Community-Acquired Pneumonia in infants and children

Review of Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America - 2011

Sabah Charania, B.S., Pharm.D.
PGY-1 Pharmacy Resident
Baptist Hospital of Miami

Objectives

- Define pneumonia
- Define criteria for community acquired pneumonia (CAP) severity of illness
- Review guidelines for management of infants and children with CAP
- Explain treatment modalities for children with failure to initial antibiotic therapy
- Discuss strategies to prevent CAP in infants and children

Pneumonia

A lower respiratory tract infection with mild to severe signs and symptoms

Image: http://www.thequietworld.com/ahealthyworld/images/pneumoniacause.jpg

Pneumonia

Simple Pneumonia
- Broncho-pneumonia: Involves airway and surrounding interstitium
- Lobar pneumonia: Involves a single lobe

Complicated Pneumonia
- Pulmonary parenchymal infection with parapneumonic effusions
- Multilobar disease
- Abscesses or cavities, necrotizing pneumonia
- Empyema, pneumothorax, or pneumonia with bacteremia

Epidemiology

- ~ 155 million cases of pneumonia occur in children annually worldwide
  - Over 2 million children die annually from pneumonia worldwide
- Annual incidence of pneumonia in US is ~ 3-4 cases per 100 children < 5 years old
  - CDC estimates that pneumonia kills a child every 20 seconds
- Pneumonia represents approximately 20% of all deaths in children < 5 years of age

Prevalence

Hospitalizations for Types of Respiratory Diseases, Children Aged <15 Years, 2005

- Pneumonia 31%
- Acute bronchitis and bronchiolitis 25%
- All other respiratory diseases 19%
- Asthma 25%

In 2005, respiratory diseases accounted for 30% of the 2.4 million hospitalizations for children aged <15 years

http://www.cdc.gov/Features/Pneumonia/

Risk Factors

- Young age
- Pre-existing lung or other serious disease (asthma, diabetes)
- Weakened or suppressed immune system
- Malnourished
- Difficulty in coughing or swallowing

Etiology

- Most common bacterial pathogens:
  - *Streptococcus pneumoniae* (S. pneumoniae)
  - *Haemophilus influenzae* (type b) (H. influenzae)
  - Atypical bacteria
- Most common viral pathogens:
  - Influenza
  - Parainfluenza
  - Respiratory syncytial viruses (RSV)

Age-Specific Etiology

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Most Common Pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>All age groups</td>
<td>Typical bacteria</td>
</tr>
<tr>
<td>Children &lt; 2 yrs</td>
<td>Viral</td>
</tr>
<tr>
<td>Children 2 - 5 yrs</td>
<td>Respiratory Syncytial Virus</td>
</tr>
<tr>
<td>Children ≥ 5 yrs</td>
<td>Atypical bacteria</td>
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Clinical Presentation

- Simple
  - Mild to severe illness
  - Coughing
  - Fever
  - Fatigue
  - Nausea
  - Vomiting
- Complicated
  - Rapid breathing or shortness of breath
  - Chills
  - Chest pain
  - Abdominal Pain

Severity of Illness

**Major Criteria**
- Invasive mechanical ventilation
- Fluid refractory shock
- Acute need for noninvasive positive pressure ventilation (NIPPV)
- Hypoxemia requiring fraction of inspired oxygen (FiO2) greater than inspired concentration or flow feasible in general care area

**Minor Criteria**
- Respiratory rate higher than WHO classification for age
- Apnea
- Increased work of breathing
- Arterial oxygen pressure (PaO2)/FiO2 ratio < 250
- Multilobar infiltrates
- Pediatric early warning score (PEWS) > 6
- Altered mental status
- Hypotension
- Presence of effusion
- Comorbid conditions
- Unexplained metabolic acidosis
Care Setting

Hospitalization

- Moderate to severe CAP (SH)
- Suspected pathogen with increased virulence [e.g., Community-acquired Methicillin Resistant Staphylococcus aureus (CA-MRSA)] (SL)
- Infants < 3-6 months with suspected bacterial CAP (SL)
- Patients with issues towards careful observation at home or compliance (SL)

