Duke Pediatrics Community-Acquired Pneumonia (CAP) Clinical Pathway

Definition: Community-acquired pneumonia (CAP) is a lower respiratory tract infection acquired outside of a hospital/healthcare setting.

Epidemiology: In the US, CAP accounts for millions of outpatient visits and is one of the most prevalent and costly indications for hospitalization.[1–3] Globally, CAP remains a leading cause of death for children under 5-years-old.[4]

Etiology: CAP is caused by several pathogens including viruses and bacteria. Common pathogens in uncomplicated pneumonia include viruses (RSV, adenovirus, influenza), *S. pneumoniae*, *H. influenzae*, *M. catarrhalis*, *S. aureus*, *S. pyogenes* (Group A Streptococcus), *M. pneumoniae*. Common pathogens in complicated pneumonia include *S. pneumoniae, S. aureus*, *S. pyogenes*.[3] Among bacterial etiologies, *S. pneumoniae* remains the most frequently identified pathogen.[5]

Inclusion Criteria: Children ≥ 60 days to 18 years old with suspected/proven CAP managed in the outpatient, emergency department, inpatient, or intensive care setting

Exclusion Criteria

- Children < 60 days old
- Tracheostomy or ventilator dependent patients
- Immunocompromised or immunosuppressed patients
- Children with cystic fibrosis or other chronic lung disease (except asthma)
- Concern for aspiration as etiology for respiratory symptoms
- Hospital or institutional-acquired pneumonia

Differential Diagnosis: foreign body aspiration, aspiration pneumonia, tuberculosis or endemic mycoses, tumor, anatomic malformation, other uncommon infections of the lungs

Diagnostic Evaluation

History and Physical Examination: The clinical diagnosis of pneumonia is a challenging and requires historical and/or physical evidence of acute infection with fever and signs or symptoms of respiratory distress. Generally, combinations of signs and symptoms have been shown to be more accurate than individual features alone.

Although there are no clear clinical definitions, the following features have been shown to be suggestive of pneumonia[6]:

- Tachypnea for age **(Table 1)**
- Fever
- Hypoxia (oxygen saturation ≤94%)
- Retractions and/or nasal flaring
- Focal rales/crackles on auscultation

Table 1: Normal respiratory rate for age

Age	Respiratory Rate (breaths/min)
0-2 months	60
2-12 months	50
1-5 years	40
> 5 years	20

Laboratory Tests and Imaging:

- Labs including CBC/d, inflammatory markers (CRP, ESR, procalcitonin), blood culture, or respiratory viral panel are not recommended for patients with mild, uncomplicated CAP.[7]
- Urinary antigen detection tests are not recommended for the diagnosis of pneumococcal pneumonia in children; false-positive tests are common.[7]
- Blood cultures may be obtained for hospitalized patients who meet any of the following: < 6 months of age with fever, not fully immunized, central venous catheter in place, admission to the ICU, effusion or empyema on chest x-ray (CXR).[8,9]
- The diagnosis of CAP can be made clinically; routine CXR are not necessary to confirm the diagnosis of suspected community-acquired pneumonia in healthy children with mild disease.[7] CXR should be reserved for cases of diagnostic uncertainty with a high clinical suspicion for CAP or for those requiring hospitalization to assess for complicated disease (e.g., effusion, empyema, or necrotizing pneumonia). CXR findings do not consistently alter patient management and they do not differentiate viral from bacterial etiology.[10,11]

Severity and Complexity of Pneumonia[7]

Complexity: complicated pneumonia is defined as pneumonia with moderate effusion (1/4-1/2 of thorax involved) or large effusion (>1/2 thorax involved), empyema, pneumothorax, lung abscess, bronchopleural fistula, or necrotizing pneumonia

Severity:

Mild Pneumonia (Outpatient Treatment)	Moderate Pneumonia (Inpatient/ICU Treatment)	Severe Pneumonia (ICU Treatment)
• No retractions, grunting, nasal flaring, or apnea • Pulse oximetry > 90% in room air • Non-toxic appearance	Any of the following: • Moderate dyspnea, including: retractions, grunting, nasal flaring, apnea • Pulse oximetry < 90% in room air • Need for HFNC or other non-invasive mechanical ventilation not meeting severe criteria	Any of the following: • Hypoxemic or hypercarbic respiratory failure requiring invasive mechanical ventilation or non-invasive mechanical ventilation with high (e.g., > 40%) or escalating FiO_2 requirement • Systemic signs of inadequate perfusion (change in mental status, hemodynamic instability)

Critical Points of Evidence

Evidence Supports

- Randomized control trials support the use of 5 days of antibiotics for treatment of mild to moderate severity community-acquired pneumonia.[12–14] Data suggest that short-course therapy is comparable to the standard of care (i.e. 7-10 days of therapy as noted in the 2011 IDSA Guidelines which have been archived, new guidelines in development) and benefits outweigh harms.

