Community-Acquired Pneumonia (CAP)- ED Phase

Arkansas Children's
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Obtain Immunization Status

Consider risk factors for TB (see considerations page)

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

What to consider if severely ill (see considerations page)

Provider Assessment

Mildly ill | Moderately ill | Severely ill

Well-appearing to Mildly ill:
No initial testing required, including chest x-ray

Consider chest x-ray if diagnosis uncertain

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
Consider 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 Hib vaccines administered or,
- **Amoxicillin and clavulanate potassium** PO if ≤ 2 Hib vaccines administered or,
- **Cefpodoxime, Cefuroxime, OR Cefprozil*** PO if ≤ 2 Hib vaccines administered
- If penicillin allergy, call ID for antibiotic options
- **Clindamycin** PO for recent or current influenza, MRSA, or empyema
- If concern for atypical pneumonia, add **azithromycin**

Treatment-Moderate

If suspected bacterial CAP, antibiotics:

- **Ampicillin** IV if > 2 Hib vaccines administered
- **Unasyn** IV or **Ceftriaxone** IV if ≤ 2 Hib vaccines administered or failed outpatient management
- **Clindamycin** IV for recent or current influenza, MRSA, or empyema
- If concern for atypical pneumonia, add **azithromycin**
- If penicillin allergy, call ID for antibiotic options

O2 to keep SpO2 >92%
IV fluids as needed

Treatment-Severe

If suspected bacterial CAP, antibiotics:

- **Ampicillin** IV if > 2 Hib vaccines administered uncomplicated pneumonia
- **Unasyn** IV or **Ceftriaxone** IV if ≤ 2 Hib 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 | Floor Admit | Floor Admit | ICU Admit

Discharge Criteria

(Meets all)

- Tolerating PO
- Not hypoxemic (≥ 90% SpO2)
- Mildly increased or normal work of breathing

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

Discharge Instructions

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

*__DO NOT__ use Cefprozil for patients with penicillin allergy

Approved by P&T Committee 6/15/21

Community-Acquired Pneumonia (CAP)- Inpatient Phase

Arkansas Children's
HOSPITALS · RESEARCH · FOUNDATION

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.)
- Cancer
- Prior/current trach or vent dependent
- Neuromuscular disease
- Sickle Cell Disease
- See detail for Pulmonary consult

! **Review immunization status and confirm by WebIZ**

! **Consider risk factors for TB (see TB risk factors page)**

Inpatient Admit Criteria
- Hypoxemia (<90% SpO2)
- Inability to tolerate PO
- Increased work of breathing (grunting, retracting, tachypnea)
- Dehydration, nausea, vomiting
- Treatment failure
- Consider IMU admit for failure to maintain SpO2 ≥ 92% on ≥ 50% 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

Empyema Identified

Empyema Identified

See chest tube pathway

Medical Unit Therapies
- Continue antibiotics:
  - **-Ampicillin** IV > 2 Hib vaccines administered
  - **-Unasyn** IV or **Ceftriaxone** IV if ≤ 2 Hib vaccines administered
  - -If penicillin allergy, call ID for antibiotic options
- If concern for atypical pneumonia, add **azithromycin**
- **Clindamycin** for recent or current influenza, MRSA, or empyema
- IV fluids as needed
- O2 to keep SpO2 ≥ 92%
- Continuous pulse oximetry monitoring if on oxygen
- Spot pulse oximetry Q4 if not on oxygen
- Consult ID for treatment failure

Transfer Criteria from PICU to IMU
Stable or weaning FiO2 and flow per HFNC protocol
Stable x12 hours post-extubation
NIPPV-consult Pulmonology

Transfer Criteria from PICU/IMU to Floor
Stable or weaning FiO2and flow per HFNC protocol
Maintain SpO2 >92%
Stable x12 hours post-extubation
No continuous sedation

PICU Diagnostics
- If intubated, perform mini BAL
- Consider respiratory viral panel and urine legionella testing
- Pleural fluid testing if pt. has a chest tube

PICU Therapies
- **Ampicillin** IV if > 2 Hib vaccines administered uncomplicated pneumonia
- **Unasyn** IV or **Ceftriaxone** IV if ≤ 2 Hib vaccines administered or failed outpatient treatment
- **Azithromycin** IV for atypical pneumonia
- **Clindamycin** and **Vancomycin** for recent or current influenza, MRSA, or empyema
- IV fluids as needed
- Respiratory support per PICU protocol
- Consult ID for treatment failure

Discharge Criteria
- Overall clinical improvement, including mental status and work of breathing
- Tolerating oral nutrition and a dose of oral antibiotics
- No fever for >24 hours
- SpO2 ≥ 90% on room air for >6 hours

Repeat Diagnostics
Repeat chest x-ray if patient not improving as expected

Consider repeat lab testing including CRP

Discharge Instructions
- Total treatment 7 days for uncomplicated disease
- F/U with PCP in 2-3 days after discharge

CRP and chest PT not routinely indicated

E. Rader 4-1659
Approved by P&T Committee 8/18/20

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.

