Community Acquired Pneumonia - Pediatric
Clinical Practice Guideline
MedStar Health
Antibiotic Stewardship

“These guidelines are provided to assist physicians and other clinicians in making decisions regarding the care of their patients. They are not a substitute for individual judgment brought to each clinical situation by the patient’s primary care provider in collaboration with the patient. As with all clinical reference resources, they reflect the best understanding of the science of medicine at the time of publication, but should be used with the clear understanding that continued research may result in new knowledge and recommendations.”

Pediatric Scope: Pneumonia and influenza were the 6th leading cause of death in children 1-4 years of age, 7th leading cause of death in children 5-9 years of age and 8th leading cause of death in children 10-14 years of age in the United States in 2013. (Center for Disease Control, 2013) Worldwide, pneumonia is the leading infectious cause of death in children, accounting for 15% of all deaths in children less than 5 years of age. (World Health Organization, 2014) Several key factors that are known to increase the severity of illness include malnutrition, prematurity, low socioeconomic status, exposure to tobacco smoke and daycare attendance. (Stuckey-Schrock, Hayes, & George, Community-Acquired Pneumonia in Children, 2012)

These guidelines are intended to assist clinicians in treating community acquired pneumonia in otherwise healthy infants and children older than 3 months of age. These guidelines do not pertain to infants ≤ 3 months of age, immunocompromised children, children with chronic lung disease (ex: cystic fibrosis) or ventilator dependent children.

I. INITIAL PRESENTATION
   • Fever (temperature ≥ 38.0 C or 100.4 F)
   • Cough
   • Abnormal lung sounds (rhonchi, crackles, wheezing, rales)
   • Variable degrees of respiratory distress (tachypnea, dyspnea, retractions, grunting, nasal flaring, apnea, altered mental status)

II. RISK FACTORS
   A. General Risk Factors
      • Age < 5 years
      • Male
      • Prematurity (Harris M. , et al., 2011)
      • Malnutrition
      • Exposure to tobacco smoke
      • Childcare attendance
      • Low socioeconomic status (Stuckey-Schrock, Hayes, & George, Community-
Acquired Pneumonia in Children, 2012)

B. Risk Factors for Progressive Disease in Hospitalized Children (Huang, et al., 2013)
   - Age <2
   - Pleural effusion
   - Tachypnea
   - Hemoglobin < 10
   - White blood cell count > 17,500/μL
   - Persistent fever > 3 days

III. SELECTION OF CARE SETTING (Bradley J. , et al., 2011)

A. Conditions that favor Outpatient management:
   - Absence of respiratory distress (no tachypnea, dyspnea, retractions, grunting, nasal flaring, apnea, altered mental status)
   - Sustained SpO2 ≥ 90%
   - Adequate outpatient caregiver support/ability to be compliant with outpatient therapy

B. Conditions that favor Inpatient management:
   - Respiratory distress (tachypnea, dyspnea, retractions, grunting, nasal flaring, apnea, altered mental status)
   - Sustained SpO2 < 90%
   - 3-6 months of age with suspected bacterial pneumonia
   - Suspected pathogen with increased virulence (ex: MRSA)
   - Poor outpatient support/concerns about the ability to be compliant with outpatient therapy

C. Conditions that favor ICU management:
   - Mechanical ventilation, CPAP, BiPAP
   - Impending respiratory failure
   - Unstable hemodynamics (sustained tachycardia, hypotension, requiring vasopressors)
   - SpO2 < 92% on inspired oxygen ≥ 0.50
   - Altered mental status

