EMPYEMA: MANAGEMENT

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- Empyema is an uncommon complication of pneumonia but it is a significant source of morbidity.
- The most frequent causative organisms include *Streptococcus pneumonia*, *Streptococcus pyogenes*, *Staphylococcus aureus* and Methicillin Resistant *Staphylococcus aureus* (MRSA).
- Empyema should be suspected in any child with pneumonia with persisting fevers despite 48 hours of intravenous (IV) antibiotics.
- Chest X-ray (AP or PA) should be performed in all children with suspected empyema. Chest ultrasound is indicated to differentiate pleural fluid from lung consolidation in suspected cases.
- There is no role for routine CT scans in the management of empyema.
- Pleural fluid sampling (diagnostic thoracocentesis) is rarely indicated or performed in children.
- 1st line antibiotic combination is IV Cefotaxime and Lincomycin or Clindamycin. 2nd line antibiotics are considered (vancomycin or linezolid) if a poor treatment response is seen.
- All inpatients diagnosed with empyema, complicating a pneumonia, requiring drainage should have their care transferred to the respiratory physician on call.
- The indication for pleural fluid evacuation is an effusion causing significant lung compression with respiratory compromise and/or persisting fever spikes. In this instance the respiratory team should be consulted. Management options include small bore percutaneous drain insertion and intrapleural urokinase instillation into the pleural cavity, or Video Assisted Thoracoscopic Surgery (VATS). The respiratory team will liaise with interventional radiology and/or thoracic surgical teams as required.

Related document:

- **Intrapleural Urokinase in Empyema Drug Protocol**: http://chw.schn.health.nsw.gov.au/o/documents/policies/drug_protocol/2015-9016.pdf

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CHANGE SUMMARY

- New SCHN guideline.
- SCH guideline "Previously Healthy Children with Empyema – Management" has been rescinded.

READ ACKNOWLEDGEMENT

- All clinical staff who may care for children with empyema should read and acknowledge they understand the contents of this guideline.

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1 Introduction

1.1 Background

- Empyema is an uncommon complication of pneumonia and represents an accumulation of infected fluid in the pleural space.
- It is a significant source of morbidity.
- British thoracic guidelines have been published in 2005 [1] and more recently local Australian guidelines were published in 2011 [2].
- These Australian guidelines were produced to address the recently reported significant variation in practice [3, 4].
- The recommendations of this protocol are largely based on the recommendations contained within the TSANZ position paper, but also incorporate local practice and experience [5].

1.2 Epidemiology

- Prevalence in children is estimated at 0.7-3.3 per 100,000 worldwide, or 0.7% of childhood pneumonias locally in Australia [6, 7].
- Increasing prevalence has been demonstrated across a number of countries
- Most frequent causative organisms include *Streptococcus pneumonia, Streptococcus pyogenes, Staphylococcus aureus and Methicillin Resistant Staphylococcus aureus (MRSA).*
- Other organisms that should be considered include *Haemophilus influenzae*, *Pseudomonas aeruginosa*, and anaerobes. *Mycoplasma pneumonia* is a rare cause of empyema, and recent data confirmed the low incidence of this organism in true empyema (<1%) [3].
- Evidence of increasing isolation of non-vaccine *S. pneumoniae* serotypes suggested in the literature since the introduction of the 7 valent pneumococcal vaccine, has been confirmed by recent local Australian and New Zealand data [3].
- There is an increasing incidence of MRSA as both a hospital and community acquired pathogen.

1.3 Definition and staging

- The presence of pus in the pleural space.
- Empyema evolves through the following stages [8]:
  - Sterile phase (termed “Exudative”)
  - Pus is present within the pleural fluid (termed “Fibrinopurulent”)
  - A final “organized” phase with thick exudate and heavy sediment (ultrasound or CT appearance or direct visualization)

1.4 Empyema should be suspected in any child with:

- Pneumonia with persisting fevers despite 48 hours of intravenous (IV) antibiotics
- This *may* be accompanied by:
  - signs of increasing respiratory distress – e.g. increased respiratory rate, increased oxygen requirement
  - changes on examination consistent with fluid collection (dullness to percussion, decreased air entry, decreased vocal and tactile fremitus) and worsening pneumonic consolidation/collapse (crepitations, bronchial breathing, dullness to percussion).

