with non-fermenting GNRs (e.g., Pseudomonas, Acinetobacter, Stenotrophomonas) or <em>Staphylococcus aureus</em> should receive 7 days of therapy if defervescence within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation†. Delayed response will likely require longer durations.</td>
<td><strong>Comments</strong></td>
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<td>High risk PCN and cephalosporin allergy: &lt;br&gt;Aztreonam* 2 g IV q8h &lt;br&gt;(+ Tobramycin* IV if admitted to ICU) &lt;br&gt;+ Vancomycin** IV (see nomogram)</td>
<td>Consider the addition of anaerobic coverage with metronidazole 500 mg IV q8h if empyema or lung abscess present</td>
<td><strong>Comments</strong></td>
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<td><strong>Linezolid may be used in patients with vancomycin allergy (not vancomycin infusion reaction).</strong> See restriction criteria for appropriate empiric and definitive use of linezolid.</td>
<td><strong>Comments</strong></td>
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*CAP: Community Acquired Pneumonia  
†: Discontinue vancomycin if no evidence of MRSA colonization (negative MRSA nasal swab) if clinically appropriate. In patients with evidence of colonization (positive MRSA nasal swab) or if unknown, discontinue vancomycin after 48-72 hours if no positive respiratory cultures for MRSA and clinically appropriate. Vancomycin can be continued for gram-positive coverage in patients with no microbiological diagnosis who are receiving aztreonam due to allergies.  
Preferred:  
Amoxicillin-clavulanate**: 875 mg BID  
Low/medium risk PCN allergy:  
Cefuroxime**: 500 mg BID  
High risk PCN allergy:  
Levofloxacin**: 750 mg PO q24h  
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.
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<td>Hospital-acquired pneumonia (current hospitalization for ≥72 hours)</td>
<td>Preferred: Cefepime* 2 g IV q8h (+ Tobramycin* IV if admitted to ICU) + Vancomycin** IV (see nomogram)</td>
<td>7 days for uncomplicated pneumonia with rapid clinical response within 72 hours (including patients with Stenotrophomonas, Acinetobacter, or Burkholderia). Patients with empyema, infected pleural effusions, lung abscesses, and bacteremia secondary to pneumonia should receive longer durations of therapy. 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.</td>
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<td>Ventilator-associated pneumonia</td>
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<tr>
<td>Low/medium risk cephalosporin allergy:</td>
<td>Meropenem* 2 g IV q8h (+ Tobramycin* IV if admitted to ICU) + Vancomycin** IV (see nomogram)</td>
<td></td>
<td>In patients with documented or high clinical suspicion for Mycoplasma, use of levofloxacin* should be preferred for treatment due to concern for macrolide resistance. Discontinue vancomycin if no evidence of MRSA colonization (negative MRSA nasal swab) if clinically appropriate. In patients with evidence of colonization (positive MRSA nasal swab) or if unknown, discontinue vancomycin after 48-72 hours if no positive respiratory cultures for MRSA and clinically appropriate. Vancomycin can be continued for gram-positive coverage in patients with no microbiological diagnosis who are receiving aztreonam due to allergies. 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. 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.</td>
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<td>High risk PCN and cephalosporin allergy:</td>
<td>Aztreonam* 2 g IV q8h (+ Tobramycin* IV if admitted to ICU) + Vancomycin** IV (see nomogram)</td>
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<td>Linezolid may be used in patients with vancomycin allergy (not vancomycin infusion reaction). See restriction criteria for appropriate empiric and definitive use of linezolid.</td>
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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.

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Footnotes:

* Dose may need to be adjusted for renal dysfunction

** For ADULTS: Dose per vancomycin nomogram with AUC goal 400-600 mcg*hr/mL

α High clinical concern for needing ICU level care can be defined as having at least 3 of the following: RR ≥30 breaths/min, SpO₂ <90% OR O₂ supplementation ≥7 L, multilobar infiltrates, confusion, hypothermia (<36°C), severe sepsis

NOTE: See Beta-lactam Allergy Evaluation and Empiric Therapy Guidance document for further allergy information. High-risk allergies are defined as: respiratory symptoms (chest tightness, bronchospasm, wheezing, cough), angioedema (swelling, throat tightness), cardiovascular symptoms (hypotension, dizzy/lightheadedness, syncope/passing out, arrhythmia), anaphylaxis. If a patient has a high-risk allergy to penicillins, cephalosporins, or carbapenems, the only beta-lactam antibiotic that can be safely used without Allergy consult is aztreonam (if the allergy is to ceftazidime or aztreonam, aztreonam should be avoided as well).