Community-Acquired Pneumonia (CAP) - ED Phase

**Inclusion Criteria**
- Suspected CAP in patients over 3 months old

**Exclusion Criteria**
- Immunodeficiencies, including congenital (e.g. SCID, HIV) and medical immunosuppression (e.g. transplant recipients)
- Risk for aspiration pneumonia
- Known lung disease other than asthma (CF, BPD, etc.)
- Prior/current trach or vent dependency
- Neuromuscular disease
- Sickle Cell Disease
- Recurrent pneumonia (2 or more occurrences in one year OR 3 occurrences in lifetime)
- Cancer

**Provider Assessment**

**Mildly ill**
- Well-appearing to Mildly ill.
- No initial testing required, including chest x-ray
- Consider chest x-ray if diagnosis uncertain

**Moderately ill**
- Moderately ill: Initial testing
  - PIV
  - 2-view chest x-ray
  - Blood cx
  - CBC with diff

**Severely ill**
- Initial testing
  - PIV
  - 2-view chest x-ray
  - Blood cx
  - CBC with diff
  - Consider Procalcitonin
  - CRP
  - Consider sputum cx if >12 yrs.
  - Consider respiratory pathogen PCR

**Empyema Identified**
- See chest tube pathway

**Treatment - Mild**
- If suspected bacterial CAP, antibiotics:
  - Amoxicillin PO if > 2 Hb vaccines administered or
  - Amoxicillin and clavulanate potassium PO if ≤ 2 Hb vaccines administered or
  - Cefpodoxime, Cefuroxime, OR Cefprozil® PO if ≤ 2 Hb vaccines administered or
  - Amoxicillin and clavulanate potassium PO if ≤ 2 Hb vaccines administered or
  - Cefuroxime
  - Clindamycin PO for recent or current influenza, MRSA, or empyema
  - If concern for atypical pneumonia, add azithromycin
  - If concern for atypical pneumonia, add azithromycin
  - O2 to keep SpO² >92%
  - IV fluids as needed

**Treatment - Moderate**
- If suspected bacterial CAP, antibiotics:
  - Amoxicillin IV if > 2 Hb vaccines administered
  - Unasyn IV or Ceftriaxone IV if ≤ 2 Hb vaccines administered or failed outpatient management
  - Clindamycin IV for recent or current influenza, MRSA, or empyema
  - If concern for atypical pneumonia, add azithromycin
  - If concern for atypical pneumonia, add azithromycin
  - O2 to keep SpO² >92%
  - IV fluids as needed

**Treatment - Severe**
- If suspected bacterial CAP, antibiotics:
  - Amoxicillin IV if > 2 Hb vaccines administered uncomplicated pneumonia
  - Unasyn IV or Ceftriaxone IV if ≤ 2 Hb vaccines administered or failed outpatient treatment
  - Azithromycin IV for atypical pneumonia
  - Vancomycin IV and clindamycin IV for influenza-related pneumonia
  - O2 to keep SpO² >92%
  - IV fluids as needed

**Discharge Criteria**
- (Meas all)
  - Tolerating PO
  - Not hypoxic (≥ 90% SpO²)
  - Mildly increased or normal work of breathing

**Discharge Instructions**
- Treat with prescribed antibiotic for 7 days
- F/U with PCP in 2-3 days

**Inpatient Admit Criteria**
- Hypoxemia (<90% SpO²)
- Inability to tolerate PO
- Increased work of breathing (grunting, retracting, tachypnea)
- Dehydration, nausea, vomiting,
- Outpatient treatment failure
- Consider IMU admit for failure to maintain SpO² ≥ 92% on 50-80% FiO₂ on optimal liter flow for cannula size

**PICU Admit Criteria**
- Altered mental status
- Concern for severe sepsis/septic shock
- Failure to maintain SpO² ≥ 92% on ≥ 80% FiO₂ for >2 hours on optimal liter flow for cannula size
- Need for new or increased positive pressure ventilation

**Approved by P&T Committee 6/15/21**

*DO NOT* use Cefprozil for patients with penicillin allergy
Clinical Definitions

**Community-Acquired Pneumonia** - Pneumonia that a person acquires outside of a hospital or other health care institution, as distinguished from nosocomial, or hospital-acquired pneumonia.

**Recurrent Pneumonia** - Two or more episodes of pneumonia occurring in 1 year or three episodes of pneumonia occurring in any time frame.

**Persistent Pneumonia** - No response to treatment or worsening in spite of antibiotic treatment or pneumonia improves but O2 need persists (team decides to send home on O2).