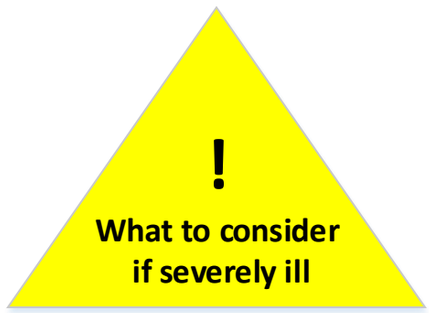
Mild Pneumonia- Minimally increased work of breathing, no hypoxemia, able to tolerate PO (see table below).

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

Medication	Route	Dose
Amoxicillin	PO	90 mg/kg/day in 2 divided doses
Amoxicillin Clavulanate	PO	Amoxicillin component-90 mg/kg/day in 2 divided doses
Azithromycin	PO	10 mg/kg on day 1, followed by 5 mg/kg/day once daily on days 2-5
Clindamycin	PO	30-40 mg/kg/day in 3 divided doses
Cefpodoxime infants >3 months to children <12 years	PO	10 mg/kg/day divided every 12 hours (max 400mg/day)
Cefpodoxime children ≥12 years	PO	200 mg every 12 hours
Cefuroxime	PO	<30 kg 250 mg BID
		≥30 kg 500 mg BID
Cefprozil (do not use in patients with penicillin allergy)	PO	15 mg/kg every 12 hours (max 500 mg/dose)

Medication	Route	Dose
Clindamycin	IV	30-40 mg/kg/day in 3 divided doses
Ampicillin	IV	200 mg/kg/day divided every 6 hours
Ceftriaxone	IV	75 mg/kg/day every 12-24 hours
Vancomycin	IV	60 mg/kg/day divided every 6-8 hours (therapeutic drug monitoring required)

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
      ii. Pneumonia improves but O2 need persists (team decides to send home on O2)
   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

Pathogen	Parenteral therapy	Oral therapy (step-down therapy or mild infection)
Streptococcus pneumoniae with MICs for penicillin ≤2.0 μg/mL	Preferred: ampicillin (150–200 mg/kg/day every 6 hours) or penicillin (200 000–250 000 U/kg/day every 4–6 h); Alternatives: ceftriaxone (50–100 mg/kg/day every 12–24 hours) (preferred for parenteral outpatient therapy) or cefotaxime (150 mg/kg/day every 8 hours); may also be effective: clindamycin (40 mg/kg/day every 6–8 hours) or vancomycin (40–60 mg/kg/day every 6–8 hours)	Preferred: amoxicillin (90 mg/kg/day in 2 doses or 45 mg/kg/day in 3 doses); Alternatives: second- or third-generation cephalosporin (cefpodoxime, cefuroxime, cefprozil); 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 <12 years old and 20 mg/kg/day in 2 doses for children ≥12 years old)
S. pneumoniae resistant to penicillin, with MICs ≥4.0 μg/mL	Preferred: ceftriaxone (100 mg/kg/day every 12–24 hours); Alternatives: ampicillin (300–400 mg/kg/day every 6 hours), 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 5–16 years old; maximum daily dose, 750 mg), or linezolid (30 mg/kg/day every 8 hours for children <12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old); may also be effective: clindamycin[a] (40 mg/kg/day every 6–8 hours) or vancomycin (40–60 mg/kg/day every 6–8 hours)	Preferred: oral levofloxacin (16–20 mg/kg/day in 2 doses for children 6 months to 5 years and 8–10 mg/kg/day once daily for children 5–16 years, maximum daily dose, 750 mg), if susceptible, or oral linezolid (30 mg/kg/day in 3 doses for children <12 years and 20 mg/kg/day in 2 doses for children ≥12 years); Alternative: oral clindamycin[a] (30–40 mg/kg/day in 3 doses)
Group A *Streptococcus*	Preferred: intravenous penicillin (100 000–250 000 U/kg/day every 4–6 hours) or ampicillin (200 mg/kg/day every 6 hours); Alternatives: ceftriaxone (50–100 mg/kg/day every 12–24 hours) 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[b] (40–60 mg/kg/day every 6–8 hours)	Preferred: amoxicillin (50–75 mg/kg/day in 2 doses), or penicillin V (50–75 mg/kg/day in 3 or 4 doses); Alternative: oral clindamycin[a] (40 mg/kg/day in 3 doses)
Stapyhylococcus aureus, methicillin susceptible (combination therapy not well studied)	Preferred: cefazolin (150 mg/kg/day every 8 hours) or semisynthetic penicillin, eg oxacillin (150–200 mg/kg/day every 6–8 hours); Alternatives: clindamycin[a] (40 mg/kg/day every 6–8 hours) or >vancomycin (40–60 mg/kg/day every 6–8 hours)	Preferred: oral cephalexin (75–100 mg/kg/day in 3 or 4 doses); Alternative: oral clindamycin[a] (30–40 mg/kg/day in 3 or 4 doses)
S. aureus, methicillin resistant, susceptible to clindamycin (combination therapy not well-studied)	Preferred: vancomycin (40–60 mg/kg/day every 6–8 hours or dosing to achieve an AUC/MIC ratio of >400) or clindamycin (40 mg/kg/day every 6–8 hours); Alternatives: linezolid (30 mg/kg/day every 8 hours for children <12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old)	Preferred: oral clindamycin (30–40 mg/kg/day in 3 or 4 doses); Alternatives: oral linezolid (30 mg/kg/day in 3 doses for children <12 years and 20 mg/kg/day in 2 doses for children ≥12 years)
S. aureus, methicillin resistant, resistant to clindamycin (combination therapy not well studied)	Preferred: vancomycin (40–60 mg/kg/day every 6-8 hours or dosing to achieve an AUC/MIC ratio of >400); Alternatives: linezolid (30 mg/kg/day every 8 hours for children <12 years old and 20 mg/kg/day every 12 hours for children ≥12 years old)	Preferred: oral linezolid (30 mg/kg/day in 3 doses for children <12 years and 20 mg/kg/day in 2 doses for children ≥12 years old); Alternatives: none; entire treatment course with parenteral therapy may be required

