**COMPPLICATED BACTERIAL PNEUMONIA GUIDELINE**

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**Definition:**
Complicated bacterial pneumonia is defined as a pneumonic process accompanied by a parapneumonic effusion, empyema, lung abscess, or pneumatocele. Small parapneumonic effusions are commonly present in community-acquired pneumonia and often resolve with appropriate antibiotic therapy. Large or complex effusions, the presence of pus (empyema) or more rarely, development of an abscess or pneumatocele require additional interventions to limit morbidity. This guideline specifically addresses the evaluation and treatment of parapneumonic effusions and empyema. 

**Incidence:**
Community-acquired bacterial pneumonia continues to be a significant disease in infants and children, with pneumonia remaining the top reason for hospitalization in the United States. Recent evidence suggests an increase in complicated pneumonia, with an incidence of 5.5/100,000 per pneumonia hospitalization.(7) Even with the introduction of the conjugate pneumococcal vaccine and decreased burden of other serious pneumococcal infections (bacteremia, meningitis, pneumonia), rates of empyema continue to increase related to a consistent burden of pneumococcal infection and an increased rate of staphylococcal isolates.

**Etiology:**
The most common causes are *Streptococcus pneumoniae* and *Staphylococcus aureus*. To a lesser extent, complicated pneumonia is caused by *Streptococcus pyogenes*, *H. influenza* type B, and anaerobes. Mycobacterial and viral infections may be associated with the development of pleural effusions, although effusions related to these etiologies are usually small and respond well to antibiotic therapy. 

**Differential Diagnosis:**
Congestive heart failure
Malignancy
Pneumothorax
Chylothorax
Hemothorax
Congenital pulmonary airway malformation
Pulmonary sequestration

**Diagnosis:**
The diagnosis of community-acquired pneumonia can often be made by clinical and physical exam findings, with tachypnea being the clinical symptom most indicative of the diagnosis. Further symptoms, including fever, cough and diminished breath sounds or crackles on auscultation support the diagnosis. Complicated bacterial pneumonia should be considered in children who do not respond to appropriate antibiotic therapy, show clinical deterioration while on therapy, or have recurrent symptoms.

**Guideline Inclusion Criteria:**
Diagnosis of pneumonia with a parapneumonic effusion or empyema, identified via chest radiography with suspected bacterial cause in children greater than 3 months to 18 years of age.

**Guideline Exclusion Criteria:**
Children less than or equal to three months
Cystic Fibrosis
Chronic lung disease
Immunodeficiency
Children undergoing chemotherapy or chronic steroid use
Sickle Cell Disease
Trauma
Lung abscess or pneumatocele
Extensive co-morbidities

**Diagnostic Evaluation:**
History and physical examination may be suggestive of complicated bacterial pneumonia but chest radiography should be used to confirm presence of pleural effusion.

**Critical Points of Evidence**

**Evidence Supports**
Primary use of ultrasound (US) over chest Computed Tomography (CT) to evaluate quality of pleural fluid.(13-15)

Use of chest tube drainage with fibrinolitics may be as effective as Video-Assisted Thoracoscopic Surgery (VATS) in the treatment of complicated bacterial pneumonia.(19-38)
**Practice Recommendations**

**Imaging**
Chest radiography used to confirm the presence of pleural fluid and to determine parapneumonic effusion size. Repeating chest radiography should be considered in patients with worsening respiratory distress or clinical instability including increase in fever, respiratory rate, and FiO2 required. Ultrasound may not visualize worsening of pleural disease. *(Strong recommendation; Moderate quality evidence.)*

Further imaging with chest ultrasound or computed tomography should be conducted for patients with moderate (¼ to ½ hemi-thorax) or large (1/2 hemi-thorax) effusion to determine effusion characteristics, as well as for patients that show signs of deterioration or no improvement within 48-72 hours of initiation of antibiotic therapy. Ultrasound is preferred over chest computed tomography to evaluate. *(Strong recommendation; Moderate quality evidence.)*

Chest computed tomography indicated for atypical clinical or radiological features, such as parenchymal abscess.

**Laboratory Testing**
Blood cultures and complete blood cell count should be obtained in all admitted patients. *(Strong recommendation; Low quality evidence.)*

Complete blood cell count should be obtained for admitted patients with severe pneumonia, to be interpreted in the context of the clinical examination and other laboratory and imaging studies. *(Weak recommendation; Low quality evidence.)*

Acute-phase reactants may be used in conjunction with clinical findings to assess response to therapy. Declining values of CRP may correlate with improvement in clinical symptoms and has the potential to serve as an objective measure of disease resolution. *(Weak recommendation; Low quality evidence.)*

Gram stain and bacterial culture of pleural fluid should be performed whenever a pleural fluid specimen is obtained. *(Strong recommendation; High quality evidence.)*

