

UNC Children's Clinical Practice Guideline Pediatric Community-Acquired Pneumonia Page 1: Overview



Developed by: Zach Willis, MD, MPH, and Bill Wilson, PharmD, BCPS, Pediatric Infectious Diseases; Jennifer Fuchs, MD, Pediatric Hospital Medicine; Katherine Clement, MD, Pediatric Critical Care Medicine; Dan Park, MD, MBA, Pediatric Emergency Medicine; Charles Esther, MD, PhD, Pediatric Pulmonary Medicine; Drew Gardner, UNC Pediatric Residency Program; Michael Phillips, MD, Pediatric General Surgery; Lynn Fordham, MD, Pediatric Radiology

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- Added recommended durations to page 6

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Pages 5-7: Antibiotic and antiviral selection for CAP, including alternatives and dosing

How to use this guideline

This document provides *guidance* in management, including diagnostic evaluation, antimicrobial therapy, procedural management, and disposition, of children with community-acquired pneumonia (CAP). **It is not intended to replace clinician judgment in individual cases.** However, it should apply to the vast majority of patients diagnosed with CAP. This guideline does not address other pulmonary infections such as COVID-19, bronchiolitis, or tuberculosis.

SARS-CoV-2 Pandemic

During the SARS-CoV-2 pandemic, testing protocols to identify respiratory viruses have changed and are updated frequently to account for testing supply. Please refer to your hospital's testing guidelines for updated guidance.

Population

Inclusion criteria: children ≥ 60 days and ≤ 18 years of age with concern for community-acquired pneumonia (CAP) and treated at UNC Children's Hospital or affiliated clinics.

Exclusion criteria:

- Immunocompromised status (malignancy, autoimmune disease, primary immunodeficiency, HIV infection, bone-marrow or organ transplant recipient)
- Sickle-cell disease
- End-stage renal disease
- Severe underlying pulmonary disease (such as cystic fibrosis or oxygen requirement at home)
- Cyanotic congenital heart disease
- Neurologic or neuromuscular disease that affects respiratory function (such as cerebral palsy, cervical spinal cord injury, or muscular dystrophy)
- Presence of artificial airway, with or without need for supplemental oxygen or ventilator support
- Any condition that, in the view of the care team, significantly increases the risk of adverse outcomes of CAP

Important Distinctions

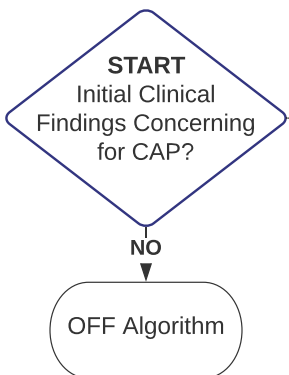
Sepsis: Sepsis is defined according to UNC Children's Sepsis Pathways. When a patient is identified as having sepsis, Sepsis Pathways take precedence over this document.

Severity of pneumonia: Definitions can be found on Page 2. Pneumonia is divided into "Mild," "Moderate," and "Severe." Most patients with mild pneumonia do not require admission to the hospital. Most patients with moderate or severe pneumonia are hospitalized.

Complications of pneumonia: These generally refer to intrathoracic complications, including significant parapneumonic pleural effusion, pleural empyema (infection within the pleural space), and intraparenchymal lung abscess.

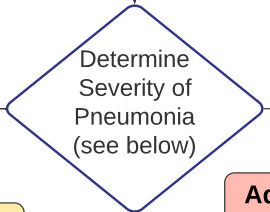
Inclusion Criteria
 - Age ≥60 days to 18 years
 - Healthy without major underlying conditions

Exclusion Criteria
 - Aspiration risk
 - Immunocompromised
 - Sickle-cell disease
 - Recent hospitalization (<30 days)
 - Underlying neuromuscular disease or lung disease other than asthma
 - Tracheostomy



Proceed with evaluation per Code Sepsis. If pneumonia considered, evaluate as recommended below under "Severe"

Please refer to institutional COVID-19 testing recommendations for the most updated testing guidance. Manage as symptomatic patients.



