TEXAS CHILDREN'S HOSPITAL
EVIDENCE-BASED OUTCOMES CENTER
Community-Acquired Pneumonia (CAP)
Evidence-Based Guideline

Definition: The presence of signs and symptoms of pneumonia in a previously healthy child, due to an infection of the pulmonary parenchyma that has been acquired outside of the hospital.

Etiology: The exact etiology of pneumonia is often unidentified due to the difficulty of obtaining a direct culture of infected lung tissue. Following the introduction of pneumococcal vaccine, the burden of invasive pneumococcal disease has declined. [1] Currently, mixed etiologies account for 30 to 50% of the children with community-acquired pneumonia. [2-4] *Mycoplasma pneumoniae* and *Chlamydia pneumoniae* are more common in school-age children. Viruses are most often identified in children <5 years of age, with respiratory syncytial virus (RSV) being the most common viral etiology in children <3 years of age. [5-7] In the Southwestern United States, data confirm the importance of *Streptococcus pneumoniae* and atypical pathogens *(M. pneumoniae, C. pneumoniae),* and the frequent occurrence of mixed infections in children with community-acquired pneumonia. [8] In children with parapneumonic effusion at Texas Children's Hospital, *Staphylococcus aureus* has become the most common organism actually isolated. [9]

Inclusion Criteria
- Age ≥60 days to 17 years
- Healthy without underlying conditions

Exclusion Criteria
- Aspiration
- Recent hospitalization (<7 days before the onset of illness)

Differential Diagnosis

Viral bronchiolitis	Pertussis
Tuberculosis (TB)	Foreign body

Diagnostic Evaluation: Pneumonia-related pathogens vary in incidence throughout the year but peak during January through April in the Southwestern United States. [8] Pathogens currently circulating in the local community should be considered in the diagnostic evaluation. Children with community-acquired pneumonia have a risk of progressing to septic shock.

Table 1. Vital Sign Changes of Sepsis [10]

Age	Heart Rate	Resp Rate	Systolic BP	Temp (°C)
0d - 1m	>205	>60	<60	<36 or >38
>1m - 3m	>205	>60	<70	<36 or >38
>3m - 1y	>190	>60	<70	<36 or >38.5
>1y - 2y	>190	>40	<70 + (age in yr x 2)	<36 or >38.5
>2y - 4y	>140	>40	<70 + (age in yr x 2)	<36 or >38.5
>4y - 6y	>140	>34	<70 + (age in yr x 2)	<36 or >38.5
>6y - 10y	>140	>30	<70 + (age in yr x 2)	<36 or >38.5
>10y - 13y	>100	>30	<90	<36 or >38.5
>13y	>100	>20	<90	<36 or >38.5

Table 2. Signs and Symptoms of Shock [10]

Exam Abnormalities			
	Cold Shock	**Warm Shock**	**Non-Specific**
Peripheral Pulses	Decreased or weak	Bounding	
Capillary Refill (central vs. peripheral)	≥3 sec	Flash (<1 sec)	
Skin	Mottled, cool	Flushed, ruddy, erythroderma (other than face)	Petechiae below the nipple, any purpura
Mental Status			Decreased, irritability, confusion, inappropriate crying or drowsiness, poor interaction with parents, lethargy, diminished arousability, obtunded

History: Assess for
- Age of child
- Immunization status, especially *S. pneumoniae,* pertussis, and influenza
- Exposure to tuberculosis (TB)

Physical Examination

The severity assessment of pneumonia is based on overall clinical appearance and behavior, including a child's alertness, respiratory effort, and ability to take oral fluids. A small percentage of children <5 years of age may present with abdominal pain or with fever and no signs of respiratory illness. [11] Although wheezing is more common in children with asthma, it can be a manifestation of viral or Mycoplasma pneumonia.

A complete physical examination should be performed. A combination of clinical findings, including vital signs and pulse oximetry, is most predictive in determining CAP:
- Infants <12 months: Nasal flaring, O_2 sat <96%, tachypnea (RR >50) and retractions
- Children 1 to 5 years: O_2 sat <96%, tachypnea (RR >40)
- Children >5 years: O_2 sat <96%, tachypnea (RR >30)

NOTE: O_2 sat ≤92% is a strong predictor of CAP. [12]

Evaluate the severity of symptoms using the Clinical Respiratory Score (CRS).