2 Investigations

2.1 Initial Investigations

1. Chest X-ray (AP or PA)
   - Should be performed in all children with suspected empyema
   - There is no role for lateral decubitus CXRs due to the availability of chest ultrasound.
2. Chest Ultrasound
   - Able to differentiate pleural fluid from lung consolidation
   - Estimates of volume of fluid are not accurate.
   - Demonstrates fibrinous septations within the pleural fluid collection which indicate a complicated effusion.
3. Blood tests (performed at baseline)
   - Blood culture.
   - FBC, CRP, EUC, LFTs, clotting studies.
   - Hypoproteinaemia (low serum albumin) is a relatively common finding but rarely requires specific treatment.
   - Secondary thrombocytosis (platelet count >500 x 10^9/L) is common but benign. Anti-platelet therapy is not required.
   - Other, rarer, complications which can occur with empyema include:
     - haemolytic uraemic syndrome with empyema caused by *S. pneumoniae.*
     - Syndrome of inappropriate ADH secretion (SIADH).
4. Sputum, where available for MC&S.

2.2 Other investigations

1. Chest CT scan
   - No role for routine CT scanning in the management of empyema [9].
   - Indicated if:
     - surgical intervention required to guide surgical approach, after consultation with the surgical team (see later section)
     - complicated pneumonia and failure to respond to further treatment to look for co-existing pathology such as abscess formation, underlying tumour etc.
2. Pleural fluid sampling (diagnostic thoracocentesis)
   - Rarely indicated or performed in children. Pleural fluid is sent at the time of pleural drain placement, if performed (see below).
3. Diagnostic bronchoscopy
   - Not indicated unless there is concern of an inhaled foreign body or unusual history.

3 Management

3.1 Managing team

- All inpatients diagnosed with empyema, complicating a pneumonia, requiring drainage should have their care transferred to the respiratory physician on call.
- In children presenting, or being transferred from another hospital, with an empyema which is likely to need drainage, admission should be under the on call Respiratory Physician. There should be early consultation with either the surgical team or the interventional radiologist on-call, depending on availability for any planned/anticipated procedure. The respiratory team will coordinate these consultations.
- Children referred from other hospitals should be transferred (preferably at an early stage) to the appropriate tertiary level paediatric centre (CHW or SCH) if:
  - Suitable investigations to clarify the presence of empyema are not available
  - An empyema is confirmed on suitable investigations and if the need for further intervention is suspected.
  - No ability to insert and manage intercostal chest catheter.

3.2 Supportive therapy

- Oxygen to maintain saturations ≥95%.
- Antipyretics.
- Adequate analgesia.

- Adequate pain relief will have beneficial effects on mobilization and chest expansion and will reduce the risk of hypoventilation-induced atelectasis complicating the speed of recovery.
- Compensatory scoliosis and shallow breathing may indicate inadequate pain control.
- Regular oral paracetamol and an NSAID if hydration is well maintained and if there are no contraindications.
- Judicious oral opioids as needed may be used with careful monitoring of sedation levels
- Consult the pain team if an ICC is inserted.

- Fluid management – The strategy used for fluid requirements should be driven by the clinical status of the child. Refer to appropriate hospital fluid management guidelines.

3.3 Antibiotic therapy

1st line: IV Cefotaxime and Lincomycin or Clindamycin

Recent data suggests a low incidence of *Mycoplasma pneumoniae* causing empyema. [3] If suspected, however a macrolide antibiotic (clarithromycin, roxithromycin or erythromycin), may be given in addition.

