

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 usually unidentified due to the difficulty of obtaining a direct culture of infected lung tissue. Following the introduction of pneumococcal conjugate vaccine, the burden of invasive pneumococcal disease has declined. (1) In a recent report, viral pathogens were detected in most (66%) cases of community-acquired pneumonia while bacteria (8%) and bacterial-viral co-detection (7%) were found less often. Respiratory syncytial virus (RSV) and human rhinovirus (HRV) were the most commonly detected pathogens. (2-4) *Mycoplasma pneumoniae* is more common in school-age children. RSV, adenovirus (AdV), and human metapneumovirus (HMPV) were detected most often in younger children (age <5 years). (5,6)

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. (7)

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. (7) 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 (8)

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 (8)

	Sign and/or Symptom
Peripheral Pulses	Decreased or weak Bounding
Capillary refill	≥ 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, influenza, COVID-19, and RSV-mAB (Nirsevimab) when appropriate
- 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. (9) Although wheezing is more common in children with asthma, it can be a manifestation of viral or *Mycoplasma pneumoniae*.

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, O₂ sat <90%, tachypnea (RR >50) and retractions
- Children 1 to 5 years: O₂ sat <90%, tachypnea (RR >40)
- Children >5 years: O₂ sat <90%, tachypnea (RR >30)

NOTE: O₂ sat ≤92% is a strong predictor of CAP. (10)

Evaluate severity of symptoms based upon the clinical parameters below.

CAP Severity Category	Description
Mild	<ul style="list-style-type: none"> • Mild to no use of accessory muscles, retractions, or nasal flaring • SpO₂ ≥90% on room air • Non-toxic appearance
Moderate	<ul style="list-style-type: none"> • Moderate intercostal retractions, use of accessory muscles or nasal flaring • SpO₂ <90% on room air • Need for high flow nasal cannula
Severe	<ul style="list-style-type: none"> • Respiratory failure requiring non-invasive positive pressure or invasive mechanical ventilation due to bacterial pneumonia • Non-invasive mechanical ventilation with FiO₂ greater than 40% or escalating FiO₂ requirement due to bacterial pneumonia • Signs/symptoms of inadequate perfusion

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. (11,12)

Laboratory Tests (13-16)

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. (17-19) The likelihood of a bacterial cause generally increases as WBC counts increase above 15,000/mm³. (20)

Blood cultures are not routinely recommended in the evaluation of uncomplicated bacterial pneumonia. (21) Obtain a blood culture only if the patient requires ICU admission or is progressing to severe or complicated pneumonia. (19,22-28) 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 (e.g., Flu & RSV admission panel, respiratory viral panel, respiratory pathogen panel) 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

- If viral pneumonia is suspected, antibiotics are not recommended.
- If bacterial pathogens are suspected, the antibiotic selections below are recommended. (29-36)
 - Administer high-dose amoxicillin for 5 days for mild severity CAP to cover *S. pneumoniae*. – Strong recommendation with moderate quality evidence (29-36)
 - Administer ampicillin or amoxicillin for 5-to-7 days for moderate severity CAP to cover *S. pneumoniae*. – Strong recommendation with moderate quality evidence. (29-36)
 - Administer ceftriaxone to patients with moderate severity CAP that are clinically deteriorating. – Strong recommendation with moderate quality evidence (29-36)
 - Consider de-escalating ceftriaxone antibiotic coverage to ampicillin in patients with severe uncomplicated pneumonia that are clinically improving without a pathogen identified. – Weak recommendation, very low quality evidence (37-41)
 - Treat children with small, simple effusions with ampicillin to cover *S. pneumoniae*. – Strong recommendation with low quality evidence (42-45)
 - Administer ceftriaxone for patients with severe bacterial CAP. Vancomycin may be appropriate for patients with severe complicated pneumonia (i.e. empyema, moderate-to-large effusions, necrotizing pneumonia, and/or lung abscess) or in children in which *S. aureus* is suspected. – Strong recommendation, low quality evidence (42-45)
- Manage small, simple effusions on IV antibiotics. Tube thoracostomy without fibrinolytics should be utilized as first-line therapy for moderate-to-large simple effusions. Complex effusions should be treated with tube thoracostomy with fibrinolytics as first-line therapy. If patient condition deteriorates, further intervention may be needed. Consider VATS for failed first-line treatment. – Strong recommendation, moderate quality evidence (46-53)
- Consider the Bacterial Versus Viral (BV) score in situations where clinical history and imaging are inconclusive for bacterial versus viral infection. – Weak recommendation, low quality evidence (54-61)

Remarks: The Bacterial Versus Viral (BV) score was developed to differentiate between bacterial and viral infection. The score is calculated based upon circulating levels of tumor necrosis factor-related apoptosis-inducing ligand (TRAIL), interferon gamma-induced protein-10 (IP-10) and C-reactive protein (CRP). Established cutoffs for the test are score <35 indicates viral infection, score >65 indicates bacterial infection (including co-infection), and 35 ≤ score ≤ 65 is considered equivocal. (54-61)

Evidence Lacking/Inconclusive

- Consider the use of ceftriaxone in unvaccinated (two-month vaccines including *Haemophilus influenzae* type B [Hib]) children or children with confirmed penicillin allergies with mild or moderate CAP. – Consensus recommendation.