Antigen testing or nucleic acid amplification through polymerase chain reaction (PCR) should be obtained if bacterial culture is negative; the test increases the detection of pathogens in pleural fluid and may be useful for management. *(Strong recommendation; Moderate quality evidence.)*

**Diagnosis**
An accurate and expedient diagnosis of an etiologic agent provides for informed decision making, resulting in improved care with focused antimicrobial therapy, and fewer interventions. *(Strong recommendation; Moderate quality evidence.)*

**Clinical Management**
*(for full recommendations see attached pathway and addendums)*

**Surgical Management**

**Simple effusion:**
Failure of antibiotics associated with lack of improvement in clinical signs including fever, respiratory rate, and FiO2 within 48-72 hours should be followed up with chest tube drainage with/without fibrinolytics or VATS as determined through surgical consultation and clinical judgment. *(Strong recommendation; High quality evidence.)*

**Complex effusion:**
Physician discretion should be used to determine appropriate surgical intervention; options include chest tube drainage with/without fibrinolytics and VATS. *(Strong recommendation; High quality evidence.)*

**Antibiotic Management**

- **Non-toxic appearance:** Ceftriaxone and Clindamycin
  - Allergy to Ceftriaxone: Levofloxacin and Clindamycin
  - Allergy to Clindamycin: Ceftriaxone and Vancomycin
- **Toxic Appearance:** Ceftriaxone and Vancomycin
  - Allergy to Ceftriaxone: Levofloxacin and Vancomycin
  - Allergy to Vancomycin: Ceftriaxone and Linezolid

Antibiotic therapy should be assessed if there is lack of improvement in clinical signs including fever, respiratory rate, and FiO2 within 48-72 hours.

**Laboratory Assessment:**

**Diagnostic:** (See Addendum 1 for full recommendations)
Initial tests:
- Blood Culture
- Complete Blood Count (CBC) with differential
- Basic Metabolic Panel (BMP)
- C – reactive Protein (CRP)
- Erythrocyte Sedimentation Rate (ESR)

Repeated laboratory testing is not recommended in patients with clear clinical improvement.

Repeat laboratory tests, including acute phase reactant tests, should be considered for patients that show signs of deterioration or are not responding within 48-72 hours after initiation of antibiotic therapy.
Consults/Referrals:
- Consult surgery for patients requiring a chest tube or drainage, as well as for patients that show signs of deterioration or no improvement within 48-72 hours of initiation of antibiotic therapy.
- Consult surgery for patients with moderate (¼ to ½ hemi-thorax) or large (1/2 hemi-thorax) effusion.
- Consult ID for diagnostic testing, antibiotic selection, as well as length of treatment.
- Consider Pulmonology consult for those with necrotizing pneumonias, which require long-term follow-up.

Admission Criteria
Children with moderate or large effusions or empyema should be admitted for clinical evaluation, antibiotic therapy and close observation of clinical course.

Discharge Criteria
- Documented overall clinical improvement, including level of activity, appetite, and decreased fever for at least 12-24 hours.
- Documented resolution of tachycardia and respiratory symptoms, including tachypnea and respiratory distress.
- Pulse oximetry measurements >90% in room air for at least 12-24 hours.
- Tolerant of oral antibiotics.
- Barriers to care, including monitoring and compliance with therapy at home are assessed.

Follow-Up Care
Chest radiograph one month post completion of the antibiotic course.\textsuperscript{(11-12)}

\textbf{Outcome Measures}
See Addendum 3 DCMC Complicated Bacterial Pneumonia Scorecard.

\textbf{Addendums}
1. Complicated Bacterial Pneumonia Infectious Diseases Recommendations
2. DCMC Complicated Bacterial Pneumonia SCORECARD

\textbf{Sepsis Evaluation}
Patients with a diagnosis of complicated bacterial pneumonia should have an evaluation for sepsis and SIRS. Appropriate IVF resuscitation and antibiotics should be given.
**Laboratory Assessment:**
- Blood Culture, CBC w/ differential, BMP, CRP, ESR, & Nasal PCR

**Ceftriaxone and Clindamycin**

**Effusion Size**
- Small effusion: < ¼ hemi-thorax
- Moderate effusion: ¼ to ½ hemi-thorax
- Large effusion: > 1/2 hemi-thorax

**Consult surgery & obtain Chest Ultrasound (consider repeat daily as necessary to evaluate pleural quality)**
- Option: Chest CT with contrast

**Primary Treatment:** Chest tube with fibrinolytics
**Secondary Treatment:** VATS

**Recommendations:**
1. Ultrasound preferred over Chest CT to evaluate quality of pleural fluid. (i.e. loculations)
2. Chest CT indicated for atypical clinical or radiological features. (i.e. parenchymal abscess)
3. Consider ID consult for diagnostic testing, antibiotic selection, as well as length of treatment.
4. Consider Pulmonology consult for those with necrotizing pneumonias which requires long-term follow-up.
5. Outpatient follow-up with a chest radiograph one month post completion of the antibiotic course is recommended.