Intensive Care

- Children requiring invasive ventilation (SH)
- Acute need for noninvasive positive pressure ventilation (SVL)
- Impending respiratory failure (SM)
- Pulse oximetry measurement <92% on inspired oxygen of ≥0.5 (SL)
- Sustained tachycardia or need of pharmacologic blood pressure (BP) or perfusion support (SH)
- Children with pneumonia-related altered mental status (SL)

Diagnostic Testing

- Pulse oximetry (SM)
- Blood cultures
  - Outpatient: Only in children with worsening CAP symptoms after initiation of antibiotic therapy (SM)
  - Inpatient: In children with presumed bacterial moderate-to-severe CAP (SL)
- Repeated blood cultures
  - Should be performed for bacteremia caused by Staphylococcus aureus regardless of clinical status (SL)
  - Not necessary for pneumococcal bacteremia with clinical improvement (WL)

Specific diagnostic testing is recommended for influenza and other respiratory viruses (SH)

- Antibacterial therapy is unnecessary in patients with positive influenza test with lack of signs indicative of bacterial co-infection (SH)

Atypical bacteria

- Testing for Mycoplasma pneumoniae should be performed in children with clinical signs and symptoms suggestive of this pathogen (WM)
- Chlamydia pneumoniae testing is not recommended (SH)

Diagnostic Testing

- Chest Radiology
  - Outpatient
    - Unnecessary for confirmation of CAP in well enough patients (SH)
    - Recommended for patients with hypoxemia or significant respiratory distress or inadequate response to initial therapy (SM)
  - Inpatient
    - Should be obtained for all hospitalized patients (SM)
Outpatient Management

- **Outpatient**
- **Age**
  - < 5 years
  - > 5 years
- **Etiology**
  - Bacterial
  - Viral
- **Typical**
- **Atypical**

Treatment: Children < 5 years

- Preschool-aged children do not routinely require antimicrobial therapy (SH)

<table>
<thead>
<tr>
<th>Typical Pneumonia</th>
<th>Atypical Pneumonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin 90 mg/kg/day PO in 2 divided doses (SIM) ± macrolide if atypical pneumonia is suspected (IM)</td>
<td>Azithromycin 10 mg/kg PO on day 1, then 5 mg/kg/day PO day 2-5</td>
</tr>
</tbody>
</table>

Alternative:
- Amoxicillin/clavulanate

Alternatives:
- Clarithromycin 15 mg/kg/day PO in 2 divided doses for 7-14 days
- Erythromycin 40 mg/kg/day PO in 4 divided doses

Treatment: Children ≥ 5 years

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<tr>
<td>Amoxicillin 90 mg/kg/day PO in 2 divided doses (maximum: 4 g/day)</td>
<td>Azithromycin 10 mg/kg PO on day 1, then 5 mg/kg/day PO day 2-5</td>
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Alternative:
- Amoxicillin/clavulanate

Alternatives:
- Clarithromycin 15 mg/kg/day PO in 2 divided doses for 7-14 days
- Erythromycin 40 mg/kg/day PO in 4 divided doses

Prophylaxis: Influenza Pneumonia

- Oseltamivir
  - Age-based dosing
    - < 3 months: not recommended - limited data
    - 3-23 months: 3.5 mg/kg once daily
  - Weight-based dosing
    - ≤ 15 kg: 30 mg/day
    - > 15 – 23 kg: 45 mg/day
    - > 23 – 40 kg: 60 mg/day
    - > 40 kg: 75 mg/day
  - Alternative:
    - Zanamivir (children ≥ 5 years old) 2 inhalations (10 mg / dose) once daily for 10 days

Prophylaxis: RSV

- Immune prophylaxis with RSV – specific monoclonal antibody is recommended for high-risk infants:
  - Infants and children < 24 months with bronchopulmonary dysplasia
  - Preterm birth (≤ 35 weeks)
  - Hemodynamically significant congenital heart disease
  - Palivizumab (Synagis®) 15 mg/kg IM monthly during the RSV season (November – April)

