COMPLICATED BACTERIAL PNEUMONIA GUIDELINE

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. [1-2]

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 pyrogenes*, *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. [6]

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 fibrynolitics 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 present 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 Fi02 required. [1,8-9] 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. [1, 7-9] Ultrasound is preferred over chest computed tomography to evaluate. [9, 13-18]
(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. [38-41]
(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. [41- 45]
(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. [42-46]
(Weak recommendation; Low quality evidence.)

Gram strain 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. [47-48]
(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.[8]
(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 Fi02 within 48-72 hours should be followed up with chest tube drainage with/without fibrinolitycs or VATS as determined through surgical consultation and clinical judgment.[13-31]

Complex effusion:

Physician discretion should be used to determine appropriate surgical intervention; options include chest tube drainage with/without fibrinolytics and VATS.[13-31]
(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 Fi02 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. [11-12]

Strong recommendation; Moderate quality evidence.)

Outcome Measures

See Addendum 3 DCMC Complicated Bacterial Pneumonia Scorecard.

Addendums

1. Complicated Bacterial Pneumonia Infectious Diseases Recommendations
2. DCMC Complicated Bacterial Pneumonia SCORECARD

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.

COMPLICATED BACTERIAL PNEUMONIA CLINICAL PATHWAY
EVIDENCE BASED OUTCOME CENTER

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

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.

Laboratory Assessment:
Blood Culture, CBC w/ differential, BMP, CRP, ESR, & Nasal PCR

Toxic Appearance
- NO → **Ceftriaxone and Clindamycin**
- YES → **Ceftriaxone and Vancomycin**

Positive Nasal PCR
- NO → **Ceftriaxone** (Consider stoping coverage for MRSA)
- YES

! 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.

Early Surgical Consultation preferred in patients requiring a chest tube / drain, as well as patients not responding rapidly to medical management

Effusion Size

Small effusion:
< ¼ hemi-thorax

→ Continue IV antibiotics alone

Moderate effusion:
¼ to ½ hemi-thorax
Or
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

Responding[1]
- No → Consider Laboratory Assessments (CRP) & Antibiotic Regimen (Worsening pleural disease may not be shown via ultrasound)
- Yes → Develop plan of care for duration and mode of antibiotic therapy

Complex effusion → **Primary Treatment:** Chest tube with fibrinolytics

Secondary Treatment: VATS

Responding[1]
- NO
- YES → Develop plan of care for duration and mode of antibiotic therapy

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)
4. Consider ID consult for diagnostic testing, antibiotic selection, as well as length of treatment.
5. Consider Pulmonology consult for those with necrotizing pneumonias which requires long-term follow-up.
6. Outpatient follow-up with a chest radiograph one month post completion of the antibiotic course is recommended.

Responding
Improvement in clinical signs including fever, respiratory rate, Fi02 within 48-72 hours.
1

Lateral decubitus films not generally indicated.

For questions concerning this pathway,
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Last Updated April 28, 2020

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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
  - PCR for staph aureus
  - PCR for strep pneumonia
  - 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
  - PCR for staph aureus
  - PCR for strep pneumonia
  - 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

Less than or equal to 10 kg	1mg in 20 ml of NS
Greater than 10 kg to 20 kg	2mg in 40 ml of NS
Greater than 20 kg to 30 kg	3 mg in 40 ml of NS
Greater than 30 kg	4 mg in 40 ml of NS

Alteplase (TPA)

COMPASS Order = alteplase
Route = intrathoracic
Frequency = qDay
Duration = 3
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Order Comments = Mix with xx ml of NS and instill via Chest Tube;
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Less than or equal to 10 kg	1mg in 20 ml of NS
Greater than 10 kg to 20 kg	2mg in 40 ml of NS
Greater than 20 kg to 30 kg	3 mg in 40 ml of NS
Greater than 30 kg	4 mg in 40 ml of NS

Addendum 2

DCMC Complicated Bacterial Pneumonia SCORECARD

Type of Measure	Domain	Measure Definition	Donabedian Classification	IOM Domain(s)
Care Process Team	Treatment	Utilization of VATS	Process	Effective, Efficient, Equitable, Safe
		Utilization of chest tube drainage with fibrynolitics	Process	Effective, Efficient, Equitable, Safe
		Utilization of chest tube drainage without fibrynolitics	Process	Effective, Efficient, Equitable, Safe
		Ultrasound utilization	Process	Effective, Efficient, Equitable, Safe
		Computed Tomography utilization	Process	Effective, Efficient, Equitable, Safe
	Efficiency in Diagnosis	Utilization of Laboratory tests: Blood Culture, CBC with differential, BMP, CRP, and ESR	Process	Effective, Efficient, Equitable, Safe
	Medication	Antimicrobial choice and dose	Process	Effective, Efficient, Safe
		Rate of VATS subsequent to non-surgical drainage	Outcome	Effective, Efficient, Equitable, Safe
		Utilization of PICC line	Process	Effective, Efficient, Equitable, Safe
Avoidable Events	Hospitalizations	Rate of readmission to hospital within 30 days	Outcome	Effective, Efficient, Safe
Throughput		Average Length of Stay	Outcome	Care Coordination, Effective, Efficient, Safe, Timely
Financial		Average Total Cost of Care	Outcome	Effective, Efficient

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Background & Guidelines

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