Clinical Respiratory Score (CRS)			
Assess	**Score 0**	**Score 1**	**Score 2**
Respiratory Rate	<2 mos: <50 2-12 mos: <40 1-5 yrs: <30 >5 yrs: <20	<2 mos: 50-60 2-12 mos: 40-50 >1-5 yrs: 30-40 >5 yrs: 20-30	<2 mos: >60 2-12 mos: >50 >1-5 yrs: >40 >5 yrs: >30
Auscultation	Good air movement, scattered expiratory wheezing, loose rales/crackles	Depressed air movement, inspiratory and expiratory wheezes or rales/crackles	Diminished or absent breath sounds, severe wheezing, or rales/crackles, or marked prolonged expiration
Use of Accessory Muscles	Mild to no use of accessory muscles, mild to no retractions, no nasal flaring on inspiration	Moderate intercostal retractions, mild to moderate use of accessory muscles, nasal flaring	Severe intercostal and substernal retractions, nasal flaring
Mental Status	Normal to mildly irritable	Irritable, agitated, restless.	Lethargic
Room Air SpO_2	>95%	90-95%	<90%
Color	Normal	Pale to normal	Cyanotic, dusky

(Add score from all rows to calculate total CRS score)

Consider the presence of parapneumonic effusion or empyema in children with pneumonia who present severely ill. Signs of pleural effusion include dyspnea, dry cough, and pain over the chest wall, exaggerated by deep breathing or coughing. Auscultatory findings may include a friction rub (leathery, rough inspiratory and expiratory breath sounds). Breath sounds may also be diminished or absent over the affected areas. [13,14]

Laboratory Tests [15-18]

Empiric antibiotic therapy should not be delayed while awaiting diagnostic test results. Laboratory tests and chest x-rays should be ordered based on clinical findings.

Routine measurement of CBC is not necessary in all children with suspected CAP; however, CBC can be helpful in deciding whether to use antibiotics or not. A CBC should be obtained in children with severe disease. [19-22] The likelihood of a bacterial cause generally increases as WBC counts increase above 15,000/mm^3. [21,23]

Blood cultures are not routinely recommended in the evaluation of uncomplicated bacterial pneumonia. [24] Obtain a blood culture only if the patient requires ICU admission or is progressing to severe or complicated pneumonia. [22,25-32]

Pending results should not delay discharge if child is being treated with appropriate antibiotics and discharge criteria has been met (see p. 3, "Discharge Criteria").

Consider molecular diagnostic tests (Flu & RSV admission panel), respiratory viral DFA, or rhinovirus PCR based on time of year and epidemiology. For more detailed information, see the Weekly Viral Epidemiology Snapshot.

Consider nasopharyngeal swab for pertussis PCR when typical symptoms are present.

PPD should be placed with history of exposure to TB including personal or family travel to TB prevalent areas.

Critical Points of Evidence*

Evidence Supports

- Administer high-dose amoxicillin for 7 days for mild severity CAP to cover *S. pneumoniae*. [22,29,30,33--54] – Strong recommendation, moderate quality evidence
  Remarks: The recommended duration of antibiotic therapy was primarily guided by the 2016 IDSA guideline on the management of hospital-acquired and ventilator-associated pneumonia in adults. This guideline recommends 7 days of antimicrobial therapy for hospital-acquired and ventilator-associated pneumonia, based on studies demonstrating equivalence between shorter and longer courses of therapy in patients with ventilator-associated pneumonia (moderate quality evidence).
- Administer ampicillin for 7 days for moderate severity CAP to cover *S. pneumoniae*. [22,29-30,33-54] – Strong recommendation, moderate quality evidence
  Remarks: The recommended duration of antibiotic therapy was primarily guided by the 2016 IDSA guideline on the management of hospital-acquired and ventilator-associated pneumonia in adults. This guideline recommends 7 days of antimicrobial therapy for hospital-acquired and ventilator-associated pneumonia, based on studies demonstrating equivalence between shorter and longer courses of therapy in patients with ventilator-associated pneumonia (moderate quality evidence).
- Treat children with small, simple effusions with ampicillin to cover *S. pneumoniae*. [22,29,30,43,45,51,52,54-56] – Strong recommendation, low quality evidence
- Administer cefTRIAXone and vancomycin for severe bacterial CAP to cover *S. pneumoniae* and *S. aureus*. [22,29,30,43,45,51,52,54-56] – Strong recommendation, low quality evidence
- Treat ill-appearing children or those with clinical deterioration with cefTRIAXone and vancomycin. [22,29,30,43,45,51,52,54-56] – Strong recommendation, low quality evidence
- Consider chest thoracostomy tube drainage with or without fibrinolytics or VATS as treatment options for complicated pleural effusion. [22,29,57-81] – Strong recommendation, moderate quality evidence