MILD

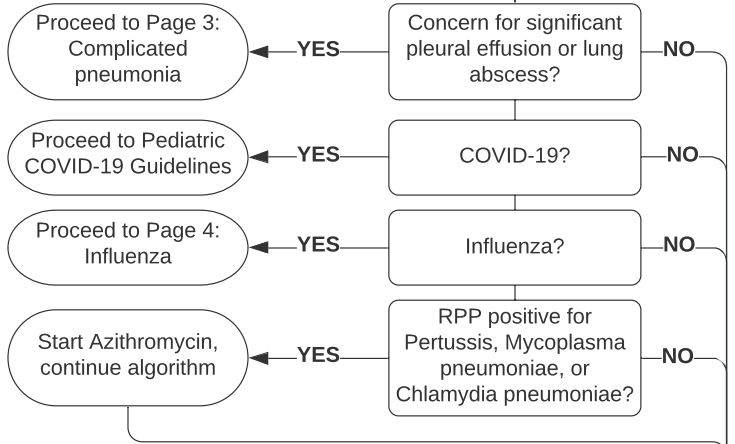
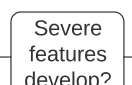
Discharge home
 -Recommended respiratory testing: Rapid PCR for flu/RSV/COVID-19
 -Start PO antibiotics (see Page 5: Antibiotic Selection)
 -Arrange follow up

MODERATE

Admit to pediatric floor
 -Recommended respiratory testing: RPP with COVID-19
 -Start IV antibiotics (see Page 5: Antibiotic Selection)
 -Obtain CXR
 -Obtain blood culture only if patient progressing to severe or complicated pneumonia

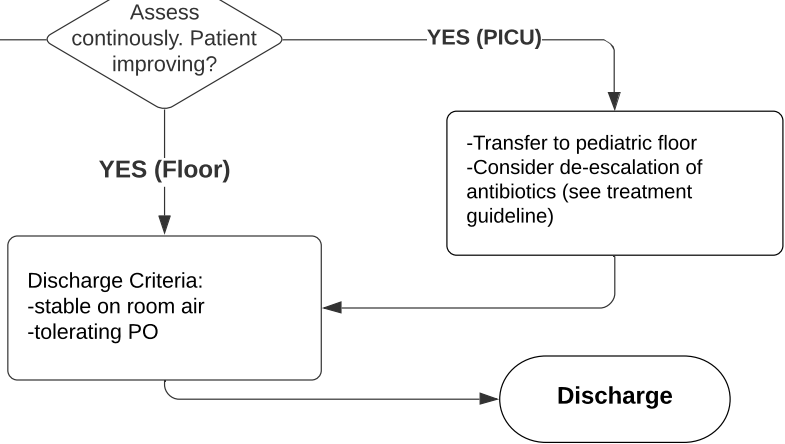
SEVERE

Admit to PICU**
 -Recommended respiratory testing: RPP with COVID-19
 -Start IV antibiotics (see treatment guideline)
 Diagnostic Tests:
 -Obtain CXR, CBC diff, BMP, blood culture
 -Respiratory culture if intubated
 Note: May go to **intermediate bed if **ONLY** severe feature is requiring HFNC. Requires approval of admitting attending.



Pneumonia Severity Assessment			
Note: if overlapping, assign more severe category			
	MILD	MODERATE	SEVERE
General Appearance	Well-appearing or mildly ill	Ill-appearing	Toxic or lethargic
Oxygen Requirement	None	Standard nasal cannula	HFNC or non-invasive or invasive ventilation
Signs of respiratory distress	None or minimal	Moderate retractions, head bobbing, and/or nasal flaring	Severe retractions, head bobbing, and/or nasal flaring
Signs of sepsis?	Absent	Absent	Present
Hydration status	Able to maintain adequate hydration	Unable to maintain adequate hydration	Unable to maintain adequate hydration

Considerations for patients who fail to improve
 -Alternative diagnosis, such as a separate infection with pulmonary manifestations
 -Antibiotic resistance
 -Development of lung abscess or empyema
 -Uncommon pathogen (e.g., Legionella, mycobacteria including TB, fungal infection such as histoplasmosis)
 -Immunocompromised state (e.g., HIV)



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Criteria for "Complicated CAP"
Community-acquired pneumonia plus any of:
-Suspicion of lung abscess
-Pleural effusion >1/4 of hemithorax
-Pleural effusion with complex fluid

START
Complicated pneumonia suspected

If not already done:
send RPP-COVID test

Please refer to institutional COVID-19 testing recommendations for the most updated testing guidance. Manage as symptomatic patients.