- Oseltamivir
  - Age-based dosing
    - Premature infants: 2 mg/kg/day in 2 doses
    - 0-8 months: 6 mg/kg/day in 2 divided doses
    - 9-23 months: 7 mg/kg/day in 2 divided doses
    - ≥24 months: ≥4 mg/kg/day in 2 doses for 5-days
  - Weight-based dosing
    - ≤ 15 kg: 60 mg/day in 2 doses
    - 15 – 23 kg: 90 mg/day in 2 doses
    - 23 – 40 kg: 120 mg/day in 2 doses
    - ≥ 40 kg: 150 mg/day in 2 doses
  - Alternative:
    - Zanamivir (children ≥ 7 years old) 2 inhalations (10 mg / dose) twice daily for 5 days
Inpatient Management

- Fully immunized: vaccinated against S. pneumoniae and H. influenzae
- Minimal resistance: minimum inhibitory concentrations (MICs) for penicillin ≤ 2.0 µg/mL
- Resistant: MICs for penicillin ≥ 4.0 µg/mL

Immunization status

- Fully immunized: vaccinated against S. pneumoniae and H. influenzae
- Not fully immunized: vaccinated against S. pneumoniae

Etiology

- Typical bacteria
- Atypical bacteria

PCN resistance

- PCN susceptible
- PCN resistant

Empiric Regimen: Typical Pneumonia

<table>
<thead>
<tr>
<th>Fully immunized</th>
<th>Not fully immunized or Suspected PCN Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin or penicillin G (SM)</td>
<td>Ceftriaxone or cefotaxime (WM)</td>
</tr>
<tr>
<td>Alternative:</td>
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</tr>
<tr>
<td>Ceftriaxone or cefotaxime</td>
<td>Vancomycin or clindamycin (if CA-MRSA is suspected) (SL)</td>
</tr>
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<td>Vancomycin or clindamycin (if CA-MRSA is suspected) (SL)</td>
<td>Alternative:</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>Vancomycin or clindamycin (if CA-MRSA is suspected)</td>
</tr>
</tbody>
</table>

Treatment: Typical Pneumonia

<table>
<thead>
<tr>
<th>Fully immunized</th>
<th>Not fully immunized</th>
</tr>
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<tbody>
<tr>
<td>PCN Sensitive</td>
<td>PCN Resistant</td>
</tr>
<tr>
<td>Ampicillin 150-200 mg/kg/day IV q6h OR</td>
<td>Ceftriaxone 100 mg/kg/day IV q12-24h (WM)</td>
</tr>
<tr>
<td>Penicillin G 200,000-250,000 units/kg/day IV q4-6h (SM)</td>
<td>Alternatives:</td>
</tr>
<tr>
<td>Ceftriaxone 50-100 mg/kg/day IV q12-24h OR</td>
<td>Ampicillin 300-400 mg/kg/day q6h OR:</td>
</tr>
<tr>
<td>Cefotaxime 150 mg/kg/day IV q8h OR</td>
<td>Levofloxacin (6 months - 5 years old): 16-20 mg/kg/day q12h; (5 - 16 years old): 8-10 mg/kg/day; max. 750 mg/day</td>
</tr>
<tr>
<td>Vancomycin 40-60 mg/kg/day IV q6-8h OR</td>
<td>Vancomycin 40 mg/kg/day IV q6-8h (if CA-MRSA is suspected) (SL)</td>
</tr>
<tr>
<td>Clindamycin 40 mg/kg/day IV q6-8h (SL)</td>
<td>Alternatives:</td>
</tr>
</tbody>
</table>

Empiric Regimen: Atypical Pneumonia

- Azithromycin (WM) ±
- β-lactam (if etiology is doubtful)

Alternatives:
- Clarithromycin
- Erythromycin
- Doxycycline (children > 7 years old)
- Levofloxacin (children who have reached growth maturity or are macrolide-intolerant)