Evidence Against

- Do not routinely use macrolides. Consider adding a macrolide (e.g., 5 days of azithromycin) only if an atypical pathogen is suspected in infants ≤3 months (e.g., *Chlamydia trachomatis*) and children ≥6 years (e.g., *Mycoplasma pneumoniae*). [22,29,30,33-54] Atypical pneumonia is unlikely for the following: consolidated lobar pneumonia, necrotizing pneumonia, cavitary pneumonia, large empyema, unilateral pneumonia, infant ≤3 months without a known exposure, or child is not school-aged. Consider atypical pneumonia for the following scenarios: antibiotic failure; diffuse, bilateral, interstitial infiltrate on X-ray (if obtained); maternal history of recent *Chlamydia* infection (for infants ≤3 months). [2,22,30,63,82-84] – Weak recommendation, low quality evidence
- Do not utilize procalcitonin levels to determine whether to initiate antibiotic therapy. [22,29,30,51,53,85-92] – Strong recommendation, low quality evidence

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

Condition-Specific Elements of Clinical Management

General:
The clinical picture of children with community-acquired pneumonia (CAP) is highly variable making the determination of etiology difficult. The child's age and severity of illness are important factors to consider in diagnosing and managing this disease. (14)

Admission Criteria
- Unable to tolerate oral fluids and medications; severely dehydrated
- Moderate or severe respiratory distress
- Failed outpatient antibiotic treatment
- Altered mental status
- Oxygen saturation consistently <90%
- Unsafe to send home/poor follow-up

Discharge Criteria
- No oxygen requirement
- Tolerating PO
- Appropriate mental status for age
- Signs of clinical improvement and decreasing fever for at least 12 hours
- Appropriate support system (e.g., PCP, caregivers)

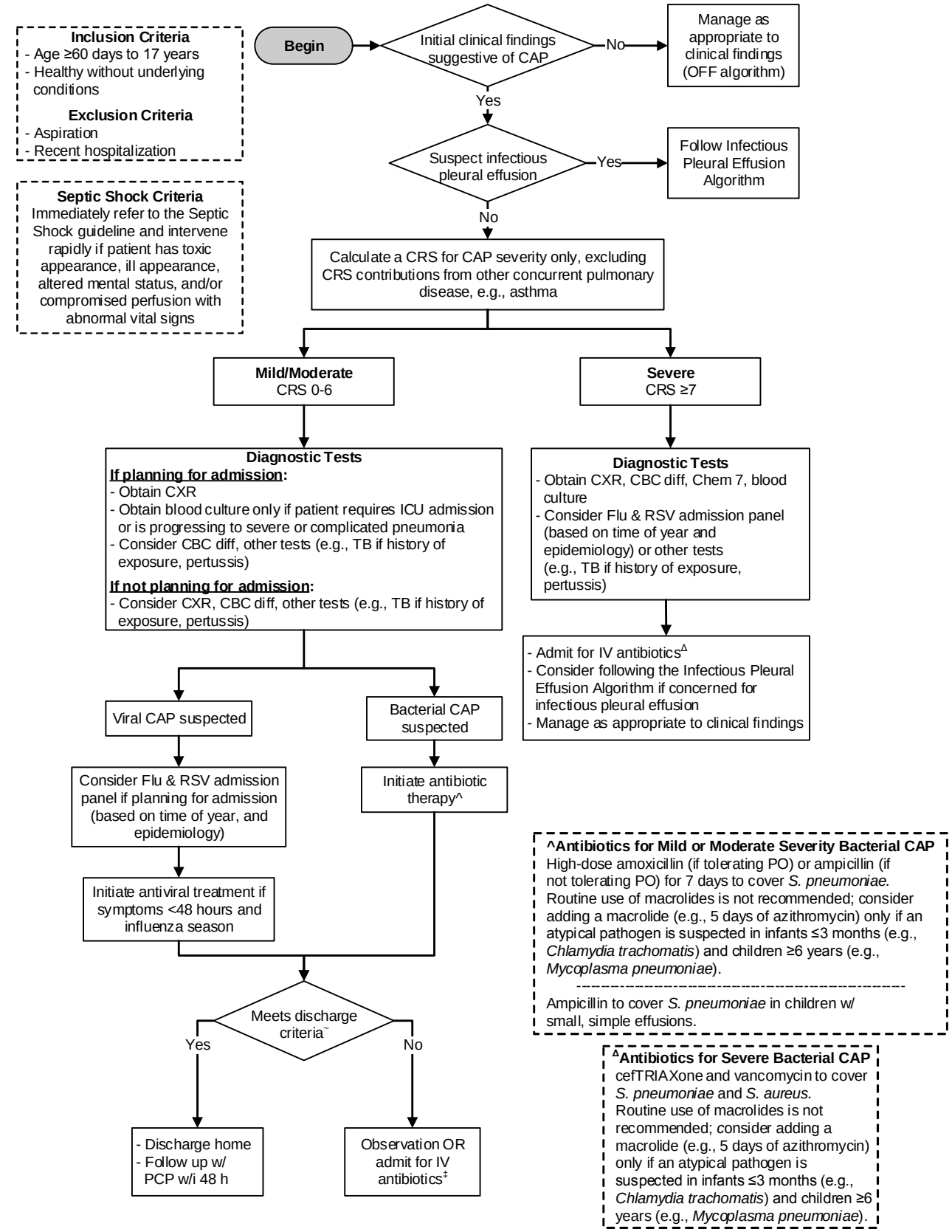
Consults/Referrals:
- Consultation with an ID specialist should be considered when allergies or prior antibiotic non-responsiveness confound the choice of therapy.
- Consultation with pulmonary, surgery, ID, and/or IR is appropriate when uncertain about management of an effusion or persistent pneumonia.