Concern for lung abscess? (abnormal clearance, air-fluid levels, etc.)

Moderate or large pleural effusion (>1/4 of hemithorax)

Continue treatment for uncomplicated CAP. Consider thoracentesis only if significant respiratory compromise. Re-evaluate as needed with CXR and/or US.

Evaluate with chest US. Loculations / complex fluid?

Initial Management of Necrotizing Pneumonia / Lung abscess

Labs	CBC/diff, CMP, CRP, blood culture. If intubated, send ETT aspirate for culture.
Imaging	CT chest with contrast
Consults	Pediatric Surgery, Pulmonology, ID
Antibiotics	See page 5 for details. Use oseltamivir or remdesivir for patients with influenza or COVID-19, respectively.

Initial Management of Empyema

Labs	CBC/diff, CMP, CRP, blood culture.
Consults	Pediatric Surgery, Pulmonology, ID
Antibiotics	See page 5 for details. Use oseltamivir or remdesivir for patients with influenza or COVID-19, respectively.
Imaging	Following initial US, additional imaging not routinely required. Chest CT with contrast in selected cases (e.g., to rule out lung abscess), in consultation with Pediatric Surgery.

Ongoing Management of Necrotizing Pneumonia / Lung abscess

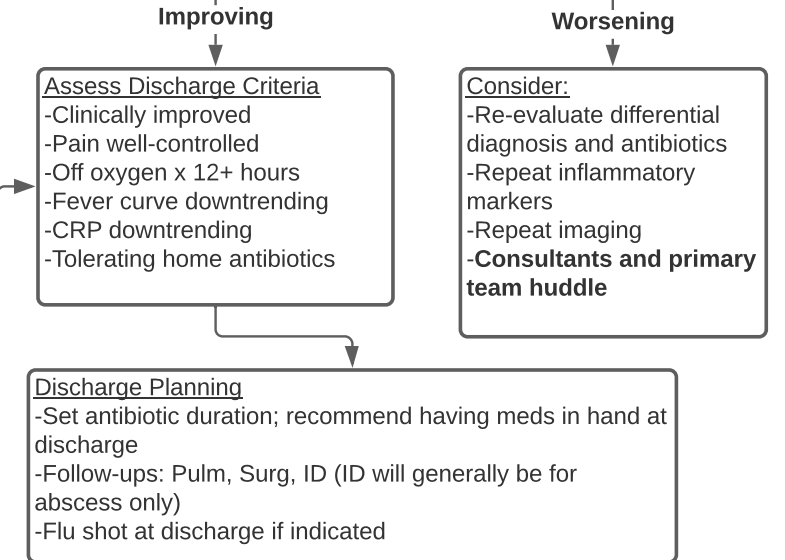
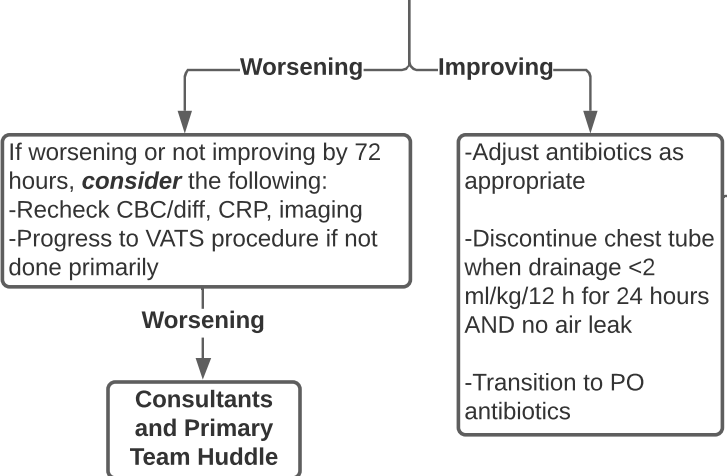
Supportive Care	Admit to ICU or floor as indicated.
Differential Diagnosis	Consider atypical causes, such as TB, infected CPAM, FB aspiration, vasculitis
Labs	As indicated; suggest monitoring every 2-3 days or more as needed.
Imaging	As indicated; repeat CT rarely indicated
Procedures	Rarely indicated due to risk of bronchopleural fistula
Antibiotics	See Page 5 for details. In most cases, prolonged antibiotic duration of 4-6 weeks, generally IV for most of inpatient course. Antivirals per protocol.