**Atypical Pneumonia** – Typically characterized by slower onset, lower fever, and CXR with a patchy, interstitial, or non-lobar pattern that appears worse than auscultatory findings. Often accompanied by URI and extra-pulmonary symptoms (e.g., headache and rash). Associated with viral and atypical bacterial pathogens such as Mycoplasma and Legionella. Mycoplasma is more often seen in children ≥5 years.

**Treatment Failure** - Treatment failure is defined as >48 hours of preferred first line therapy in a patient that tolerated the regimen with increasing respiratory distress, increasing respiratory support requirement, or worsening fever curve.

**Mild Pneumonia** - Minimally increased work of breathing, no hypoxemia, able to tolerate PO (see table below).

**Moderate Pneumonia** - Hypoxemia, inability to tolerate PO, moderately increased work of breathing (grunting, retracting, tachypnea) (see table below).

**Severe Pneumonia** - Significantly increased work of breathing, altered mental status, concern for respiratory failure, sepsis, failure to maintain O2 sat (with FiO2 of 50%), need for positive pressure ventilation (see table below).

**Complicated Pneumonia** - Presence of 1 or more of the following:
- Loculated pleural fluid shown by chest x-ray, chest ultrasound, or by chest CT
- Pleural fluid consistent with empyema
- Chest tube placement
- Thoracotomy/decortication
Considerations

For severely ill patients consider the following:

- The possibility of *S. aureus* pneumonia
- Empyema
- Lung abscess
- Congenital heart disease
- Other congenital lung malformations
- Foreign body aspiration
- Pertussis (especially in < 6 months of age)
# Pneumonia Pathway Medication Dosing Guidelines

<table>
<thead>
<tr>
<th>Medication</th>
<th>Route</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>PO</td>
<td>90 mg/kg/day in 2 divided doses</td>
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<tr>
<td>Amoxicillin Clavulanate</td>
<td>PO</td>
<td>Amoxicillin component-90 mg/kg/day in 2 divided doses</td>
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<tr>
<td>Azithromycin</td>
<td>PO</td>
<td>10 mg/kg on day 1, followed by 5 mg/kg/day once daily on days 2-5</td>
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<tr>
<td>Clindamycin</td>
<td>PO</td>
<td>30-40 mg/kg/day in 3 divided doses</td>
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<tr>
<td>Cefpodoxime infants &gt;3 months to children &lt;12 years</td>
<td>PO</td>
<td>10 mg/kg/day divided every 12 hours (max 400mg/day)</td>
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<tr>
<td>Cefpodoxime children ≥12 years</td>
<td>PO</td>
<td>200 mg every 12 hours</td>
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<tr>
<td>Cefuroxime</td>
<td>PO</td>
<td>&lt;30 kg 250 mg BID</td>
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<td></td>
<td>≥30 kg 500 mg BID</td>
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<tr>
<td>Cefprozil</td>
<td>PO</td>
<td>15 mg/kg every 12 hours</td>
</tr>
<tr>
<td>(do not use in patients with penicillin allergy)</td>
<td></td>
<td>(max 500 mg/dose)</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>IV</td>
<td>30-40 mg/kg/day in 3 divided doses</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>IV</td>
<td>200 mg/kg/day divided every 6 hours</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>IV</td>
<td>75 mg/kg/day every 12-24 hours</td>
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<tr>
<td>Vancomycin</td>
<td>IV</td>
<td>60 mg/kg/day divided every 6-8 hours (therapeutic drug monitoring required)</td>
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</table>
Reasons to Consider Pulmonary Consult

1. **Specific conditions**
   a. Recurrent pneumonia
   b. Persistent pneumonia (does not respond to antibiotic treatment)
      i. No response to treatment or worsening in spite of antibiotic treatment
   c. Persistent abnormalities on CXR beyond 6-8wks, even if clinical symptoms resolve
   d. Pneumonia severe enough to require high FiO2, CO2 retention, PICU (intubation/ventilation)
   e. Pneumonia with unusual clinical features: e.g., pneumonia without elevated WBC, pneumonia on CXR without fever, cough, etc.
   f. Pneumonia with associated findings that may indicate underlying multisystem disorder: e.g., hepatic lesions, arthritis, chronic sinusitis, nasal polyps, steatorrhea, poor weight gain

2. **Pneumonia in special conditions**
   a. Pneumonia associated with hemoptysis due to tuberculosis, autoimmune disease, ILD, alveolar hemorrhage
   b. Persistent tachypnea in infancy to rule out interstitial lung disease
   c. Pulmonary nodules on imaging
   d. Pneumonia in patient with signs of underlying other lung disease: e.g., interstitial pattern, ground glass, mosaic patterns on chest imaging

3. **Pneumonia in compromised/vulnerable host**
   a. Neurological impairment (CP, etc)
   b. Muscular dystrophies, myopathies
   c. SMA
   d. Thoracic dystrophy
   e. Dysphagia/chronic aspiration