Follow-Up Care:
- Children diagnosed with CAP who are not hospitalized should follow up with their PCP within 24 to 48 hours regardless of initiating antibiotic therapy.
- Follow-up care is recommended for all children hospitalized with CAP.
- For the child who is not following the expected clinical course, consider complications, viral etiology, TB, an alternative diagnosis, or ineffective antibiotic treatment due to lack of antibiotic coverage or resistance patterns.

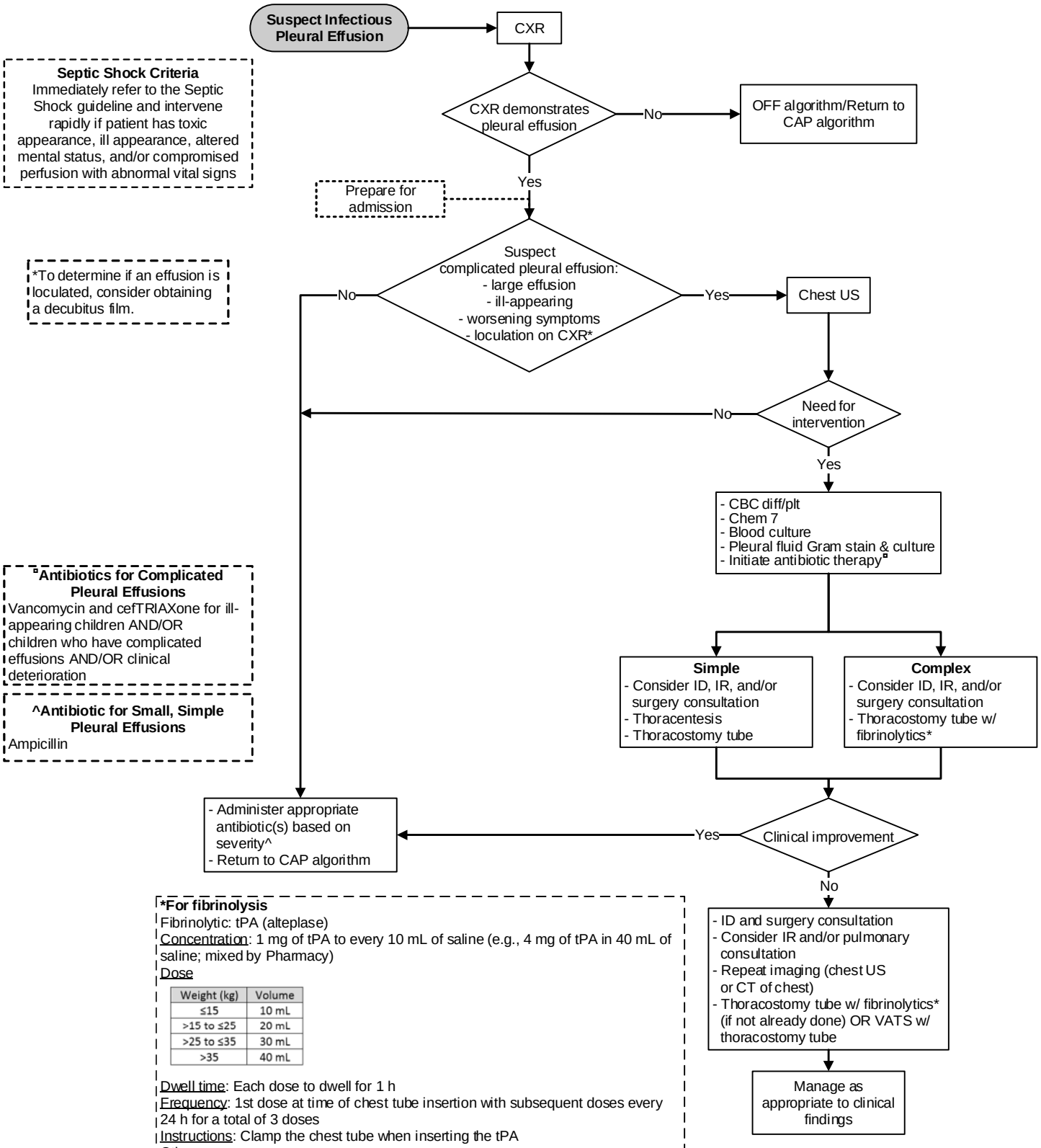
Measures
Process
- Percentage of patients on protocol
- Length of stay (inpatient, ICU)
- # of patients receiving vancomycin

