Community Acquired Pneumonia

Clinical Practice Guideline

Pediatric CAP is most often caused by viruses. Viral etiologies are associated with:

- Preschool age (<5 years)
- Gradual onset with mixture of upper and lower respiratory symptoms
- Bilateral auscultatory findings, including wheezing
- Interstitial infiltrates

The most common bacterial etiologies for pediatric pneumonia are:
Uncomplicated: *S. pneumoniae*, *M. pneumoniae*[1]
Complicated[2]: *S. pneumoniae, S. pyogenes* (Group A Strep), S. *aureus*

Table. Overview of First-Line Treatment Recommendations

	Drug	Dose	Route	Frequency	Duration[3]
Uncomplicated, outpatient	Amoxicillin	80-100mg/kg/day	Oral	q12h	5 days
Uncomplicated, inpatient	Ampicillin	200mg/kg/day	IV	q6h	5-7 days
Uncomplicated, mechanical ventilation	Ceftriaxone	50-100mg/kg/day	IV	q12-24h	5-7 days
Complicated, non-ICU	Ceftriaxone PLUS Clindamycin	50-100mg/kg/day 40mg/kg/day	IV	q12-24h q8h	7 days from drainage of effusion. If not amenable to drainage, afebrile.
Complicated, mechanical ventilation	Ceftriaxone PLUS Vancomycin	50-100mg/kg/day 60mg/kg/day	IV	q12-24h q6h	7 days from drainage of effusion. If not amenable to drainage, afebrile.

Footnotes:
[1] No current evidence to show that antibiotic treatment improves outcomes.
[2] Complicated pneumonia = Presence of pleural effusion or empyema, pneumothorax, lung abscess, bronchopleural fistula, necrotizing pneumonia.
[3] Final duration should be based on severity illness and clinical course.

ED/Inpatient Workup

(Patients Who Are or Will Likely be Hospitalized)

Clinical Practice Guideline

Monroe Carell Jr. Children's Hospital at Vanderbilt

Box 1. **Pediatric CAP is most often caused by viruses.**
Viral etiologies are associated with:
- Preschool age (<5 years)
- Gradual onset with mixture of upper and lower respiratory symptoms
- Bilateral auscultatory findings, including wheezing
- Interstitial infiltrates

Community Acquired Pneumonia
Clinical suspicion for CAP based on age and presentation

Inclusion/Exclusion Criteria:

Inclusion Criteria:
- Age 6 months to <18 years

Exclusion Criteria:
- Tracheostomy
- Cystic Fibrosis
- Immunosuppression
- Hospitalization for any reason within the preceding 7 days

Labs and Imaging
1. ***Uncomplicated pneumonia*:** Additional lab testing (including blood cultures) not routinely recommended.

2. ***If pleural effusion***, consider ***Chest Ultrasound*** to evaluate character of effusion AND consultation with ***Pediatric Surgery*** OR ***Interventional Radiology*** for evaluation of drainage.

3. ***If pleural effusion, ICU admission OR complications***, recommend ***CBC with Diff*** AND ***C-reactive protein*** AND ***Basic Metabolic Panel*** AND ***Blood Culture***

Level of suspicion for bacterial CAP? (see Box 1)

High or unsure → Consider testing for influenza and/or other viruses seasonally if results will inform management decision (e.g. use of antivirals or antibiotics)

Low → Further Testing or Antibiotics NOT recommended

Flu Positve? — yes → **Oseltamivir** - 5 day course
- < 1 year: 3mg/kg/dose q12h
- > 1 year, < 15kg: 30mg q12h
- > 1 year, 15-23kg: 45mg q12h
- > 1 year, 23-40 kg: 60mg q12h
- > 1 year, > 40kg: 75mg q12h

no

SARS-CoV-2 Positve? — yes → Refer to COVID-19 treatment guidance

no

RSV Positive? — yes → Consider supportive care without antibiotics

no

> 1 virus positive? — yes → Consider supportive care without antibiotics

no

Mycoplasma or Chlamydophila positive? — yes → **Consider azithromycin**
10mg/kg/day on day 1
5mg/kg/day days 2-5, q24h

no

Antibiotic guidance on pp. 4-6. Duration p. 7
Send procalcitonin if considering prescribing antibiotics and low result would change management. Do not prescribe PCT < 0.25.