Pathogen	Parenteral therapy	Oral therapy (step-down therapy or mild infection)
Haemophilus influenza, typeable (A-F) or nontypeable	Preferred: intravenous ampicillin (150-200 mg/kg/day every 6 hours) if β-lactamase negative, ceftriaxone (50–100 mg/kg/day every 12-24 hours) if β-lactamase producing, or cefotaxime (150 mg/kg/day every 8 hours); 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)	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; Alternatives: cefdinir, cefixime, cefpodoxime, or ceftibuten
Mycoplasma pneumoniae	Preferred: intravenous azithromycin (10 mg/kg on days 1 and 2 of therapy; transition to oral therapy if possible); 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)	Preferred: azithromycin (10 mg/kg on day 1, followed by 5 mg/kg/day once daily on days 2–5); Alternatives: clarithromycin (15 mg/kg/day in 2 doses) or oral erythromycin (40 mg/kg/day in 4 doses); for children >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)
Chlamydia trachomatis or *Chlamydophila pneumoniae*	Preferred: intravenous azithromycin (10 mg/kg on days 1 and 2 of therapy; transition to oral therapy if possible); 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)	Preferred: azithromycin (10 mg/kg on day 1, followed by 5 mg/kg/day once daily days 2–5); Alternatives: clarithromycin (15 mg/kg/day in 2 doses) or oral erythromycin (40 mg/kg/day in 4 doses); for children >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)

Doses for oral therapy should not exceed adult doses.

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

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

[b] 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.

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Metrics

TBD...

References

1. Berube MS, Pickett JP, Leonesio C, eds. *The American Heritage Medical Dictionary*. Boston, MA: Houghton Mifflin Co; 2008.

2. Bradley JS, Byington, CL, Shah, SS, et al. The management of community-acquired pneumonia in infants and children older than 3 months of age: Clinical practice guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. *Clinical Infectious Diseases*. 2011;53(7):e25-e76. doi:10.1093/cid/cir531.

3. Esposito S, Cohen R, Domingo JD, et al. Antibiotic therapy for pediatric community-acquired pneumonia: do we know when, what and for how long to treat?. *Pediatr Infect Dis J.* 2012;31(6):e78-e85. doi:10.1097/INF.0b013e318255dc5b.

4. Gerber J, Metijian T, Siddharth M, et al. Community acquired pneumonia clinical pathway- All settings. Children's Hospital of Philadelphia website. https://www.chop.edu/clinical-pathway/community-acquired-pneumonia-clinical-pathway-assess-patient-presence-and-severity#. Updated July 2020. Accessed August 17, 2020.

5. Harris M, Clark J, Coote N, et al. British Thoracic Society guidelines for the management of community acquired pneumonia in children: update 2011. *Thorax.* 2011;66:ii1-ii23. doi:10.1136/thoraxjnl-2011-200598.

6. Messinger AI, Kupfer O, Hurst A, Parker S. Management of pediatric community-acquired bacterial pneumonia. *Pediatrics in Review*. 2017;38(9):394-409. doi: 10.1542/pir.2016-0183.

7. Tan TQ, Mason EO, Wald ER, et al. Clinical characteristics of children with complicated pneumonia caused by Streptococcus pneumonia. *Pediatrics*. 2002;110:1-6. doi: 10.1542/peds.110.1.1.