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Clinical Knowledge Management (CKM) Council (Last Periodic Review: 05/24/2018)
**Introduction**

Hospitalizations of children with community-acquired pneumonia complicated by parapneumonic effusion and/or empyema are associated with high costs, largely attributable to prolonged length of stay\(^7\)-\(^9\) and intensive procedural management.\(^10\)-\(^12\) Clinical guidelines and recommendations released in 2011 and 2012 endorsed chest tube placement as an acceptable, less invasive, first-line procedural treatment option over video-assisted thoracoscopic surgery (VATS),\(^1\),\(^6\) which is 20\% to 35\% more costly.\(^2\),\(^3\) However, subsequent changes in practice patterns have been slow, and the management approach and care coordination for these patients remains unnecessarily variable.\(^13\)

This guideline has been developed to assist in the evaluation and management of pediatric patients requiring hospitalization for suspected community-acquired bacterial pneumonia complicated by parapneumonic effusion and/or empyema (i.e., complicated pneumonia). The recommendations include what imaging and laboratory testing to consider, when and what type of pleural drainage procedure to consider, antibiotic therapy selection and monitoring parameters.

**Scope**

**Intended User(s):** Physicians, Advanced Practice Providers, Nurses, and Pharmacists

**Objective(s):** To guide the diagnosis and management of pediatric patients requiring hospitalization for complicated pneumonia.

**Target Population:** Pediatric patients age 2 months to 18 years who present to the Emergency Department (ED), floor or intensive care unit (ICU) with suspected complicated pneumonia and who do not have one or more of the following criteria/conditions: extensive comorbidities, chronic lung disease, cystic fibrosis, immunodeficiency, concurrent chemotherapy or chronic steroid use, trauma, sickle cell disease, and/or concern for chronic aspiration.

**Clinical Questions Considered:**

- What initial and ongoing workup is necessary to diagnose and manage complicated pneumonia?
- What imaging modalities are best suited to evaluate a patient with complicated pneumonia?
- What measures (signs, symptoms, and/or results) should be considered to determine the need for drainage, response to therapy, decision for chest tube removal, and criteria for discharge?
- What is the optimal drainage modality (chest tube with or without fibrinolysis, VATS with or without decortication, thoracotomy) and who should perform the drainage procedure (IR, surgery, Intensivist) in what setting?
- What fibrinolytic and antibiotic regimens (drug, frequency, duration and route) are recommended for the initial and ongoing treatment of complicated pneumonia?
- What consultants should be involved and when in the management course?
Recommendations

Diagnosis:

- In a child with history and physical examination findings suggestive of community-acquired bacterial pneumonia complicated by a parapneumonic effusion and/or empyema (including persistent fever, cough, tachypnea, oxygen requirement, or focal exam findings), a chest radiograph (CXR - anteroposterior and lateral) should be obtained.\(^6\) (UW Health High quality evidence, strong recommendation)

- In a child requiring hospitalization for complicated pneumonia (pneumonia complicated by parapneumonic effusion and/or empyema), obtain the following (UW Health Very low quality evidence, strong recommendation):
  - Complete blood count (CBC) with differential
  - Erythrocyte sedimentation rate (ESR)
  - C-reactive protein (CRP)
  - Sputum (if cooperative, older child) or endotracheal tube aspirate for gram stain and culture
  - Blood culture: Refer to UW Health Clinical Policy 2.5.8 – Blood Cultures for Pediatric Patients for additional guidance on blood culture collection
  - If toxic appearing: Also obtain anterior nares AND oropharyngeal (throat) swabs for methicillin-resistant *Staphylococcus Aureus* (MRSA) PCR

Antibiotic Therapy:

- In a clinically-stable child requiring hospitalization for complicated pneumonia, empiric antibiotic therapy should be initiated using a second or third-generation parenteral cephalosporin (e.g., Cefuroxime 150 mg/kg/day IV divided every 8 hours to maximum of 1.5 g per dose or Ceftriaxone 100mg/kg/day IV or IM every 24 hours to maximum of 2 g per dose) to broadly cover the typical causal pathogens.\(^6\) (UW Health Moderate quality evidence, strong recommendation)