Outpatient Algorithm

(Patients Being Discharged from Clinic or ED)

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Level of suspicion for bacterial CAP? (see Box 1)

Low → Further Testing or Antibiotics NOT recommended

High or unsure → Atypical pathogen suspected and age ≥ 6 years?

yes → **Consider azithromycin** 10mg/kg/day on day 1 5mg/kg/day days 2-5, q24h

no → Consider testing for influenza and/ or other viruses seasonally if results will inform management decision (e.g. use of antivirals or antibiotics)

Flu Positive and/or high risk for flu-related complications[1]?

yes → **Oseltamivir** - 5 day course
- < 1 year: 3mg/kg/dose q12h
- > 1 year, < 15kg: 30mg q12h
- > 1 year, 15-23kg: 45mg q12h
- > 1 year, 23-40 kg: 60mg q12h
- > 1 year, > 40kg: 75mg q12h

no → SARS-CoV-2 Positve?

yes → Refer to COVID-19 treatment guidance

no → RSV Positive?

yes → Consider supportive care without antibiotics

no → Antibiotic guidance on page 3
Send procalcitonin if considering prescribing antibiotics and low result would change management. Do not prescribe PCT < 0.25.

[1]**High risk for flu-related complications:**
- Age <5 years
- Comorbid conditions (asthma, cardiopulmonary or neurologic)

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Outpatient Treatment
(Patient being discharged from ED or outpatient setting)

	Drug	Dose	Route	Frequency	Duration
First-line[1]	**Amoxicillin**	**80-100mg/kg/day**	**Oral**	**q12h**	**5 days**
On beta-lactam antibiotics ≥48 hours	Amoxicillin/clavulanate	80-100mg/kg/day	Oral	q12h	5 days
Concern for aspiration[2]?	Amoxicillin	80-100mg/kg/day	Oral	q12h	5 days
Concern for severe penicillin allergy (i.e. anaphylaxis)[3]	Clindamycin	40mg/kg/day	Oral	q8h	5 days

[1] If not up to date on age-appropriate immunizations against Hib/PCV, consider amoxicillin/clavulanate 80-100mg/kg/day oral q12h or cefpodoxime 10mg/kg/day oral q12h.

[2] Empiric antibiotics are not indicated after an aspiration event or for aspiration pneumonitis. Aspiration pneumonitis typically resolves within 24-48 hours. For patients who develop pneumonia following an aspiration event, anaerobic coverage is not necessary, unless lung abscess or necrosis are present. Prescribe routine pneumonia antibiotics. Target pathogens: *Streptococcus* and *Peptostreptococcus* spp.

[3] Consider delabeling protocol for patients with reported drug allergy that is not high risk (i.e. rash, family history, etc)

Inpatient Treatment
(Patient being admitted to medical unit or ICU without mechanical ventilation /shock)