Outcome
- Time to initiation of O_2 wean
- Time to O_2 wean completion
- Mortality rate
- Failure to respond to antibiotic treatment
  - Unplanned readmission within 48 hours and type of antibiotic
  - Unplanned clinic revisit within 48 hours and type of antibiotic
- Need for surgery following fibrinolytic therapy and thoracostomy tube
- Direct variable costs

TCH Evidence-Based Outcomes Center
Clinical Algorithm for Community-Acquired Pneumonia (CAP)



TCH Evidence-Based Outcomes Center
Clinical Algorithm for Infectious Pleural Effusions



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Appendix A

We did not critically evaluate the evidence for infants <60 days. In an effort to provide guidance for these children, Infectious Disease has provided the antibiotic recommendations below.

- Infants <60 days with mild severity bacterial CAP (outpatient) should be treated with high-dose amoxicillin to cover *S. pneumoniae*.
- Neonates <28 days with moderate severity bacterial CAP should initially be treated with ampicillin and gentamicin.
- Infants ≥28 days to 60 days with moderate severity bacterial CAP should be treated with ampicillin ± macrolide to cover *S. pneumoniae* and atypical pathogens.
- Infants <60 days with severe bacterial CAP should be treated with cefTRIAXone and vancomycin to cover *S. pneumoniae* and *S. aureus*.
- Do not routinely use macrolides. Consider adding a macrolide (e.g., 5 days of azithromycin) only if an atypical pathogen is suspected in infants ≤3 months (e.g., *Chlamydia trachomatis*). [22,29,30,33-54] Atypical pneumonia is unlikely for the following: consolidated lobar pneumonia, necrotizing pneumonia, cavitary pneumonia, large empyema, unilateral pneumonia, infant ≤3 months without a known exposure, or child is not school-aged. Consider atypical pneumonia for the following scenarios: antibiotic failure; diffuse, bilateral, interstitial infiltrate on X-ray (if obtained); maternal history of recent *Chlamydia* infection (for infants ≤3 months). [2,22,30,63,82-84]