- In a toxic/ill appearing child, empiric antibiotic therapy with vancomycin (40-60 mg/kg/day IV divided every 6 hours to maximum of 2 g/dose) or linezolid (30 mg/kg/day IV or PO divided every 8 hours to maximum of 600 mg/dose) in addition to cefuroxime or ceftriaxone.\(^6\) (UW Health Moderate quality evidence, strong recommendation) Clindamycin is not routinely recommended for the treatment of suspected MRSA pneumonia given resistance patterns at this institution. (UW Health Moderate quality evidence, conditional recommendation)

- The antibiotic regimen should be modified in accordance with the child’s clinical response to therapy, blood/pleural fluid culture and 16s ribosomal test results (if applicable), and in consultation with Pediatric Infectious Disease (ID) (if applicable).\(^6\) (UW Health High quality evidence, strong recommendation)

- The duration of antibiotic treatment depends on clinical response to therapy. Consider transitioning to oral antibiotics once the patient is off supplemental oxygen, tolerating oral intake, and the chest tube is removed (if applicable). Depending on child’s response to therapy, oral antibiotic options may include Augmentin (90 mg/kg/day PO divided every 12 hours to maximum of 2 g/dose and 4 g/day), Cefpodoxime (10 mg/kg/day PO divided every 12 hours to maximum of 200 mg/dose) or Linezolid (30 mg/kg/day PO divided every 8 hours to maximum of 600 mg/dose). In most children, transitioning to oral antibiotics prior to discharge and treatment for a total course of 2-4 weeks is adequate.\(^6\) (UW Health Low quality evidence, conditional recommendation)
Imaging and Drainage of Pleural Fluid:

- A child without moderate or worsening respiratory compromise and no mediastinal shift can initially be treated with antibiotics alone. *(UW Health Low quality evidence, conditional recommendation)*

- A child with moderate or worsening respiratory compromise (including moderate tachypnea, increased work of breathing, and increasing oxygen requirement) OR mediastinal shift should have a chest ultrasound (US) to characterize pleural space disease and guide the need for pleural drainage. *(UW Health Low quality evidence, conditional recommendation)* The degree of clinical compromise has been shown to be indicative of the size of the effusion.¹,⁶

- US is the preferred imaging modality over chest CT and MRI imaging in these patients because it yields timely diagnostic information, assesses the quality of pleural fluid, identifies loculations, assists with direct drainage by Interventional Radiology (IR), and requires no sedation.¹ *(UW Health Moderate quality evidence, strong recommendation)*

- Chest CT should be reserved for complex cases involving the need for surgical planning.¹ *(UW Health Moderate quality evidence, strong recommendation)*

- If a chest US is ordered, the child should be placed NPO in anticipation of likely pleural drainage and Pediatric Surgery, and Pediatric ID should be consulted. *(UW Health Low quality evidence, conditional recommendation)* On the general care floors, IR should also be consulted. The primary team should page the IR resident (RADIOLOGY RES INTERVENTIONAL RADIOLOGY) to discuss the case and next steps. If drainage is anticipated, an order for a chest tube should be placed by the primary team (Thoracentesis W tube (IR only)). If the patient has been admitted to the Pediatric Intensive Care Unit, the patient’s primary ICU team may take responsibility both for chest tube placement and sedation.

- If a chest tube is indicated, a 12-French chest tube should be placed by IR and/or the Pediatric Intensivist. *(UW Health Moderate quality evidence, strong recommendation)* Results from 3 single-institution clinical trials²-⁴ suggest that initial chest tube placement with installation of fibrinolytics resulted in similar length of stay and treatment failure rates when compared to VATS and was 20% to 35% less costly.²,³ Larger chest tubes confer no significant advantage to smaller chest tubes when fibrinolysis is used.⁵

- IR is responsible for contacting the Pediatric Anesthesia service for coordination of sedation for chest tube placement, per anesthesia request guidelines. The Pediatric Intensive Care Unit can also be contacted for sedation services, if needed. Providers should try to minimize the number of instances the pediatric patient is sedated or undergoes general anesthesia during the encounter or admission. *(UW Health Moderate quality evidence, strong recommendation)*

Pleural Fluid Testing:

- If obtained, pleural fluid specimens should be sent to the lab for:
  - cell count to assist with differentiating bacterial from mycobacterial, fungal or malignancy etiologies *(UW Health Low quality evidence, conditional recommendation)*;
- aerobic/anaerobic culture with gram stain *(UW Health High quality evidence, strong recommendation)*;
- 16s ribosomal testing *(UW Health Moderate quality evidence, strong recommendation)*;
- Any additional pleural fluid should be held. Fluid should be sent for fungal smear and culture if gram stain is negative and cell count suggests a fungal infection.