Note: Improvement is usually gradual, and some initial worsening can occur.

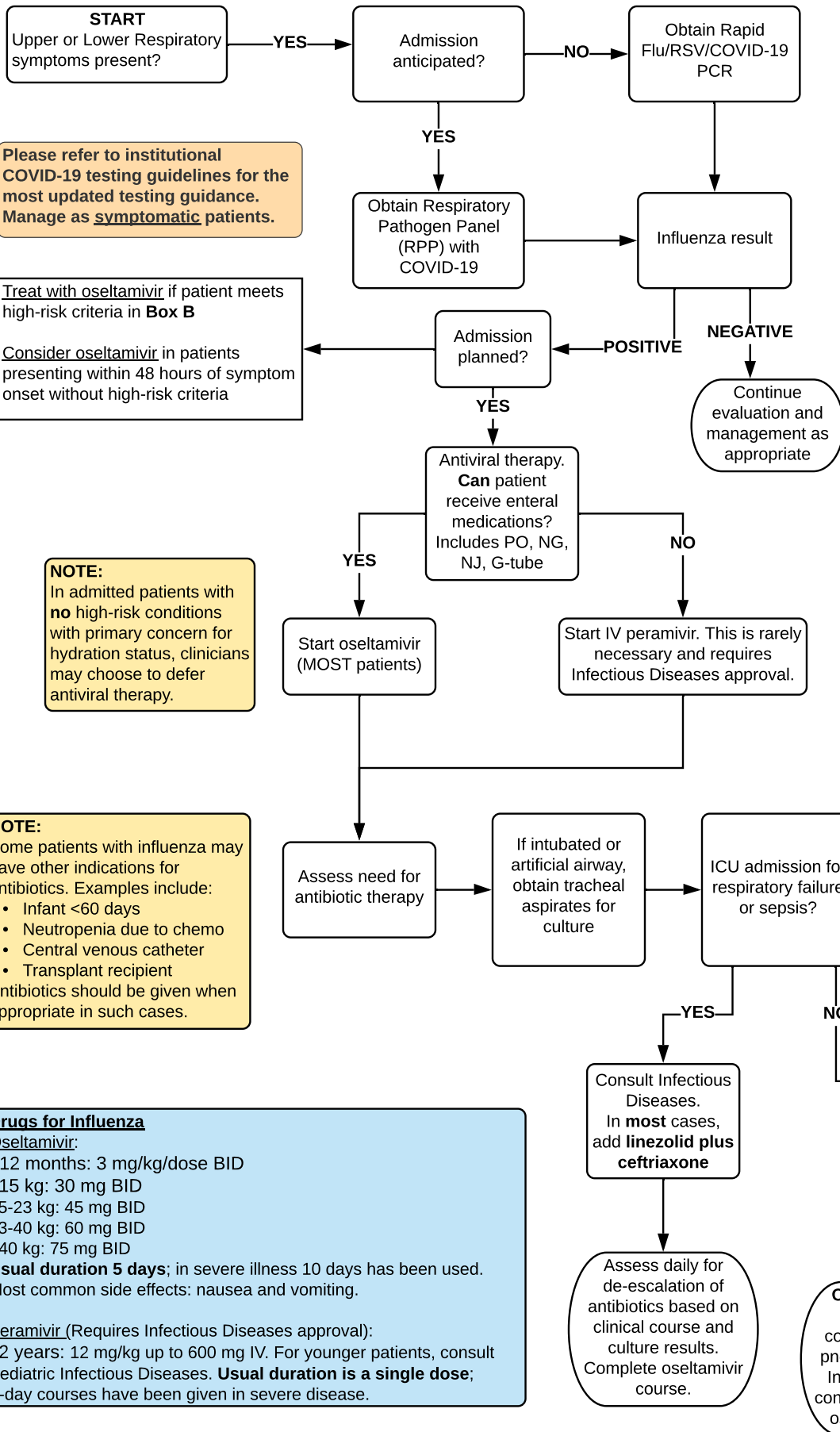
Procedural Management of Empyema

- Preferred option: chest tube to be placed by Pediatric Surgery, with or without video-assisted thoracoscopic surgery (VATS) depending on duration of symptoms.
- tPA instillation Q24 hours x 3 doses should be given after chest tube placement.