Evidence Lacking/Inconclusive

- While two meta-analyses demonstrated a moderate ability of procalcitonin to distinguish bacterial from nonbacterial pneumonia (AUROC 0.670.71), limitations were identified.[15,16] Sensitivity ranged from 53% to 69%,

indicating the potential for missing true positive cases. Specificity ranged from 60% to 73%, suggesting the possibility of misclassification.

Evidence Against

- There are no signs or symptoms that distinguish atypical from typical bacterial CAP, and azithromycin is overprescribed for pediatric CAP.[15,17] M. pneumoniae is frequently detected in asymptomatic patients (up to 20%), and symptomatic *M. pneumoniae* infection is often self-limited with insufficient evidence to support the efficacy of antibiotics including azithromycin.[18–20] Do not use if lobar pneumonia is suspected (does not provide coverage of *S. pneumoniae*).
- CXR cannot identify the etiologic pathogen in children with CAP, except when pleural effusion is present. Obtaining a CXR is not recommended in mild cases of CAP. CXR may have utility if there is diagnostic uncertainty or if the results would change the clinician's decision to prescribe antibiotics.[7,10,11]
- Cefdinir should not be used for treatment of CAP as it is not effective against *S. pneumoniae.*

Condition-Specific Elements of Clinical Management

General

Uncomplicated CAP:

- CBC/d, inflammatory markers, and blood culture are not necessary in mild CAP.[7–9]
- CXR is not necessary with high clinical suspicion and low concern for complicated pneumonia.
- Etiology testing is not routinely recommended for CAP unless suspicious for influenza.[3,7,20–22]
- Procalcitonin may be considered for uncomplicated CAP if there is etiological uncertainty and if the result will help determine need for antibiotic therapy.[15,23,24]

Complicated CAP

- Consider PA/lateral CXR in patients being admitted to the PICU or for concern for complicated pneumonia.[8,11]
- For moderate to large effusions, obtain ultrasound to evaluate for free flowing fluid versus loculations/empyema.[7,25]
- Consider drainage in large or symptomatic effusions.[7,25]
- For admitted patients or those with complicated pneumonia, consider obtaining:
    - CBC/d, BMP, and blood culture
    - Nasal PCR screening -- Consider nasal MRSA screening culture for patients with severe/complicated pneumonia who are started empirically on clindamycin/vancomycin. Anti-MRSA therapy can generally be stopped in patients who do not have positive nasal MRSA PCR.
    - Etiology testing -- Send viral testing only if a viral etiology is thought to be the sole cause of disease and detecting a virus will change management. *M. pneumoniae* is known to cause pneumonia but it is unknown whether antibiotic treatment is beneficial in improving clinical outcomes. Additionally, positive *M. pneumoniae* PCR tests are common in asymptomatic hosts.
- Procalcitonin is not recommended for complicated pneumonia as it is unlikely to change management decisions regarding antibiotics.

Treatment Recommendations

Complexity	Severity	First-Line Therapy	Severe Allergy to First-Line β-lactam	Duration of Treatment/Comments
Uncomplicated May include children with small, simple effusions	**Mild CAP, outpatient**	**Amoxicillin** 90 mg/kg/day PO q12h (max: 4g/day)	**Clindamycin** 40 mg/kg/day PO q8h (max: 600 mg/dose PO)	Total of 5 days of therapy
	Moderate CAP, inpatient/ICU	**Amoxicillin** 90 mg/kg/day PO q12h (max: 4g/day) OR **Ampicillin** 75 mg/kg/dose IV q6h (max: 2g/dose)	**Ceftriaxone** 100 mg/kg/day IV q24h or q12h OR **Clindamycin** 40 mg/kg/day IV q8h (max: 900 mg/dose IV)	Total of 5 days of therapy
	Severe CAP, inpatient/ICU	**Ceftriaxone** 100 mg/kg/day IV q24h or q12h +/- **Clindamycin** 40 mg/kg/day IV/PO q8h (max: 900 mg/dose IV, 600 mg/dose PO; preferred MRSA therapy*)	**Clindamycin** 40 mg/kg/day IV q8h (max: 900 mg/dose IV)	Total of 5-7 days; longer durations may be necessary for children with bacteremia or severe disease Transition to **amoxicillin** when able to tolerate PO or at time of discharge, whichever occurs first
Complicated Includes children with pleural empyema or moderate or large effusions. Does not include children with small, simple effusions.	**Moderate CAP, inpatient/ICU**	**Ceftriaxone** 100 mg/kg/day IV q24h or q12h AND **Vancomycin** dosed by levels to achieve goal trough of 15-20 mcg/mL*	**Clindamycin** 40 mg/kg/day IV q8h (max: 900 mg/dose IV) AND **Levofloxacin** 6 mo-4 years: 10 mg/kg/dose IV/PO q12h ≥ 5 years: 10 mg/kg/dose IV/PO q24h (max: 750 mg/dose)	Duration and targeted therapy dependent upon clinical course & culture data
	Severe CAP, inpatient/ICU			
If concerned for atypical PNA: ≥ 5 years old AND not improving clinically after 48-72h on appropriate therapy	**Azithromycin** 10 mg/kg PO (max: 500 mg/day) once on day 1 then 5 mg/kg PO (max: 250 mg/day) daily on days 2-5. Children < 5 years old should not be treated empirically for mycoplasma, as antibiotic therapy has not been shown to be beneficial in this age group.			