4. **Pneumonia in high-risk patients**
   a. Pulmonary disease associated with pulmonary hypertension
   b. BPD/CLD of prematurity and oxygen-dependent kids (NICU discharge)
   c. Primary ciliary dyskinesia
   d. Congenital lung malformation (new TEF, cystic adenomatoid malformations, sequestration, etc)
   e. Severe asthma admitted (for help with outpatient management and follow-up)

**Pulmonary should be consulted for: non-invasive CPAP or BiPAP (for help in discharge planning and outpatient follow up), patient being discharged on home oxygen**
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Parenteral therapy</th>
<th>Oral therapy (step-down therapy or mild infection)</th>
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<tbody>
<tr>
<td><em>Streptococcus pneumoniae</em> with MICS for penicillin ≤2.0 mg/L</td>
<td>Preferred: amoxicillin (150-200 mg/kg/day every 6 hours) or penicillin (200,000-250,000 UI/kg/day every 4-6 h);</td>
<td>Preferred: amoxicillin 650 mg/kg/day in 2 doses or 45 mg/kg/day in 3 doses;</td>
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<td>Alternatives: ceftriaxone (150 mg/kg/day every 8 hours); may also be effective: clindamycin (40 mg/kg/day every 6-8 h) or vancomycin (40-60 mg/kg/day every 6-8 h);</td>
<td>Alternatives: second- or third-generation cephalosporin (cefotaxime, ceftriaxone, cefuroxim, oral levofloxacin, if susceptible (16-20 mg/kg/day in 2 doses for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5 to 16 years old); maximum daily dose: 750 mg or oral linezolid (30 mg/kg/day in 3 doses for children &lt;12 years old and 20 mg/kg/day in 2 doses for children ≥12 years old);</td>
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<tr>
<td>S. pneumoniae resistant to penicillin, with MICS &gt;4.0 mg/L</td>
<td>Preferred: ceftriaxone 100 mg/kg/day every 12-24 h;</td>
<td>Preferred: oral levofloxacin (15-20 mg/kg/day in 2 doses for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5-16 years old; maximum daily dose: 750 mg); if susceptible, or oral linezolid (30 mg/kg/day in 3 doses for children &lt;12 years old);</td>
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<td>Alternatives: ampicillin (300-400 mg/kg/day every 6 hours), levofloxacin (19-20 mg/kg/day every 12 hours for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5-16 years old; maximum daily dose: 750 mg); or linezolid (30 mg/kg/day every 6 hours for children &lt;12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old); may also be effective: clindamycin* (40 mg/kg/day every 6-8 h) or vancomycin (40-60 mg/kg/day every 6-8 h);</td>
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<td></td>
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<td>Alternatives: oral clindamycin* (30-40 mg/kg/day in 3 doses);</td>
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<tr>
<td>Group A Streptococcus</td>
<td>Preferred: intravenous penicillin (100,000-250,000 UI/kg/day every 4-6 hours) or amoxicillin (200 mg/kg/day every 6 hours);</td>
<td>Preferred: amoxicillin 850-75 mg/kg/day in 2 doses, or penicillin V (65-75 mg/kg/day in 3 or 4 doses);</td>
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<td>Alternatives: ceftriaxone (60-100 mg/kg/day every 12-24 hour) or cefotaxime (150 mg/kg/day every 8 hours); may also be effective: clindamycin, if susceptible (40 mg/kg/day every 6-8 hours) or vancomycin (40-60 mg/kg/day every 6-8 hours);</td>
<td>Alternatives: oral clindamycin* (40 mg/kg/day in 3 doses);</td>
</tr>
<tr>
<td>Staphylococcus aureus, methicillin susceptible combination therapy not well studied</td>
<td>Preferred: cefazolin (150 mg/kg/day every 6 hours) or semisynthetic penicillin, eg oxacillin (150-200 mg/kg/day every 6-8 hours);</td>
<td>Preferred: oral cephalosporin (75-100 mg/kg/day in 3 or 4 doses);</td>
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<td>Alternatives: clindamycin* (40 mg/kg/day every 6-8 hours) or vancomycin (40-60 mg/kg/day every 6-8 hours);</td>
<td>Alternatives: oral clindamycin* (30-40 mg/kg/day in 3 or 4 doses);</td>
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<td>S. aureus, methicillin resistant, susceptible to clindamycin combination therapy not well studied</td>
<td>Preferred: vancomycin (100-60 mg/kg/day every 6-8 hours or dosing to achieve an AUC/MIC ratio of &gt;4000); or clindamycin (40 mg/kg/day every 6-8 hours);</td>
<td>Preferred: oral clindamycin (30-40 mg/kg/day in 3 or 4 doses);</td>
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<td>Alternatives: linezolid (30 mg/kg/dose every 8 hours for children &lt;12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old);</td>