Send pleural fluid for Gram stain and culture, cell counts (AFB and fungal cultures if suspected). Optional: pH, glucose, LDH



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Box A: Influenza Season
November 15 - March 30
OR
As defined by CDC
(<https://www.cdc.gov/flu/weekly/>)
or Hospital Epidemiology

Box B: High-Risk Patients
Any of the following:

- <2 years of age
- Immunocompromised
- Pregnant
- Chronic pulmonary disease, including asthma
- Chronic cardiovascular disease (symptomatic)
- Chronic renal disease
- Chronic liver disease
- Chronic hematologic disease, such as sickle-cell disease
- Metabolic disease, including diabetes mellitus
- Neurologic/developmental conditions (epilepsy, cerebral palsy, spinal cord injury, etc.)
- Obesity (BMI > 99th %ile)

Box C: Diagnostics

Rapid COVID-19 + Influenza A/B + RSV PCR:

- Turnaround: 60 min
- Sensitivity: >99%

Respiratory Pathogen Panel + COVID:

- Turnaround: <4 hours
- Sensitivity: >99%

Note: See hospital testing guidelines for most updated preferences. Lab is unable to add RPP-COVID onto rapid test. AVOID sending rapid test followed by RPP-COVID.

Please refer to institutional COVID-19 testing guidelines for the most updated testing guidance. Manage as **symptomatic** patients.

Treat with **oseltamivir** if patient meets high-risk criteria in **Box B**

Consider **oseltamivir** in patients presenting within 48 hours of symptom onset without high-risk criteria

NOTE:
In admitted patients with **no** high-risk conditions with primary concern for hydration status, clinicians may choose to defer antiviral therapy.

NOTE:
Some patients with influenza may have other indications for antibiotics. Examples include:

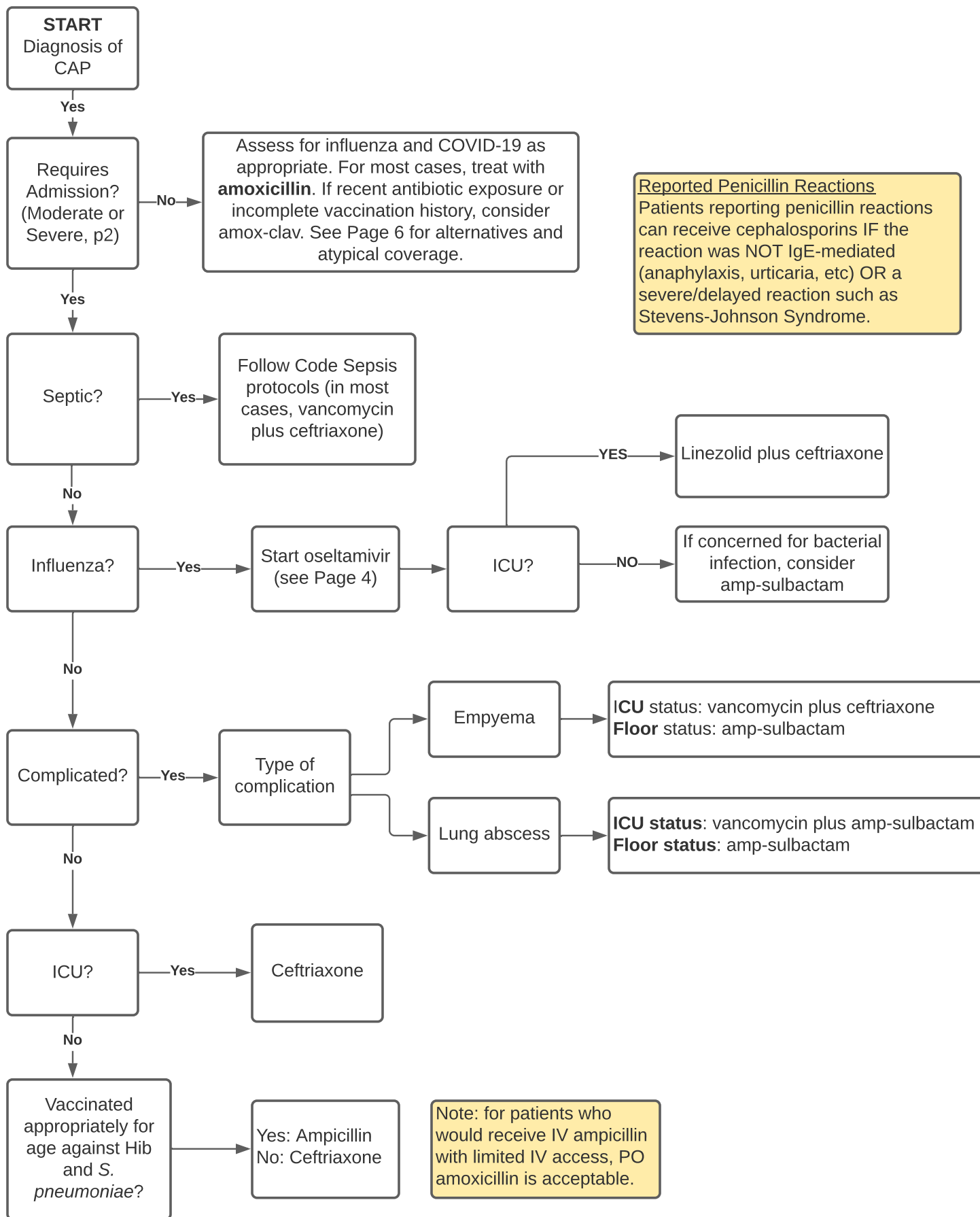
- Infant <60 days
- Neutropenia due to chemo
- Central venous catheter
- Transplant recipient