- Further analysis of pleural fluid (e.g., pH, glucose, protein and lactate dehydrogenase) rarely changes management and is not routinely recommended in these children. *(UW Health Very Low quality evidence, conditional recommendation)*

### Fibrinolytic Installation:
- If a chest tube is placed and loculations are present on US, 3 doses of alteplase should be administered through the chest tube approximately 24 hours apart. *(UW Health High quality evidence, strong recommendation)* When loculations are present, chest tube placement with installation of fibrinolytic has been shown to be superior to chest tube drainage alone. Pediatric Surgery (not IR) is responsible for alteplase administration on the floor 7 days per week, regardless of who placed the chest tube. Alteplase may be administered by ICU staff if patient is in the PICU. Alteplase dosing is suggested at approximately 0.1 mg/kg/dose (maximum: 4 mg) mixed in 10-40mL of normal saline with a 1-hour dwell time. TPA dosing can be ordering using the Pediatric tPA order set, which is written as follows.

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>tPA Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 kg</td>
<td>1 mg in 10 mL NS</td>
</tr>
<tr>
<td>10-20 kg</td>
<td>2 mg in 20 mL NS</td>
</tr>
<tr>
<td>20-30 kg</td>
<td>3 mg in 30 mL NS</td>
</tr>
<tr>
<td>&gt; 30 kg</td>
<td>4 mg in 40 mL NS</td>
</tr>
</tbody>
</table>

### Continued Monitoring and Response to Therapy:
- Routine daily chest x-rays are not recommended before or after placement of a chest tube, or following its removal, if the child remains clinically stable. *(UW Health Low quality evidence, strong recommendation)* If clinically unstable, refer to recommendations below under Treatment Failure.

- Chest tubes should be clamped or removed under the guidance of Pediatric Surgery and/or IR for criteria such as: (1) child is responding to therapy (including improving fever curve, improving oral intake, and decreased FiO2 after 48-72 hours), (2) no intrathoracic air leak is present, and (3) chest tube drainage is less than 1 mL/kg/day calculated over the previous 12 hours. *(UW Health Very low quality evidence, conditional recommendation)*

### Treatment Failure:
- If a child experiences treatment failure (i.e., no improvement in fever curve, oral intake, or FiO2 after 48-72 hours), a CRP and chest US can be repeated and a change in antibiotic regimen and/or further laboratory evaluation should be considered in consultation with Pediatric ID. *(UW Health Low quality evidence, conditional recommendation)*

- If a child experiences failure after 72 hours of initial chest tube management, placement of a new chest tube or video-assisted thoracoscopic surgery (VATS) may be considered as second or third line therapy when ongoing respiratory compromise is
caused by a persistent pleural effusion. (*UW Health Moderate quality evidence, conditional recommendation*). This decision should be made in consultation with the IR, Pediatric Surgery and Pediatric ID.

- Consultation with Pediatric Pulmonary is recommended if necrotizing pneumonia is diagnosed or in recalcitrant cases requiring long-term follow-up. (*UW Health Very low quality evidence, conditional recommendation*)

**PICC Placement:**
- Peripherally inserted central catheter (PICC) placement for longer duration intravenous (IV) antibiotics should be reserved for severe or recalcitrant cases. (*UW Health Very low quality evidence, strong recommendation*) The decision to place a PICC must be discussed with Pediatric ID and weighed with the associated risks and benefits of placement relative to the risks and benefits of additional anesthesia (if required) and prolonged IV antibiotic therapy.

- If PICC placement is needed, attempt to coordinate placement with other procedures in order to undergo the minimal number of sedations. (*UW Health Very low quality evidence, strong recommendation*)

**Discharge Criteria:**
- Patients are eligible for discharge when they have overall clinical improvement, including a decreasing fever curve, improving PO and activity, maintaining oxygen saturations over 90% on room air, demonstration of removal of chest tube without deterioration for at least 12-24 hours, and outpatient follow up has been arranged with their primary care provider and Pediatric ID (if PICC therapy is needed). (*UW Health Low quality evidence, conditional recommendation*)

- Most children do not require any follow up imaging after discharge. (*UW Health Very low quality evidence, strong recommendation*) Exceptions may include those severe or recalcitrant cases.