Appendix B

Pneumonia Without Effusion/Empyema Pathway

	Acute Care Floor Target Length of Stay: 2.5 Days	PCU	PICU
Admission Criteria	ANY of the following: ☐ Oxygen therapy ☐ Frequent suctioning or respiratory treatments (no more frequently than every 2 hours; if every 2 hours, then can continue for at most 12 hours) ☐ Respiratory distress ☐ Need for IV antibiotics (failed outpatient oral therapy) ☐ IV fluids for inadequate oral intake	ANY of the following: ☐ CPAP or BiPAP initiation ☐ High flow oxygen that does not meet acute care criteria ☐ Moderate-severe respiratory distress ☐ Respiratory distress requiring extended frequent observation, respiratory treatments, or suctioning every 1 hour for more than 4 hours or every 2 hours for more than 12 hours ☐ Moderate-severe dehydration	ANY of the following: ☐ Impending respiratory failure ☐ Impending intubation ☐ Severe dehydration
Goals for Transfer to Lower Level of Care		☐ Decreased respiratory support (oxygen and suctioning) to meet acute care floor criteria • Off CPAP or BiPAP	☐ Decreased respiratory support to meet PCU or acute care floor criteria • Extubated
Discharge Criteria	ALL of the following: ☐ O_2 sat ≥90% without supplemental O_2 ☐ Improved work of breathing ☐ Fever curve stable or trending down (need not be afebrile) ☐ Maintaining hydration status without supplemental IV fluids ☐ Age-appropriate or baseline mental status for age		
Discharge Preparation	ALL of the following: ☐ Appropriate medication regimen prescribed and patient's ability to obtain medication confirmed ☐ Evaluate support system (caregiver, PCP, funding, etc.) and address identified needs ☐ Pending consults completed ☐ Prepare patient/caregiver for transition to self-care (transportation arrangements confirmed, care management needs met, PCP confirmed) ☐ Patient/caregiver education		

Appendix B (Continued)

Pneumonia without Effusion/Empyema Pathway

Recommendations for inpatient care:			
	Acute Care Floor **Target Length of Stay: 2.5 Days**	**PCU**	**PICU**
Assessment & Testing	• Bloodwork not routinely indicated • Repeat chest x-ray not routinely indicated	• Bloodwork not routinely indicated • Repeat chest x-ray not routinely indicated	• Mini-BAL if indicated
Consults	• Child Life consult if needed for coping techniques, procedural teaching, psychosocial support • Social Work consult if needed; Case Manager consult if home care needs identified; Financial Counselor consult if patient unfunded • For complicated pneumonia, take patient off pathway and consider Surgery, IR, ID, and/or Pulmonary consult(s)		
O_2	• Pulse oximetry per oxygen weaning protocol • Wean oxygen per oxygen weaning protocol to maintain O_2 sat ≥90%	Per PCU orders	Per PICU orders
Medications	• Antibiotics per CAP Guidelines: Use oral antibiotics unless indication for IV therapy • Pain medication per protocol • IV fluids if indicated • Additional medications as indicated	• Antibiotics per CAP Guidelines: Transition to oral antibiotics when signs of clinical improvement • Pain medication per protocol • IV fluids if indicated • Additional medications as indicated	• Antibiotics per CAP Guidelines: Transition to oral antibiotics when signs of clinical improvement • Pain medication per protocol • IV fluids if indicated • Additional medications as indicated
Other	Other orders: vital signs, ins/outs, age appropriate diet, activity as tolerated, isolation precautions if needed		

Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

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No relevant financial or intellectual conflicts to report.

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
   - PICO questions established
   - Evidence search confirmed with content experts

2. Review of Existing External Guidelines
   - Infectious Diseases Society of America and American Thoracic Society 2016; Pediatric Infectious Diseases Society and Infectious Diseases Society of America (IDSA) 2011; British Thoracic Society (BTS) 2011; World Health Organization 2014; European Association for Cardio-Thoracic Surgery 2015; Children's Hospital of Philadelphia 2012, Revised 2016; Seattle Children's Hospital 2012, Revised 2016; Cincinnati Children's Hospital 2012
3. Literature Review of Relevant Evidence
   - Searched: PubMed, Cochrane, AHRQ, CINAHL, Trip, BestBETs, AAP, BMJ Clinical Evidence, Google Scholar

4. Critically Analyze the Evidence
   - 7 meta-analyses, 12 randomized controlled trials, and 33 nonrandomized studies

5. Summarize the Evidence
   - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in a Community-Acquired Pneumonia evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.
This clinical standard 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" provides evidence to support an intervention
"Evidence Against" provides evidence against an intervention.
"Evidence Lacking/Inconclusive" indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence.*
The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	**Type of Evidence**
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the diagnosis and management of community-acquired pneumonia in children. 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 hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children's Hospital. Content Expert Teams 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 (guidelines, summaries, or pathways) 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.

Version History

Date	Comments
Oct 2008	Originally completed
Jan 2013	Updated
Aug 2018	Updated
Jan 2019	Revised the 'Vital Sign Changes of Sepsis' table