2nd line: consider vancomycin or linezolid if poor treatment response, defined as:

- Continuing clinical deterioration despite 1st line antibiotics
- Failure to defervesce as anticipated, taking into account the likely clinical course for the organism isolated.
- These cases should be discussed with Infectious Diseases and Microbiology services

- Antibiotic therapy should be adjusted when identification of the infecting organism and its sensitivities are confirmed by the laboratory.
- Antibiotic therapy should cover the most commonly encountered organisms. In a recent Australian-based study these were *Streptococcus pneumoniae, Streptococcus pyogenes, Staphylococcus aureus and MRSA* [3].
- Risk factors for MRSA infection include
  - Aboriginal or Torres Strait Islander ethnicity
  - previous history of skin lesions (e.g. boils)
- Rationalise IV antibiotic choice based on culture isolates and sensitivity patterns as they become available
- Convert to oral antibiotics once afebrile for 24 – 48 hours
- Oral antibiotics should be given for 1-3 weeks in total. If a macrolide is given, then it should be given for 10 days in total, from the date of commencement.

3.4 Indication for evacuation of pleural fluid

- The indication for pleural fluid evacuation is:
  - An effusion causing significant lung compression with respiratory compromise and/or persisting fever spikes.
  - Defining exact criteria for intervention is challenging, but the merits of intervention on all pleural effusions with a rim of fluid >2cm on ultrasound examination should be carefully considered.
  - The decision is made on a case by case basis by the respiratory team in consultation with interventional radiology and thoracic surgery (based on availability).
- In smaller pleural effusions with minimal respiratory impact, evacuation may be of minimal clinical benefit and should be avoided.
- Evacuation may be indicated for diagnostic or therapeutic purposes if defervescence does not occur despite prolonged, either anticipated or culture determined, appropriate IV antibiotics.

3.5 Recommended treatment options for evacuation

1. Small bore percutaneous drain insertion and intrapleural urokinase instillation into the pleural cavity
   - Small bore percutaneous ICC inserted by interventional radiology or general surgery using ultrasound guidance under general anaesthetic.
     - Evidence suggests that small bore drains (8-12F) are just as effective as large bore and are more comfortable, less invasive and encourage better mobilization and coughing. This is associated with a better recovery and shorter hospital admissions.
   - A CXR should be performed after ICC insertion.
   - The ICC should be clamped for one hour after the first 10 mL/kg is drained to reduce the risk of re-expansion pulmonary oedema [10].
2. Video Assisted Thoracoscopic Surgery (VATS)
   - VATS may be considered as the preferred initial therapy if
     - dense fibrinous septations visible at empyema diagnosis which are deemed unlikely to respond to ICC drainage and intrapleural urokinase therapy (note: based on anecdotal evidence alone, as empyema staging has not been shown to affect outcome) [9].
   - It should also be considered as 2nd line evacuation therapy if there is significant effusion with evidence of mass effect causing persisting or worsening significant respiratory compromise and/or fever *despite* ICC drainage, IV antibiotics and intrapleural urokinase therapy.
   - If VATS is being considered the case should be directly discussed with the on-call surgeon.
   - A CT chest is not routinely recommended in this situation.
   - A 10% failure rate with ICC and fibrinolytics is reported in the literature [11].

3.6 Additional points to consider

1. *Pleural fluid sampling at the time of evacuation*
   - Pleural fluid should be sent for
     - cytology
     - MC&S including smear and culture for Acid Fast Bacilli (AFB) and TB PCR and TB culture if *Mycobacterium tuberculosis* is suspected.
     - LDH, albumin.
     - *Streptococcus pneumonia* PCR
2. *Long line insertion*
   - All children with empyema having a general anaesthetic should have a long line inserted at the same time.
3. *Patient or Nurse Controlled Analgesia (PCA or NCA, respectively).*

   Pain may arise due to the pneumonic process, having an ICC in situ, or due to the administration of urokinase into the pleural cavity via the ICC.
   - Pain team consult and PCA/NCA in all children where an ICC is left in situ.
   - This should be continued for the duration that the percutaneous drain is in situ.
   - Following ICC insertion a PCA/NCA should be started in the recovery room or failing that shortly after arrival back on the ward.
4. *Physiotherapy*
   - The only role of physiotherapy is for:
     - early mobilization
     - encouragement of deep breathing and coughing to aid resolution/prevention of atelectasis and/or consolidation.
   - Chest-directed physiotherapy should not be performed in the following situations:
     - Prior to evacuation of pleural fluid.
     - Radiological evidence of necrotizing pneumonia.
     - Bronchopulmonary fistula.