	Drug	Dose	Route	Frequency	Notes
First-line (including patients with simple parapneumonic effusion)	**Ampicillin[1]**	**200mg/kg/day**	**IV**	**q6h**	Ceftriaxone if not up-to-date on age-appropriate Hib/PCV immunizations. Target pathogen: *S. pneumoniae*
On beta-lactam antibiotics ≥ 48 hours?	Ampicillin OR Ceftriaxone[1]	200mg/kg/day 50-100mg/kg/day	IV	q6h q12-24h	Consider ceftriaxone if patient was appropriately taking beta-lactam without improvement and high concern for bacteria. Most pneumonia is caused by viruses - consider additional diagnostic testing and reassess need for antibiotics.
Concern for aspiration?	Ampicillin[2]	200mg/kg/day	IV	q6h	Empiric antibiotics are not indicated after an aspiration event or for aspiration pneumonitis. Aspiration pneumonitis typically resolves within 24-48 hours. For patients who develop pneumonia following an aspiration event, anaerobic coverage is not necessary, unless lung abscess or necrosis are present. Prescribe routine pneumonia antibiotics. Target pathogens: *S. pneumoniae, Streptococcus* and *Peptostreptococcus*.
Necrotizing / complicated pneumonia and/or Concern for *S. aureus*?	Ceftriaxone[3] PLUS Clindamycin[4]	50-100mg/kg/day 40mg/kg/day	IV	q12-24h q8h	Consider *S. aureus* in patients with influenza or with necrotizing or complicated pneumonia or in severe or rapidly deteriorating patients. Consider sending nasal MRSA PCR brefore starting anti-*S.* aureus antibiotics and stop anti-*S. aureus* antibiotics if negative. Target pathogens: *S. pneumoniae, S. pyogenes* (Group A Strep), *S. aureus*
Confirmed Mycoplasma	Azithromycin	10mg/kg on day 1	Oral	q24h	No current evidence to show that antibiotic treatment improves outcomes.

IN ALL CASES: In complicated patients, consider consultation with **Pediatric Infectious Diseases** for further antibiotic recommendations.

1. If ***concern for severe cephalosporin allergy,*** treat with clindamycin (*40mg/kg/day q8h, oral or IV*)
2. If **neurologic impairment** and history supportive of significant aspiration event, consider ampicillin-sulbactam (*200mg/kg/day q6h IV*).
3. If n***ecrotizing or complicated pneumonia and concern for severe penicillin allergy***, treat with levofloxacin (*< 5 years 20mg/kg/day q12h, ≥ 5 years 10mg/kg/day q24h, oral or IV)* PLUS clindamycin (*40mg/kg/day q8h IV*)
4. Consider substituting **vancomycin** (*IV only: 60mg/kg/day q6h, dose adjust for renal function as needed*) for **clindamycin** for those with very severe CAP and/or concern for rapid clinical deterioration. Consider sending nasal MRSA PCR before starting *S. aureus* treatment and stop anti-*S. aureus* antibiotics if negative.
5. Antibiotics should be tailored to microbiology results when available.

ICU Treatment
(mechanical ventilation)

	Drug	Dose	Route	Frequency	Notes
First-line	**Ceftriaxone[1]**	**50-100mg/kg/day**	**IV**	**q12h-24h**	Target pathogen: *S. pneumoniae*
On beta-lactam antibiotics ≥ 48 hours?	Ceftriaxone[1]	50-100mg/kg/day	IV	q12-24h	
Concern for aspiration?[2]	Ceftriaxone[1]	50-100mg/kg/day	IV	q12-24h	Target pathogens: *S. pneumoniae*, *Streptococcus* and *Peptostreptococcus*.
Moderate to large pleural effusion?	Ceftriaxone[1] PLUS Clindamycin[3,4]	50-100mg/kg/day 40mg/kg/day	IV	q12-24h q8h	Target pathogens: *S. pneumoniae*, *S. pyogenes* (Group A Strep), *S. aureus*
Necrotizing / complicated pneumonia?	Ceftriaxone[1] PLUS Vancomycin[4]	50-100mg/kg/day 60mg/kg/day	IV	q12-24h q6h	Target pathogens: *S. pneumoniae*, *S. pyogenes* (Group A Strep), *S. aureus*
Shock	Ceftriaxone[1] PLUS Vancomycin[4]	50-100mg/kg/day 60mg/kg/day	IV	q12-24h q6h	Target pathogens: *S. pneumoniae*, *S. pyogenes* (Group A Strep), *S. aureus*
Concern for *S. aureus*?	Clindamycin[3, 4]	40mg/kg/day	IV	q8h	Consider *S. aureus* in patients with influenza or with necrotizing or complicated pneumonia.
Confirmed Mycoplasma	Azithromycin	10mg/kg on day 1 5mg/kg days 2-5	Oral	q24h	No current evidence to show that antibiotic treatment improves outcomes.