IV. PATHOGENESIS: In many children, testing may indicate 2 or 3 pathogens, including combinations of viruses and bacteria. A 2011 study of 76 hospitalized children with CAP found 18 distinct viruses and six bacteria in sputum samples by culture and PCR. Viruses were found in 72% of samples. Bacteria were found in 91% of samples. Both viruses and bacteria were found in 66% of samples. The most commonly found viruses were Rhinovirus (30%), human bocavirus (18%) and human metapneumovirus (14%). The most commonly found bacteria were Streptococcus pneumonia (50%), Haemophilus influenza (38%) and Moraxella catarrhalis (28%). The pairing of Rhinovirus and Streptococcus pneumoniae was the most common bacterial-
viral combination occurring in approximately 16% of cases. The clinical significance of the viral-bacterial combinations is not yet well understood, but the authors of this particular study found a potential association to treatment failure. (Honkinen, Lahti, Osterback, Ruuskanen, & Waris, 2012) Additionally, the incidences of certain pathogens vary by age group given the development of the immune system and age-related exposures. (Bradley J., et al., 2011)


A. Viruses
- Approximately 80% of CAP in children < 2 years of age is caused by a virus.
- The incidence of a viral etiology decreases with age. Viruses are responsible for CAP in children > 5 years of age in only 1/3 of cases.
- Common viruses:
  - Respiratory syncytial virus (found in up to 40% of children <2 years of age)
  - Influenza A, B
  - Parainfluenza viruses 1, 2 and 3
  - Rhinovirus
  - Human metapneumovirus
  - Human bocavirus
  - Coronavirus
  - Adenovirus

B. Atypical bacteria
- Mycoplasma pneumoniae
  - Typically found in older children.
  - Course is classically slowly progressive and is associated with malaise, low grade fever, sore throat and cough developing over 3-5 days.
- Chlamydia trachomatis and Chlamydia pneumoniae
  - More often found in infants than older children.

C. Bacteria
- Streptococcus pneumonia (most common)
- Haemophilus influenzae type b
- Moraxella catarrhalis
- Staphylococcus aureus, including MRSA
- Nontypable Haemophilus influenza

V. DIAGNOSTIC TESTING ROUTINELY RECOMMENDED
- Pulse oximetry should be performed in all children with pneumonia and suspected hypoxemia. The presence of hypoxemia should guide decisions regarding site of care and further diagnostic testing.
• **Testing for influenza** is recommended (when seasonally appropriate) as a positive test would guide appropriate antiviral therapy. Additionally, antibacterial therapy is not recommended for children with a positive influenza test unless there is compelling evidence that there is a bacterial coinfection. (Bradley J., et al., 2011)

• **Mycoplasma testing** should be performed for children with signs and symptoms consistent with but not classic for *Mycoplasma pneumoniae* to help guide antibiotic selection.

**NOT ROUTINELY RECOMMENDED**

• **Chest x-ray** is not necessary to confirm CAP in patients well enough to be treated in the outpatient setting. Chest x-ray is recommended for all hospitalized patients in order to fully characterize the infiltrate and identify any possible complications that may warrant interventions beyond antimicrobial and supportive therapies. (Bradley J., et al., 2011)

• **Blood cultures** are not routinely recommended for non-toxic, fully immunized children being managed in the outpatient setting. Blood cultures should be obtained for children failing to demonstrate clinical improvement with initial antibiotic therapy as well as for children ill enough to require hospitalization. (Bradley J., et al., 2011)

• **Acute phase reactants (ESR, CRP, procalcitonin)** should not routinely be obtained in children managed as outpatients. They may be helpful in measuring the response to therapy in an inpatient setting.

• **Chlamydophila pneumoniae testing** is not recommended as reliable and readily available diagnostic tests do not currently exist.

• **Complete blood cell count** is not recommended. However, it may provide useful information in those with more serious disease for clinical management in the context of clinical exam and other laboratory and imaging studies.

• **Antibacterial therapy is not necessary** for children with a positive test for influenza virus in the absence of clinical, laboratory, or radiographic findings that suggest bacterial coinfection.

**VI. DRUG THERAPY**

• **Amoxicillin should be used as first-line therapy** for previously healthy, appropriately immunized infants and preschool children with mild to moderate CAP suspected to be of bacterial origin. Amoxicillin provides appropriate coverage for *Streptococcus pneumoniae*, the most prominent invasive bacterial pathogen. Table 1 lists preferred agents and alternative agents for children allergic to amoxicillin.