Treatment: Atypical Pneumonia

<table>
<thead>
<tr>
<th>Preferred</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azithromycin 10 mg/kg IV (max 500 mg) on days 1 and 2 of therapy and transition to oral therapy (WM)</td>
<td>Step-down therapy</td>
</tr>
<tr>
<td>±</td>
<td>Clarithromycin 15 mg/kg/day in 2 doses</td>
</tr>
<tr>
<td>β-lactam (if etiology is doubtful)</td>
<td>Doxycycline (children &gt; 7 years old): 2-4 mg/kg/day in 2 doses</td>
</tr>
<tr>
<td></td>
<td>Oral erythromycin or levofloxacin</td>
</tr>
<tr>
<td></td>
<td>Severe disease</td>
</tr>
<tr>
<td></td>
<td>Erythromycin 20 mg/kg/day IV q6h</td>
</tr>
<tr>
<td></td>
<td>Levofloxacin 16-20 mg/kg/day IV q12h; max. 750 mg/day</td>
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Penicillin Allergy

Treatment is not well-defined

- Non-serious allergic reaction:
  - Trial of amoxicillin under supervision
  - Oral cephalosporin (e.g. cefuroxime)

- Serious allergy:
  - Respiratory fluoroquinolone
  - Clindamycin (if susceptible)
  - Macrolide (higher resistant rates)
  - Linezolid

Duration of Therapy

- Shortest effective duration is recommended (SM)
- Most commonly, duration of 10 days has been studied
- Varies based on severity of illness and pathogen involved
  - CA-MRSA may require longer treatment (SM)

Treatment Failure

- Clinical improvement should be seen with 48-72 hours of adequate anti-infective therapy (SM)

- If inadequate response:
  - Assess current severity of illness (SL)
  - Imaging evaluation (WL)
  - Scrutinize to identify resistance versus presence of another pathogen (WL)

Complicated Pneumonia

- Additional Considerations:
  - Size of the effusion (SM)
  - Extent of respiratory compromise (SM)

- Recommendations:
  - Small effusions can usually be managed with antibiotic therapy (SM)
  - Drainage for moderate, complicated effusions with anti-infective therapy (SM)

Discharge Eligibility

- Clinical improvement for at least 12-24 hrs (SVL)
- Consistent pulse oximetry measurements >90% in room air (SM)
- Stable and/or baseline mental status (SVL)
- Documentation demonstrating tolerance to home anti-infective and oxygen therapy (SL)
- Assessment of barriers to adequate care post-discharge (WVL)
- Chest tube removed for at least 12-24 hrs (SVL)
- Ineligible if increased work for breathing or sustained tachypnea or tachycardia (SH)

Prevention Strategies

- Children should be immunized for *S. pneumoniae*, *H. influenzae*, and pertussis (SH)
- Immunizations for bacterial pathogens:
  - *S. pneumoniae*
    - 13-valent pneumococcal vaccine
  - *H. influenzae*
    - PRP-OMP
    - PRP-T (ActHIB & Hiberix)
  - Pertussis
    - DTap
Prevention Strategies

- Annual influenza vaccine is strongly recommended for all:
  - Infants ≥ 6 months of age (SH)
  - Children (SH)
  - Adolescents (SH)

- Influenza and pertussis vaccines are strongly recommended for:
  - Parents and caretakers of infants < 6 months of age (SW)
  - Pregnant adolescents (SW)

Patient Case

- A mother walks into a pediatrician’s office with her 6 year-old boy, JW. JW has been experiencing cough, fever, and sore throat for the past couple of days and is not responding to his mom’s home remedies.
  - Weight: 22 kg
  - Temperature: 100.4°F
  - Height: 3’4”
  - SpO2: 94%
  - Relevant immunization history: Influenza vaccine

- Based on physical examination, the physician diagnosed JW with CAP.

- JW’s anti-infective therapy should cover for:

  JW’s anti-infective therapy should cover for?

  How would you treat?

Is it true...

- Parents and caretakers of infants < 6 months of age, including pregnant adolescents, should be immunized with influenza and pertussis vaccines to protect infants from exposure. **True**

- Antimicrobial therapy is routinely required for preschool-aged children with CAP. **False**

- Children on adequate therapy should demonstrate clinical and laboratory signs of improvement with 24-48 hours. **False**

Additional References


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