IN ALL CASES: Consider consultation with **Pediatric Infectious Diseases** for further antibiotic recommendations in complicated patients

1. If concern for severe cephalosporin allergy, use **levofloxacin** (*oral; <5 yr 20mg/kg/day q12h, ≥ 5 yr 10mg/kg/day q24h)*
2. Empiric antibiotics are not indicated after an aspiration event or for aspiration pneumonitis. Aspiration pneumonitis typically resolves within 24-48 hours. For patients who develop pneumonia following an aspiration event, anaerobic coverage is not necessary, unless lung abscess or necrosis are present. Prescribe routine pneumonia antibiotics.
3. Consider substituting **vancomycin** (*IV only: 60mg/kg/day q6h, dose adjust for renal function as needed*) for **clindamycin** for those with very severe CAP and/or concern for rapid clinical deterioration.
4. Consider sending nasal MRSA PCR before starting *S. aureus* treatment and stop anti-*S. aureus* antibiotics if negative.
5. Antibiotics should be tailored to microbiology results when available.

Transition to Oral Antibiotics

These recommendations can generally be applied to patients receiving first-line therapy. Antibiotics should be tailored to microbiology results when available.

Empiric Antibiotic	Suggested Oral Antibiotic
Ampicillin	**Amoxicillin** 90mg/kg/day PO div q8-12 h; max 4 grams/day
Ampicillin-sulbactam OR Ceftriaxone	**Amoxicillin-clavulanate** 45mg/kg/dose of amoxicillin component q12 h; max : 2 grams/dose of amoxicillin component
Clindamycin + Ceftriaxone	MRSA screen negative or no MRSA screen obtained and rapid improvement w/o evidence of necrotizing pneumonia and negative cultures: **Amoxicillin-clavulanate** 45mg/kg/dose of amoxicillin component q12 h; max: 2 grams/dose of amoxicillin component MRSA screen positive or no MRSA screen obtained and clinical/radiographic features consistent with staphylococcal pnemonia[1]: **Clindamycin** (if susceptible, clinically improving on this agent) 13mg/kg/dose q8 h; max 600mg/dose
Vancomycin + Ceftriaxone	MRSA screen negative or no MRSA screen obtained and rapid improvement w/o evidence of necrotizing pneumonia and negative cultures:: **Amoxicillin-clavulanate** 45mg/kg/dose of amoxicillin component q12 h; max: 2 grams/dose of amoxicillin component MRSA screen positive or no MRSA screen obtained and clinical/radiographic features consistent with staphylococcal pnemonia[1]: **Levofloxacin** ≥ 6 mos and < 5 years: 10mg/kg/dose q12h; max 375 mg/dose ≥ 5 years: 10mg/kg/dose q24h; max 750 mg/dose **AND Clindamycin** (if susceptible, clinically improving on this agent) 13mg/kg/dose q8 h; max 600mg/dose

[1]Clinical/radiographic features include: influenza or with necrotizing or complicated pneumonia

Antibiotic Duration

	Duration	Notes
Uncomplicated pneumonia	5-7 days[1]	5 days are recommended for previously healthy children who improve within 48-72 hours of antibiotic therapy; 7 day duration favored for children with underlying medical conditions or those who are slower to respond to initial therapy. Transient *S pneumoniae* bacteremia in otherwise uncomplicated pneumonia does not warrant prolonged or IV antibiotic therapy
Severe or Complicated pneumonia	7 days from drainage of effusion. If not amenable to drainage, 7 days from afebrile.[1]	**Severe** = Patients with severe respiratory failure (e.g., patients requiring invasive mechanical ventilation or high non-invasive pressures and/or FiO2>60%) that is primarily attributed to bacterial pneumonia **Complicated** = Presence of empyema, pneumothorax, lung abscess, bronchopleural fistula, necrotizing pneumonia or moderate to large pleural effusion

[1]Final duration to be based on severity of illness and clinical course. Longer durations may needed in complicated infections.