Antibiotics should be given when appropriate in such cases.

Drugs for Influenza

Oseltamivir:
<12 months: 3 mg/kg/dose BID
≤15 kg: 30 mg BID
15-23 kg: 45 mg BID
23-40 kg: 60 mg BID
>40 kg: 75 mg BID
Usual duration 5 days; in severe illness 10 days has been used.
Most common side effects: nausea and vomiting.

Peramivir (Requires Infectious Diseases approval):
≥2 years: 12 mg/kg up to 600 mg IV. For younger patients, consult Pediatric Infectious Diseases. **Usual duration is a single dose;** 5-day courses have been given in severe disease.



UNC Children's Clinical Practice Guideline
 Pediatric Community-Acquired Pneumonia
 Pages 6-7: Antibiotic Selection, De-escalation, and Dosing



Table 1: Overview of Antibiotic Selection for Children (1 month to 18 years) with CAP

Patient Characteristics		Preferred Antimicrobial	Usual Duration	Alternative Antimicrobial Therapy Options	Notes
Mild (Outpatient)	Fully immunized – at least 3 doses of Hib and PCV13, usually at 6-month visit	Amoxicillin	5 days	Recent exposure to amoxicillin (last 30 days): Amoxicillin/clavulanic acid Penicillin allergy: Clindamycin	Viruses and pneumococcus are most common causes. Oral cephalosporins are inferior to penicillins for pneumococci. Consider atypical infection in children ≥5 years of age (rare below 5 years)
	Incompletely immunized, including <6 months of age	Amoxicillin-clavulanate	≥6 months: 5 days <6 months: 7-10 days	Penicillin allergy: Clindamycin	<i>Haemophilus</i> may be more likely.
	Influenza positive, meets criteria for treatment	Oseltamivir	5 days	NA	Highest efficacy if oseltamivir started within 48 hours of symptom onset
Moderate (Inpatient, Floor)	Fully immunized (as above)	Ampicillin ADD oseltamivir if influenza positive.	≥6 months: 5 days <6 months: 7-10 days	Ceftriaxone Penicillin allergy: Clindamycin	May extend duration for ≥6 month olds up to 7-10 days if prolonged inpatient recovery.
	Not fully immunized, not meeting “Severe CAP” criteria (Table 1), ≥ 1 month old	Ceftriaxone ADD oseltamivir if influenza positive.	≥6 months: 5 days <6 months: 7-10 days	Cephalosporin allergy: Levofloxacin	Underimmunization increases the patient’s risk of infection caused by <i>Haemophilus influenzae</i> type b and <i>Streptococcus pneumoniae</i> .
	Influenza positive	Oseltamivir	5 days	If antibiotics indicated, ampicillin-sulbactam preferred	Most patients with influenza do not require antibiotics.
	Complications: empyema or lung abscess	Ampicillin-sulbactam	Empyema: 2-3 weeks Lung abscess: 4-6 weeks	Penicillin allergy: discuss with ID. Levofloxacin +/- clindamycin may be considered.	Definitive management of complicated pneumonia is individualized.
Severe (PICU)	≥ 1 month old and admitted to PICU without influenza or complications	Ceftriaxone	7-10 days	May add clindamycin or vancomycin if empiric MRSA coverage indicated (e.g., recent MRSA infection, known MRSA colonization, recent hospitalization [60 days]).	Send ETT aspirate cultures from all patients at intubation (or ASAP) Consider de-escalating anti-MRSA agents if MRSA is not identified in cultures.
	≥ 1 month old and admitted to PICU with influenza and concern for bacterial pneumonia	Linezolid PLUS ceftriaxone PLUS oseltamivir	7-10 days Oseltamivir: 5 days	Clindamycin OR vancomycin may be used in place of linezolid if patient is unable to tolerate linezolid (e.g., thrombocytopenia, multiple serotonergic drugs)	Definitive management of empyema and lung abscess is individualized.
	Admitted to PICU with complications (empyema or lung abscess)	<u>Empyema:</u> Vancomycin PLUS ceftriaxone <u>Lung abscess:</u> Vancomycin PLUS ampicillin-sulbactam	Empyema: 2-3 weeks Lung abscess: 4-6 weeks	Clindamycin OR vancomycin may be used in place of linezolid, as above.	