**Disclaimer**
Clinical practice guidelines assist clinicians by providing a framework for the evaluation and treatment of patients. This guideline outlines the preferred approach for most patients. It is not intended to replace a clinician’s judgment or to establish a protocol for all patients. It is understood that some patients will not fit the clinical condition contemplated by a guideline and that a guideline will rarely establish the only appropriate approach to a problem.
Methodology

Development Process
Each guideline is reviewed and updated a minimum of every 3 years. All guidelines are developed using the guiding principles, standard processes, and styling outlined in the UW Health Clinical Practice Guideline Resource Guide. This includes expectations for workgroup composition and recruitment strategies, disclosure and management of conflict of interest for participating workgroup members, literature review techniques, evidence grading resources, required approval bodies, and suggestions for communication and implementation.

Methods Used to Collect the Evidence:
The following criteria were used by the guideline author(s) and workgroup members to conduct electronic database searches in the collection of evidence for review.

Literature Sources:
- Electronic database search (e.g., PubMed)
- Databases of systematic reviews (e.g., Cochrane Library)
- Hand-searching journals, external guidelines and presentations

Time Period: 1997-2018

Methods to Select the Evidence:
Empyema, pediatrics/children, English-speaking

Methods Used to Formulate the Recommendations:
The workgroup members created recommendations internally via a consensus process using discussion of the literature, other organizations guidelines and expert experience/opinion. If issues or controversies arose where consensus could not be reached, the topic was escalated appropriately per the guiding principles outlined in the UW Health Clinical Practice Guideline Resource Guide.

Methods Used to Assess the Quality of the Evidence/Strength of the Recommendations:
Internally developed recommendations, or those adopted from external sources without an assigned evidence grade, were evaluated by the guideline workgroup using an algorithm adapted from the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (see Figure 1).
Figure 1. GRADE Methodology adapted by UW Health

Rating Scheme for the Strength of the Evidence/Recommendations:

**GRADE Ranking of Evidence**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>High</td>
<td>We are confident that the effect in the study reflects the actual effect.</td>
</tr>
<tr>
<td>Moderate</td>
<td>We are quite confident that the effect in the study is close to the true effect, but it is also possible it is substantially different.</td>
</tr>
<tr>
<td>Low</td>
<td>The true effect may differ significantly from the estimate.</td>
</tr>
<tr>
<td>Very Low</td>
<td>The true effect is likely to be substantially different from the estimated effect.</td>
</tr>
</tbody>
</table>

**GRADE Ratings for Recommendations For or Against Practice**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>The net benefit of the treatment is clear, patient values and circumstances are unlikely to affect the decision.</td>
</tr>
<tr>
<td>Conditional</td>
<td>Recommendation may be conditional upon patient values and preferences, the resources available, or the setting in which the intervention will be implemented.</td>
</tr>
</tbody>
</table>

**Recognition of Potential Health Care Disparities:** Hospitalizations of children with complicated pneumonia were increasingly common but are beginning to decline. There is unnecessary variability in care of these children across hospitals. Although there may be small differences between management and outcomes for children from different racial, ethnic and socioeconomic backgrounds, the variability in care primarily centers around the different experiences and management styles of providers.
Collateral Tools & Resources

The following collateral tools and resources support staff execution and performance of the evidence-based guideline recommendations in everyday clinical practice.

Metrics
1. # of patients with Chest US vs. CT/MRI
2. # of patients with daily CXR
3. # of patients with chest tube vs. VATS
4. # of patients receiving appropriate dosing and timing of tPA after chest tube placement
5. # of patients requiring 2 or more pleural procedures
6. # of patients with appropriate antibiotic therapy choices
7. # of patients with PICC placed
8. Hospital length of stay

Clinical Practice Guidelines
1. Surgical and Interventional Radiology Antimicrobial Prophylaxis – Adult/Pediatric-Inpatient/Ambulatory
2. Antimicrobial Use Therapeutic Pearls – Adult/Pediatric-Inpatient/Ambulatory

Order Sets & Smart Sets
1. IP – Pediatric – General Care – Admission [1325]
2. IP – Venous Access Team – PICC Placement Request – Pediatric - Supplemental [1429]