*Use nasal MRSA PCR to determine ability to discontinue MRSA coverage. At Duke, 88% of MRSA isolates are sensitive to clindamycin.

Admission Criteria

Inpatient Criteria:	ICU admission criteria:
Signs of respiratory distress: moderate dyspnea, retractions, grunting, nasal flaring, apnea	Impending respiratory failure: hypoxia, hypercarbia, escalating FiO_2 requirement
Oxygenation < 90% on room air	Need for high flow nasal cannula, non-invasive positive pressure ventilation, or mechanical ventilation
Inability to tolerate PO	Systemic signs of inadequate perfusion (change in mental status, hemodynamic instability)
Concern for complicated pneumonia including: moderate-large effusion, empyema, abscess, necrosis	

Consults and Referrals

- Pediatric surgery: Complicated pneumonia with large effusion (>1/2 thorax), empyema, or loculated effusion
- Pediatric infectious diseases: Complicated moderate/severe CAP

Infection Control: Transmission based precautions are recommended. Please see policy. Contact isolation is required for patients who are MRSA positive on nasal PCR.

Discharge Criteria:

- Tolerating oral antibiotic AND
- Maintaining adequate hydration AND
- No signs of respiratory distress AND
- Oxygen saturation ≥90% on room air

Follow up Care:

- Recommend follow up with PCP at end of antibiotic therapy for moderate-severe CAP
- If indicated, follow up with pediatric ID and pediatric surgery

Measures:

- Utilization of the CAP clinical pathway
- Antibiotic utilization including narrow-spectrum antibiotic use concordant with the clinical pathway
- Antibiotic duration concordant with the clinical pathway
- Length of stay for CAP – emergency department and inpatient

Maestro Care Tools: PED Pediatric Pneumonia, Community Acquired, Admission for Age 90 days to 18 years (Order Set)

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Pathway Preparation

This pathway was prepared by the Duke Pediatrics STEP Committee in collaboration with content experts at Duke Children's Hospital and faculty members in the Duke University School of Medicine. Development of these evidence-based care clinical pathways promote the mission of providing high quality care within the organization

Development Process

This pathway was developed using the process outlined in the Duke Pediatrics STEP Committee manual. The literature appraisal documents the following steps:

1. Review Preparation
- PICO questions established
- Evidence search confirmed with content experts
2. Review of Existing Internal and External Guidelines/Pathways
3. Literature Review of Relevant Evidence
4. Critically Analyze the Evidence
5. Summarize the Evidence
- Materials used in the development of the guideline/pathway, evidence summary, and order sets are maintained by the Duke Pediatrics STEP Committee

Evaluating the Quality of Evidence

This pathway specifically summarizes the evidence *in support of or against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions. *"Evidence Supports"* the pathway provides clear evidence from well-designed randomized controlled trial(s) (RCT[s]) that the benefits of the intervention exceed harm.

"Evidence Against" provides clear evidence from more than one well done RCT that the intervention is likely to be ineffective or that it is harmful.

"Evidence Lacking/Inconclusive" indicates there is currently insufficient data or inadequate data to support or refute a specific intervention.

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The STEP Committee remains aware of the controversies in the clinical management of patients. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by STEP Committee as deemed appropriate for its intended use. Content experts are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner must use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient's family, to make the ultimate judgment regarding care.

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Version History

Date	Comments
May 2020	Original pathway developed
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