Table 2: IV to PO conversion/de-escalation

IV Antibiotic	Recommended PO Antibiotic	Notes
Ampicillin	High-dose amoxicillin	High-dose = 90 mg/kg/day of amoxicillin
Ampicillin-sulbactam	High-dose amoxicillin/clav	
Ceftriaxone	High-dose amox/clav Cefuroxime (preferred cephalosporin) Cefdinir	Amox/clav preferred if no penicillin allergy. Cefuroxime or cefdinir may be used in patients with penicillin allergy
Linezolid	Linezolid	In absence of positive cultures for <i>Staphylococcus aureus</i> , consider discontinuation of linezolid

Table 3: Antibiotic dosing recommendations

Antimicrobial	Dose	Max Dose	Route	Notes
Amoxicillin	90 mg/kg/day divided BID	2000 mg	PO	
Amoxicillin / clavulanic acid	90 mg/kg/day divided BID	2000 mg amoxicillin	PO	Dosing based on amoxicillin component. Recommended formulations: amoxicillin 600 mg / 42.9 mg clavulanate (14:1) (Not on inpatient formulary) amoxicillin 400 mg / 57 mg clavulanate suspension (7:1) amoxicillin 875 mg / 125 mg clavulanate tablet (7:1)
Ampicillin	200 mg/kg/day divided q6h	2000 mg	IV	
Ampicillin / sulbactam	200 mg/kg/day divided q6h	2000 mg ampicillin	IV	Dosing based on ampicillin component
Azithromycin	10 mg/kg on day 1, followed by 5 mg/kg once daily for days 2 through 5	500 mg (day 1) 250 mg (days 2-5)	IV / PO	
Cefdinir	14 mg/kg/day BID	300 mg	PO	May be used in patients with severe penicillin allergy. Not preferred due to low activity against Pneumococcus
Ceftriaxone	50 mg/kg once daily	2000 mg	IV	
Cefuroxime	30 mg/kg/day BID	500 mg	PO	Preferred cephalosporin for Pneumococcus; Suspension not on inpatient formulary, has unpleasant taste
Clindamycin	40 mg/kg/day divided TID	600 mg (IV) 450 mg (PO)	IV / PO	Doses > 450 mg may be given orally; however, GI distress may occur.
Doxycycline	2 mg/kg/dose BID	100 mg	IV / PO	
Levofloxacin	< 5 yo: 10 mg/kg BID ≥ 5 yo: 10 mg/kg daily	750 mg	IV / PO	May be used in patients with severe beta-lactam allergy (e.g., IgE-mediated reaction, anaphylaxis)
Linezolid	< 12 yo: 10 mg/kg TID ≥ 12 yo: 10 mg/kg BID	600 mg	IV / PO	
Oseltamivir	3 mg/kg/dose BID	75 mg	PO	Only use if influenza PCR test positive or if patient admitted to PICU with high concern for influenza
Vancomycin	15-20 mg/kg/dose q6-8h	2000 mg	IV	Place inpatient consult to pharmacy for vancomycin dosing & monitoring. Target troughs 15-20 mg/L.