• **Macrolide antibiotics** should be prescribed for treatment of children (primarily school-aged children and adolescents) evaluated in an outpatient setting with findings compatible with CAP caused by atypical pathogens. Laboratory testing for *M. pneumoniae* should be performed if available in a clinically relevant time frame. Table 1 lists preferred and alternative agents for atypical pathogens.

• **Influenza antiviral therapy** (Table 2) should be administered as soon as possible to children with moderate to severe CAP consistent with influenza virus infection during widespread
local circulation of influenza viruses, particularly for those with clinically worsening disease documented at the time of an outpatient visit. Because early antiviral treatment has been shown to provide maximal benefit, treatment should not be delayed for confirmation of positive influenza test results. Negative influenza diagnostic tests, especially rapid antigen tests, do not conclusively exclude influenza disease. Treatment after 48 hours of symptomatic infection may still provide clinical benefit to those with more severe disease.

Table 1. Empiric Therapy for Outpatient Pediatric Community-Acquired Pneumonia (CAP)

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<thead>
<tr>
<th>Outpatient</th>
<th>Presumed bacterial pneumonia</th>
<th>Presumed atypical pneumonia</th>
<th>Presumed influenza pneumonia a</th>
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<td>&lt;5 years old (preschool)</td>
<td>Amoxicillin, oral 90 mg/kg/day in 2 doses for 5 days</td>
<td>Azithromycin oral (10 mg/kg (max. 500mg) on day 1, followed by 5 mg/kg/day (max. 250 mg) once daily on days 2–5); Alternative: oral amoxicillin clavulanate amoxicillin component, 90 mg/kg/day in 2 doses for 5 days</td>
<td>Oseltamivir ≥24 months old: ~4 mg/kg/day in 2 doses, for a 5-day treatment</td>
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<td>Alternatives: oral clarithromycin (15 mg/kg/day in 2 doses for 7-14 days) or oral erythromycin (40 mg/kg/day in 4 doses for 7-14 days)</td>
<td>≤15 kg: 60 mg/day; &gt;15 to 23 kg: 90 mg/day; &gt;23 to 40 kg: 120 mg/day; &gt;40 kg: 150 mg/day (divided into 2 doses for each group)</td>
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<td>9–23 months old: 7 mg/kg/day in 2 doses; 0–8 months old: 6 mg/kg/day in 2 doses; premature infants: 2 mg/kg/day in 2 doses</td>
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<td>≥5 years old</td>
<td>Oral amoxicillin (90 mg/kg/day in 2 doses b to a maximum of 4 g/day c); for children with presumed bacterial CAP with inability to distinguish typical from atypical CAP, a macrolide can be added to a β-lactam antibiotic for empiric therapy; alternative: oral amoxicillin clavulanate (amoxicillin component, 90 mg/kg/day in 2 doses b to a maximum dose of 4000 mg/day, eg, one 2000-mg tablet twice daily b)</td>
<td>Same as above</td>
<td>Same as above</td>
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For children with drug allergy to recommended therapy, see Evidence Summary for Section V. Anti-Infective Therapy. For children with a history of possible, nonserious allergic reactions to amoxicillin, treatment is not well defined and should be individualized. Options include a trial of amoxicillin under medical observation; a trial of an oral cephalosporin that has substantial activity against *S. pneumoniae*, such as cefpodoxime, cefprozil, or cefuroxime, provided under medical supervision; treatment with levofloxacin; treatment with linezolid; treatment with clindamycin (if susceptible); or treatment with macrolide (if susceptible).

For children with bacteremic pneumococcal pneumonia, particular caution should be exercised in selecting alternatives to amoxicillin, given the potential for secondary sites of infection, including meningitis.