Evidence Against

- Use of antibiotics with viral pneumonia. (29-45)
- Do **not** routinely use macrolides. Macrolides (e.g., 5 days of azithromycin) should only be considered if an atypical pathogen is suspected in infants ≤3 months (e.g., *Chlamydia trachomatis*) and children ≥6 years (e.g., *Mycoplasma pneumoniae*). 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). – Strong recommendation, low quality evidence (36,62,63)
- **Remarks:** The use of macrolides as an anti-inflammatory agent for previously healthy patients or patients with asthma is discouraged.
- Do not utilize procalcitonin levels to determine whether to initiate antibiotic therapy. (65-80) – Strong recommendation, low quality evidence
- MRSA nasal PCR protocols are not recommended at this time to reduce the usage of vancomycin in children with suspected community acquired pneumonia. (81-90) – Strong recommendation, low quality evidence

Remarks: At this time, there are low rates of MRSA in the community. The ordering process for vancomycin provides an automatic stop order at 48 hours when warranted by culture results. With a current turnaround time of 24 hours for the MRSA nasal PCR lab, implementation of this test may not substantially lower the time on anti-MRSA antibiotics for our population. This recommendation should be revisited with the availability of new evidence or a change in laboratory turnaround time.

*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. ⁽¹²⁾

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
- 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