<td>Alternatives: oral linezolid 30 mg/kg/day in 3 doses for children &lt;12 years old and 20 mg/kg/day in 2 doses for children ≥12 years old;</td>
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<td>S. aureus, methicillin resistant, resistant to clindamycin combination therapy not well studied</td>
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<td>Preferred: oral linezolid (30 mg/kg/day in 3 doses for children &lt;12 years old and 20 mg/kg/day in 2 doses for children ≥12 years old);</td>
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<td>Alternatives: linezolid (30 mg/kg/day every 8 hours for children &lt;12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old);</td>
<td>Alternatives: none; entire treatment course with parenteral therapy may be required;</td>
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<td><em>Haemophilus influenzae</em>, typeable (A-E or nontypable)</td>
<td>Preferred: intravenous ampicillin (150-200 mg/kg/day every 6 hours) if β-lactamase negative, cefotaxime (80-100 mg/kg/day every 12-24 hours) if β-lactamase producing, or cefotaxime (150 mg/kg/day every 8 hours);</td>
<td>Preferred: amoxicillin (75-100 mg/kg/day in 3 doses) if β-lactamase negative or amoxicillin clavulanate (amoxicillin component, 45 mg/kg/day in 3 doses or 90 mg/kg/day in 2 doses) if β-lactamase producing;</td>
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<td>Alternatives: intravenous ciprofloxacin (30 mg/kg/day every 12 hours) or intravenous levofloxacin (16-20 mg/kg/day every 12 hours for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5 to 16 years old, maximum daily dose, 750 mg);</td>
<td>Alternatives: cefdinir, cefixime, cefpodoxime, or cefditoren;</td>
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<tr>
<td>Mycoplasma pneumoniae</td>
<td>Preferred: intravenous azithromycin (10 mg/kg on days 1 and 2 of therapy; transition to oral therapy if possible);</td>
<td>Preferred: azithromycin (10 mg/kg on day 1, followed by 5 mg/kg/day once daily on days 2-5);</td>
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<tr>
<td></td>
<td>Alternatives: intravenous erythromycin lactobionate (20 mg/kg/day every 6 hours) or levofloxacin (16-20 mg/kg/day every 12 hours; maximum daily dose, 750 mg)</td>
<td>Alternatives: clarithromycin (15 mg/kg/day in 2 doses) or oral erythromycin (40 mg/kg/day in 4 doses); for children &gt;7 years old, doxycycline (2.4 mg/kg/day in 2 doses; for adolescents with skeletal maturity, levofloxacin (500 mg once daily) or moxifloxacin (400 mg once daily);</td>
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<tr>
<td>Chlamydia trachomatis or Chlamydia pneumoniae</td>
<td>Preferred: intravenous azithromycin (10 mg/kg on days 1 and 2 of therapy; transition to oral therapy if possible);</td>
<td>Preferred: azithromycin (10 mg/kg on day 1, followed by 5 mg/kg/day once daily on days 2-5);</td>
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<td>Alternatives: intravenous erythromycin lactobionate (20 mg/kg/day every 6 hours) or levofloxacin (16-20 mg/kg/day in 2 doses for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5 to 16 years old; maximum daily dose, 750 mg)</td>
<td>Alternatives: clarithromycin (15 mg/kg/day in 2 doses) or oral erythromycin (40 mg/kg/day in 4 doses); for children &gt;7 years old, doxycycline (2.4 mg/kg/day in 2 doses); for adolescents with skeletal maturity, levofloxacin (500 mg once daily) or moxifloxacin (400 mg once daily);</td>
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</table>

Doses for oral therapy should not exceed adult doses.

Abbreviations: AUC, area under the time vs. serum concentration curve; MIC, minimum inhibitory concentration.

* Clindamycin resistance appears to be increasing in certain geographic areas among *S. pneumoniae* and *S. aureus* infections.

* For β-lactam-allergic children.
TB Risk Factors

- A close contact with known or suspected contagious people with tuberculosis disease
- A child born in a high prevalence region of the world (basically, outside the US)
- A child who travels in a high prevalence region of the world
- A child who is around travelers from foreign countries
- A child frequently exposed to adults who are HIV infected, homeless, illicit drug users, nursing home residents, incarcerated or institutionalized.
Contributing Members

Dr. Rebecca Cantu - Hospital Medicine
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Dr. Amber Morse - Emergency Medicine
Dr. Holly Maples - Antibiotic Stewardship Director
Dr. Matthew Malone - Intensive Care Medicine
Dr. Amit Agarwal - Pulmonology
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Metrics

TBD...
References