Abbreviation: CA-MRSA, community-associated methicillin-resistant *Staphylococcus aureus*.

- See Table 1 for dosages.
- See text for discussion of dosage recommendations based on local susceptibility data. Twice daily dosing of amoxicillin or amoxicillin clavulanate may be effective for pneumococci that are susceptible to penicillin.
- Not evaluated prospectively for safety.
VII. DURATION OF TREATMENT

A. Treatment courses of 10 days have been best studied, although shorter courses may be just as effective, particularly for more mild disease managed on an outpatient basis.

B. Infections caused by certain pathogens, notably CA-MRSA, may require longer treatment than those caused by *S. pneumoniae*.

C. The duration of antimicrobial therapy in children in the developed world has primarily been studied in the context of antibiotic registration trials, comparing newer agents with those having a standard treatment course of 10 days (5 days for azithromycin, which has distinctly different tissue-site pharmacokinetics compared with β-lactam antibiotics) in these protocols. (Bradley J. S., et al., 2011)

VIII. MINIMIZING ANTIMICROBIAL RESISTANCE

1. Antibiotic exposure selects for antibiotic resistance; therefore, limiting exposure to any antibiotic, whenever possible, is preferred.

2. Limiting the spectrum of activity of antimicrobials to that specifically required to treat the identified pathogen is preferred.

3. Using the proper dosage of antimicrobial to be able to achieve a minimal effective concentration at the site of infection is important to decrease the development of resistance.

4. Treatment for the shortest effective duration will minimize exposure of both pathogens and normal microbiota to antimicrobials, and minimize the selection for resistance.

IX. HOW SHOULD THE CLINICIAN FOLLOW THE CHILD WITH CAP FOR THE EXPECTED RESPONSE TO THERAPY

A. Children receiving adequate therapy should demonstrate clinical and laboratory signs of improvement within 48–72 hours. For children whose condition deteriorates after admission and initiation of antimicrobial therapy or who show no improvement within 48–72 hours, further investigation should be performed.

X. PATIENT EDUCATION

*Please review the information below with your patients.*

A. Pneumonia is an infection of the lungs that can often be prevented with vaccines and can usually be treated with antibiotics, antiviral drugs (such as Tamiflu), or specific drug therapies.

B. Pneumonia and other respiratory infections can be prevented by following good hygiene practices, such as washing your hands regularly and disinfecting frequently touched surfaces.

C. Avoid exposure to cigarette smoke.

D. Make sure the child is up to date on the vaccines that are recommended to prevent infection by bacteria or viruses that may cause pneumonia.
   - These vaccines include:
     - Pneumococcal
- Haemophilus influenza b (Hib)
- Pertussis (whooping cough)
- Varicella (chicken pox)
- Measles
- Influenza (flu)

E. To protect infants from exposure, parents and caretakers of infants <6 months of age, including pregnant adolescents are recommended to get immunized with vaccines for influenza virus and pertussis.

F. High-risk infants should be provided immune prophylaxis with respiratory syncytial virus (RSV)-specific monoclonal antibody to decrease the risk of severe pneumonia and hospitalization caused by RSV.

G. Call your physician if your child shows any of the following warning signs that the pneumonia is worsening or spreading.
   - Fever lasting more than a few days despite using antibiotics
   - Breathing difficulties
   - Evidence of an infection elsewhere in the body: red swollen joints, bone pain, neck stiffness, vomiting, or other new signs or symptoms.
   - Skin, fingernails or toenails turn blue.

H. Parents should follow these home care guidelines
   - Rest.
   - Increase fluid intake.
   - Cough suppressants containing codeine or dextromethorphan should not be used, because coughing is necessary to clear the excessive secretions caused by the infection.
   - Use over the counter drugs such as acetaminophen or ibuprofen to relieve fever or minor discomfort.
References:


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<th>Next Scheduled Review Date:</th>
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<td>October 2017 Pediatric Ambulatory Workgroup</td>
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