3.7 Urokinase administration

Refer to **Intrapleural Urokinase in Empyema Drug Protocol**:
http://chw.schn.health.nsw.gov.au/o/documents/policies/drug_protocol/2015-9016.pdf

4 Ongoing management of Percutaneous ICC and ICC removal

- All ICC should be connected to an uni-directional flow drainage system (e.g. underwater seal bottle) which must be kept below the level of the child's chest at all times.
- Once urokinase administration course has finished, twice daily flushes of normal saline 10mL should commence and continue until the ICC is removed.
  - 10mL should be administered as 5mL up from the 3 way tap, 5mL down from the 3 way tap.
- Consider removal once pleural fluid output falls to below 1-2mL/kg/day.
  - Ensure that the ICC is not blocked.
- A period of clamping prior to removal is not recommended.
- Refer to SCHN Chest Drain Practice Guideline for details of removal technique.
- Consider earlier removal if evidence of pneumatocoele or necrotic pneumonia near to chest drain tip to minimise the associated risk of bronchopulmonary fistula formation.
- A chest x-ray is not routinely required following ICC removal if the child remains clinically stable.
- Once ICC is removed, mobilization and exercise is recommended.

5 Discharge and further management

- Discharge is appropriate once tolerating oral antibiotics for a 24 hour period without re-emergence of fever.
- To complete 1-3 weeks of antibiotics, including IV antibiotic course administered in hospital.
- Review in respiratory clinic at 4 weeks post discharge. The CXR may not return to baseline for 4-6 months. For regional and rural patients, in most cases, this follow up can be performed through their local paediatrician.
- The child should be followed in the outpatient clinic until they have recovered completely and the CXR has returned to near normal.

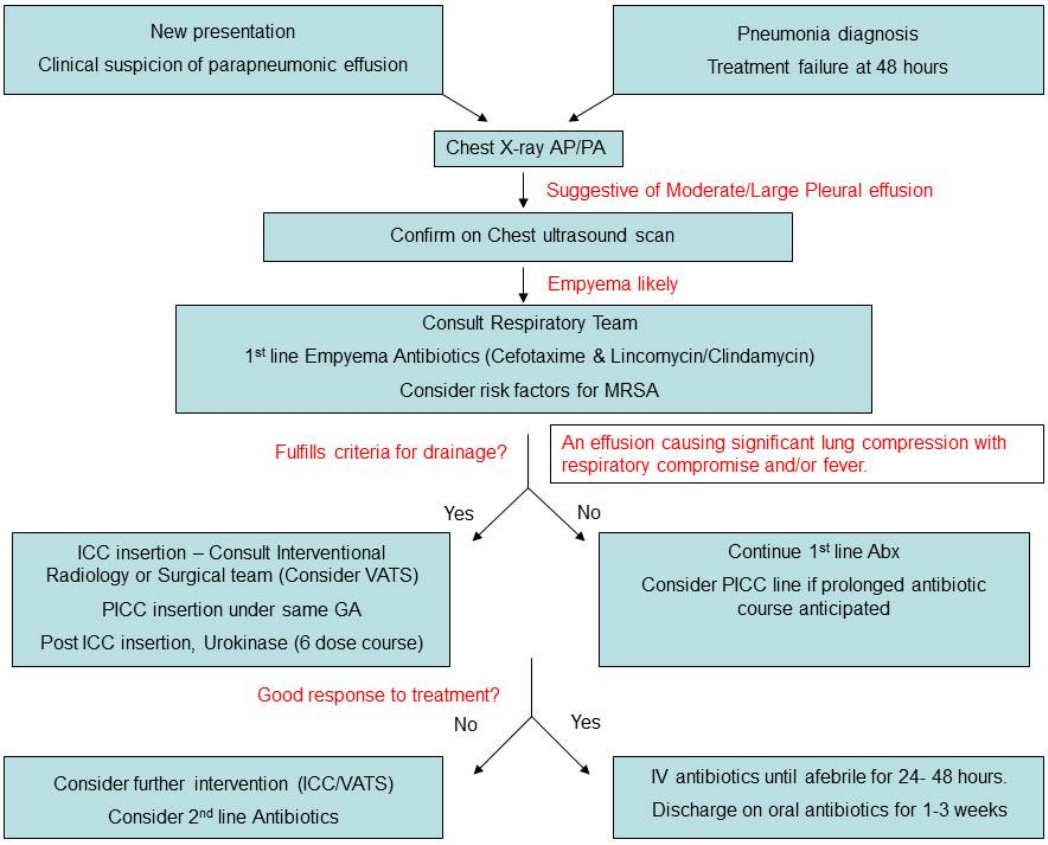
6 Further Pneumococcal vaccine booster dose