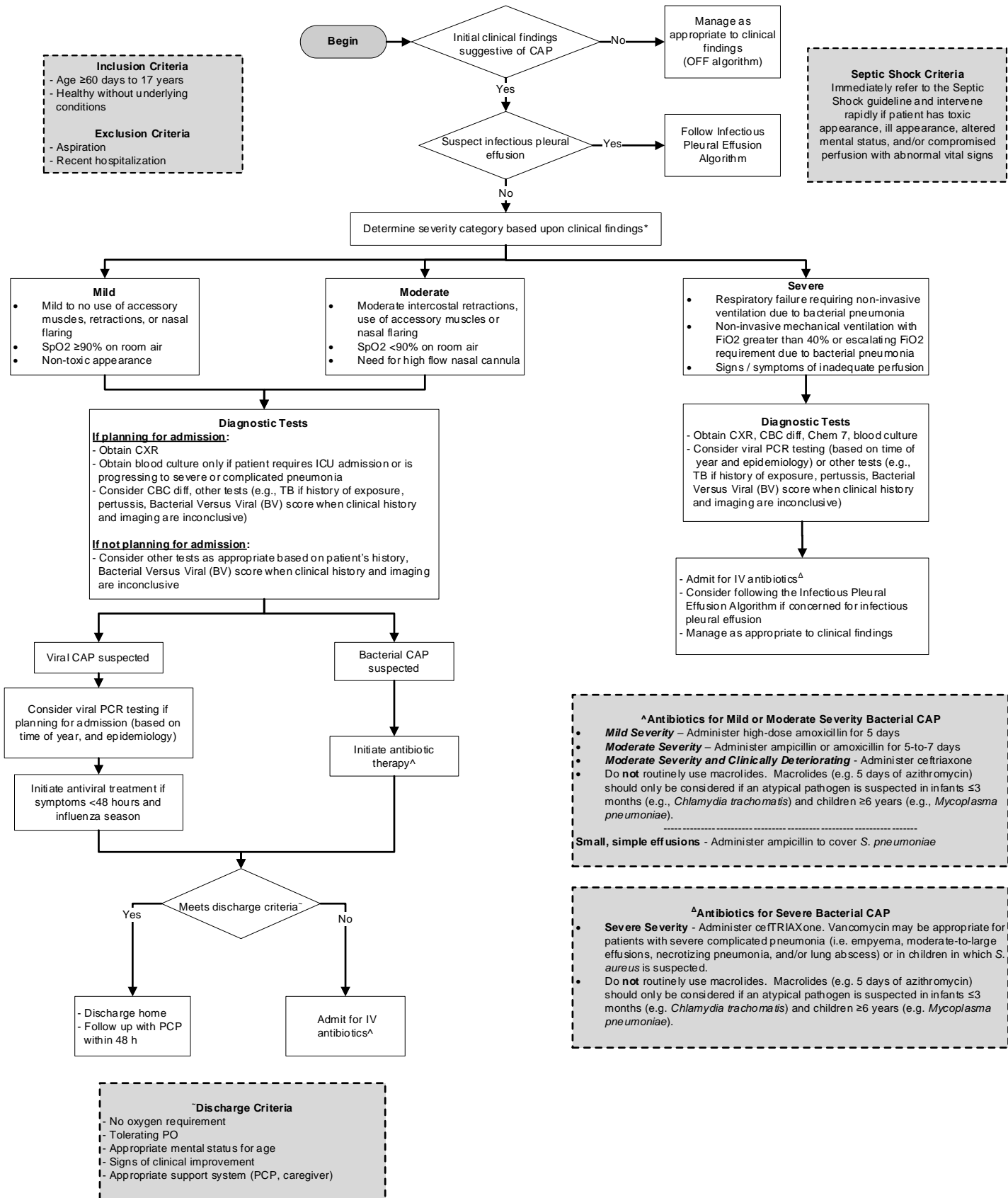
Process

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

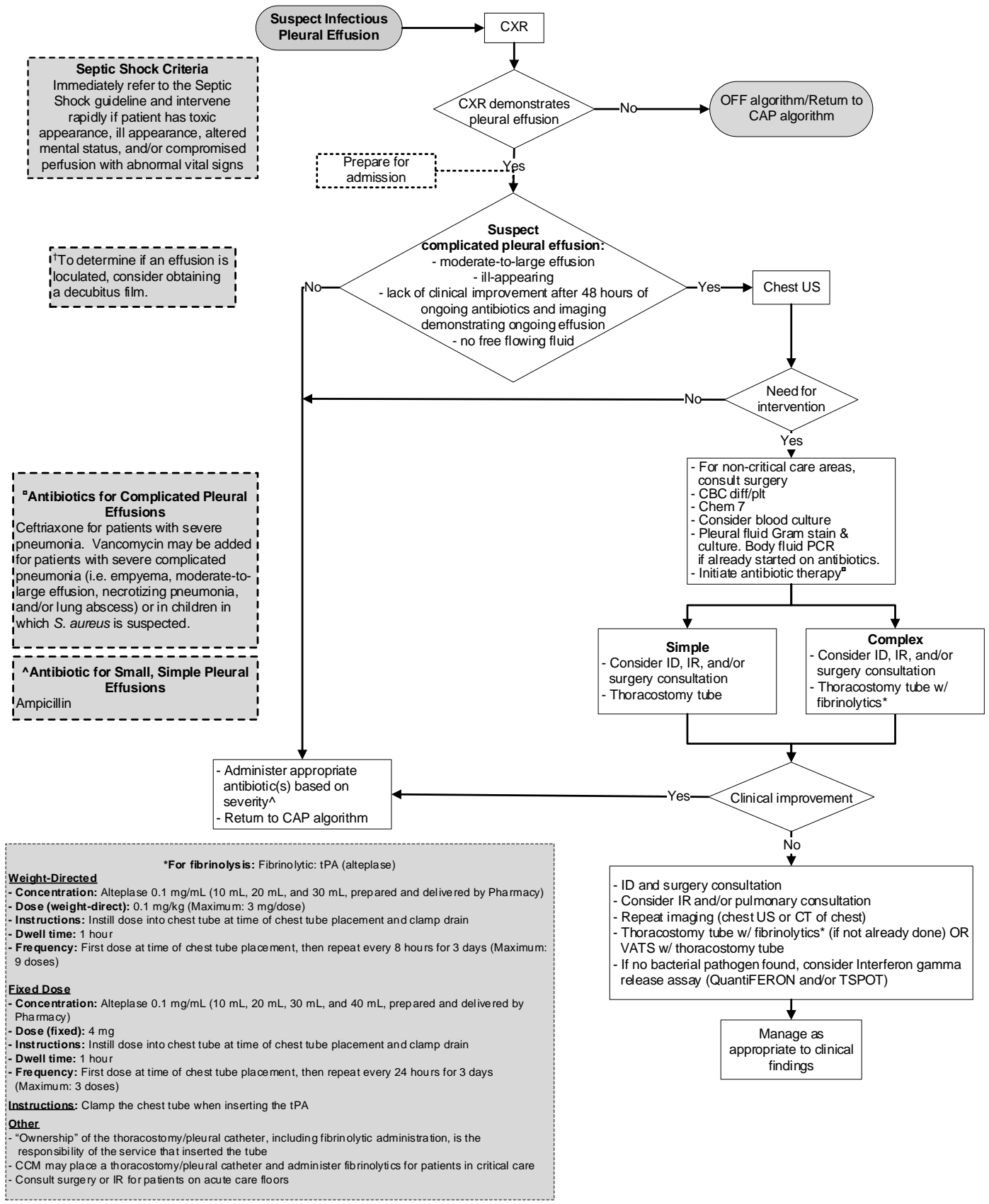
Outcome

- Time to initiation of O₂ wean
- Time to O₂ 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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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 2022; Seattle Children’s Hospital 2012, Revised 2023; Cincinnati Children’s Hospital 2012; American Thoracic Society and Infectious Disease Society of America 2019; European Association for Cardio Thoracic Surgery (EACTS) 2015; The American Association for Thoracic Surgery 2017
3. Literature Review of Relevant Evidence
 - Searched: PubMed, Cochrane, AHRQ, CINAHL, Trip, BestBETs, AAP, BMJ Clinical Evidence, Google Scholar
4. Critically Analyze the Evidence
 - 14 meta-analyses, 8 randomized controlled trials, and 37 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
Sept 2021	Revised Signs and Symptoms of Shock Table
June 2024	Guideline Update