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**Inclusion Criteria:**
- Chest radiograph with suspected bacterial effusion of moderate to large size, or meeting criteria for inpatient admission in children 3 months to 18 years.

**Exclusion Criteria:**
- Children less than or equal to three months
- Cystic Fibrosis
- Chronic lung disease
- Immunodeficiency
- Children undergoing chemotherapy or chronic steroid use
- Sickle Cell Disease
- Trauma
- Lung abscess or pneumatocele
- Extensive co-morbidities

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**Alert:**
Patient determined to have clinical deterioration should be managed off pathway based on clinical judgment.
- Increase in general fever pattern.
- Increase need for supplemental oxygen.
- Decline in cardiovascular status.
Antibiotic

Non-toxic appearance:
Negative Nasal PCR: Ceftriaxone
Positive Nasal PCR: Ceftriaxone and Clindamycin
  - Allergy to Ceftriaxone: Levofloxacin and Clindamycin
  - Allergy to Clindamycin: Ceftriaxone and Vancomycin

Toxic Appearance: Ceftriaxone and Vancomycin
  - Allergy to Ceftriaxone: Levofloxacin and Vancomycin
  - Allergy to Vancomycin: Ceftriaxone and Linezolid

Laboratory Test

1. Blood Culture
2. CBC with differential
3. BMP
4. CRP
5. ESR
6. Nasal PCR

If tracheal secretions obtained:
  - Gram stain and Culture
    Save extra fluid in lab for future PCR if culture is negative
    o PCR for staph aureus
    o PCR for strep pneumonia
    o PCR for mycoplasma

If Pleural Fluid obtained:
  - Gram stain and Culture
  - Cell count and differential
    Save extra fluid in lab for future PCR if culture is negative
    o PCR for staph aureus
    o PCR for strep pneumonia
    o PCR for mycoplasma

If blood cultures are negative consider:
  - nasal swab for staph aureus culture
  - nasal swab for strep pneumonia culture

Alteplase (TPA)

COMPASS Order = alteplase
  Route = intrathoracic
  Frequency = qDay
  Duration = 3
  Duration unit = day(s)
  Order Comments = Mix with xx ml of NS and instill via Chest Tube;
  Dwell time = 60 minutes; chest tube remains clamped during dwell time

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<thead>
<tr>
<th>Weight</th>
<th>Dose</th>
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<tr>
<td>Less than or equal to 10 kg</td>
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<td>Greater than 10 kg to 20 kg</td>
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<td>3 mg in 40 ml of NS</td>
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<td>Greater than 30 kg</td>
<td>4 mg in 40 ml of NS</td>
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## Addendum 2

### DCMC Complicated Bacterial Pneumonia SCORECARD

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Domain</th>
<th>Measure Definition</th>
<th>Donabedian Classification</th>
<th>IOM Domain(s)</th>
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<td>Care Process Team</td>
<td>Treatment</td>
<td>Utilization of VATS</td>
<td>Process</td>
<td>Effective, Efficient, Equitable, Safe</td>
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<tr>
<td></td>
<td></td>
<td>Utilization of chest tube drainage with fibrinolics</td>
<td>Process</td>
<td>Effective, Efficient, Equitable, Safe</td>
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<tr>
<td></td>
<td></td>
<td>Utilization of chest tube drainage without fibrinolics</td>
<td>Process</td>
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<td></td>
<td></td>
<td>Ultrasound utilization</td>
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<td>Computed Tomography utilization</td>
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<td>Efficiency in Diagnosis</td>
<td>Utilization of Laboratory tests: Blood Culture, CBC with differential, BMP, CRP, and ESR</td>
<td>Process</td>
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<td>Medication</td>
<td>Antimicrobial choice and dose</td>
<td>Process</td>
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<td>Throughput</td>
<td>Rate of VATS subsequent to non-surgical drainage</td>
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<td>Rate of readmission to hospital within 30 days</td>
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<td>Care Coordination, Effective, Efficient, Safe, Timely</td>
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<td>Average Total Cost of Care</td>
<td>Outcome</td>
<td>Effective, Efficient</td>
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References

Background & Guidelines

1. The Management of Community-Acquired Pneumonia in Infants and Children Older Than 3 Months of Age: Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America John S. Bradley, et al., IDSA, 2011
3. BTS guidelines for the management of pleural infection in children I M Balfour-Lynn, et al., Thorax 2005
5. Impact of an Evidence-Based Algorithm on Quality of Care in Pediatric Parapneumonic Effusion and Empyema Kyrie L. Shomaker, et al., Pediatric Pulmonology 2010

Imaging


Treatment/Management

Laboratory Testing

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