- There are over 90 different serotypes of pneumococcus, and vaccines only cover against a selection of the commonly encountered serotypes.
- Vaccinations commonly used in NSW are:

- 7-valent pneumococcal conjugate vaccine *(Prevenar 7)(this* is no longer available, having been replaced in 2011 by *Prevenar 13* made by the same manufacturer): covers serotypes 4, 6B, 9V, 14, 18C, 19F & 23F
- 13-valent pneumococcal conjugate vaccine *(Prevenar 13)*: additionally covers 1, 3, 5, 6A, 7F, and 19A
- 23-valent polysaccharide Pneumovax vaccine: additional covers 2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20, 22F and 33F but does not cover 6A.

- At present use of booster doses are not recommended following empyema in either national or international guidelines, nor is there data to suggest the risk of empyema recurrence is sufficient to warrant this.
- All pneumococcal isolates from culture-positive cases of invasive disease are routinely sent for serotype identification for public health purposes. The results are usually available after one month.

7 Flowchart for Empyema Management



8 References

1. Balfour-Lynn IM, Abrahamson E, Cohen G, Hartley J, King S, Parikh D, Spencer D, Thomson AH, Urquhart D: Bts guidelines for the management of pleural infection in children. Thorax 2005;60 Suppl 1:i1-21.
2. Strachan RE, Jaffe A: Recommendations for managing paediatric empyema thoracis. Med J Aust 2011;195:95.
3. Strachan RE, Cornelius A, Gilbert GL, Gulliver T, Martin A, McDonald T, Nixon GM, Roseby R, Ranganathan S, Selvadurai H, Smith G, Soto-Martinez M, Suresh S, Teoh L, Thapa K, Wainwright CE, Jaffe A: Bacterial causes of empyema in children, australia, 2007-2009. Emerg Infect Dis 2011;17:1839-1845.
4. Strachan RE, Cornelius A, Gilbert GL, Gulliver T, Martin A, McDonald T, Nixon GM, Roseby R, Ranganathan S, Selvadurai H, Smith G, Soto-Martinez M, Suresh S, Teoh L, Thapa K, Wainwright CE, Jaffe A: A bedside assay to detect streptococcus pneumoniae in children with empyema. Pediatr Pulmonol 2011;46:179-183.
5. van Loo A, van Loo E, Selvadurai H, Cooper P, Van Asperen P, Fitzgerald DA: Intrapleural urokinase versus surgical management of childhood empyema. J Paediatr Child Health 2010
6. Strachan R, Jaffe A: Assessment of the burden of paediatric empyema in australia. J Paediatr Child Health 2009;45:431-436.
7. Jaffe A, Balfour-Lynn IM: Management of empyema in children. Pediatr Pulmonol 2005;40:148-156.
8. Society AT: Management of nontuberculous empyema. . Ann Rev RespirDis 1962;85:935-936.
9. Jaffe A, Calder AD, Owens CM, Stanojevic S, Sonnappa S: Role of routine computed tomography in paediatric pleural empyema. Thorax 2008;63:897-902.
10. Kasmani R, Irani F, Okoli K, Mahajan V: Re-expansion pulmonary edema following thoracentesis. Cmaj 2010;182:2000-2002.
11. Avansino JR, Goldman B, Sawin RS, Flum DR: Primary operative versus nonoperative therapy for pediatric empyema: A meta-analysis. Pediatrics 2005;115:1652-1659.