Patient Resources
1. Kids Health -- Pneumonia
2. Kids Health – Blood culture
4. Kids Health – Blood test: Erythrocyte Sedimentation Rate (ESR)
5. Kids Health – Blood test: C-Reactive Protein (CRP)
6. Kids Health – Anesthesia Basics
7. Kids Health – Anesthesia – What to Expect
8. Kids Health – Preparing Your Child for Anesthesia
10. Kids Health – Word! CT Scan or CAT Scan
11. Health Facts for You #7595 – Caring for your child’s PICC
12. Health Facts for You #5093 – Understanding your Peripherally Inserted Central Catheter

Policies
1. UW Health Clinical Policy 2.5.8 (Blood cultures for pediatric patients)
2. UW Health Clinical Policy #2.3.30: Pediatric Procedural Sedation
Appendix A. Children Hospitalized for Complicated Pneumonia
Management Algorithm

Pneumonia with parapneumonic effusion or empyema identified on CXR due to a suspected community-acquired bacterial cause in a hospitalized child 2 months to 18 years of age

- Obtain labs
  - Blood culture, CBC with differential, ESR, CRP, ETT aspirate or sputum (if cooperative child) for gram stain and culture

- Start Antibiotics
  - (See dosing guidelines)
  - Well appearing: Cefuroxime or Ceftriaxone
  - Toxic appearing: Add Vancomycin or Linezolid and obtain anterior nares and oropharyngeal swabs for MRSA PCR

- Continue IV antibiotics alone

- Moderate or worsening degree of respiratory compromise or mediastinal shift?
  - No
  - Yes
    - Place patient NPO
    - Obtain chest ultrasound
    - Consult IR, Peds Surgery and ID
    - IR coordinate sedation and place 12F chest tube
    - Send pleural fluid for cell count, gram stain, bacterial culture, 16S PCR and hold
    - IR coordinate sedation and place 12F chest tube
    - Loculations?
      - No
      - Yes
        - Continue IV antibiotics
        - Administer 3 doses of alteplase 24 hours apart (See dosing guidelines)
        - Clamp and remove chest tube
        - Continue IV antibiotics
        - Loculations?
          - No
          - Yes
            - Continue IV antibiotics
            - Administer 3 doses of alteplase 24 hours apart (See dosing guidelines)
            - Clamp and remove chest tube
            - Continue IV antibiotics
  - Repeat CRP and chest ultrasound
  - Consider changing antibiotic regimen

- Responding?
  - No
  - Yes
    - Consider transition to PO antibiotics once off oxygen and tolerating PO for a total 2-4 week course

- Clamp and remove chest tube per surgery/IR recommendations

Exclusion criteria
- Age <2 months or >18 years
- Extensive co-morbidities
- Cystic Fibrosis
- Chronic Lung Disease
- Immunodeficiency
- Concurrent chemotherapy
- Chronic steroid use
- Sickle cell disease
- Trauma
- Chronic aspiration

Medication dosing guidelines
- Cefuroxime: 150 mg/kg/day IV divided every 8 hours (max: 1.5 g/dose)
- Ceftriaxone: 100 mg/kg/day IV every 24 hours (max: 2 g/dose)
- Vancomycin: 40-60 mg/kg/day IV divided every 6 hours (max: 2 g/dose)
- Linezolid: 30 mg/kg/day IV/PO divided every 8-12 hours (max: 600 mg/dose)
- Cefpodoxime: 10 mg/kg/day PO divided every 12 hours (max: 200 mg/dose)
- Augmentin: 90 mg/kg/day PO divided every 12 hours (max: 2 g/dose and 4 g/day)
- Alteplase: 0.1 mg/kg in 10-40 ml NS (max: 4 mg/dose; Pediatric tPA orderset)

Recommendations
1. Lateral decubitus films, daily CXRs and chest CTs are generally not recommended.
2. Consider pulmonary consult for patients with necrotizing pneumonia which requires long-term follow up.
3. VATS may be considered as second or third line therapy if patient fails initial chest tube management (~17%).
4. Response to therapy = Improving fever curve and PO intake and decreased FiO2 after 48-72 hours
5. Alteplase administration on the floor should be done by the peds surgery team, no matter who placed the chest tube.
6. PICC with home IV antibiotics reserved for severe or recalcitrant cases after discussion with ID.
References


