# EMPYEMA

## Introduction

These guidelines may not be appropriate for neonates, the immunocompromised child or a child with chronic lung disease (e.g. cystic fibrosis, bronchiectasis, neonatal chronic lung disease).

Empyema refers to the presence of pus within the pleural space, most often in association with an underlying pneumonia, and may result in sepsis and impaired respiratory function. Compared with community acquired pneumonia, empyema is associated with higher morbidity, longer hospitalization, longer duration of antibiotic therapy, and often requires invasive intervention. While the prognosis in appropriately treated children is very good, with complete recovery and restoration of normal lung function, care is potentially complex and requires close attention to detail.

Empyema has a reported incidence of 1-4 per 100,000 children worldwide and occurs as a complication in 0.6-3% of hospitalised patients with pneumonia. A rapid increase in incidence has been reported since the 1990s in Australia, the USA, the UK and Canada.

It develops in a continuum however three stages are described:

- **Exudative** – a simple parapneumonic effusion arising from inflamed pleura.
- **Fibrinopurulent** – frank pus and fibrin deposition within the pleural space leads to septation and loculation (complicated parapneumonic effusion / empyema).
- **Organised** – fibroblast infiltration leads to the formation of a thick non-elastic peel.

![While this guideline focuses on the empyema, underlying pneumonia may be an as or more important part of the child's illness. Where progress is poor, fever persists or respiratory function is severely compromised, consider the role of the pneumonia as well as the empyema.](image)

Readers are referred to the British Thoracic Society Guideline and Thoracic Society of Australia and New Zealand position statement for further detail (see references below).
**EMPYEMA**

**Starship Services:**
Children with empyema will have a clearly nominated care team throughout their admission as per Starship Responsibility of Care Guideline.

**Admitting team:**
Most children admitted via Starship Children’s Emergency Department with known or suspected empyema will come under General Paediatrics. Those with known or suspected relevant underlying lung disease (e.g. bronchiectasis), relevant significant co-morbidity (e.g. primary immunodeficiency), or who don’t make anticipated clinical progress should be referred to the Respiratory Service. Referral to the Respiratory Service may also be appropriate in those with particularly severe empyema/pneumonia. The nominated care team is responsible for day to day care, communication and referrals.

**Surgical team:**
Cases requiring surgical intervention will be referred to the on call Paediatric General Surgical Service. At the point they are accepted for surgery, their care will be transferred to the surgical service until the last drain is removed, at which time they will be passed back to the appropriate medical team. While they have drains in situ, they will generally be cared for on ward 24b. It is anticipated the medical team(s) will provide appropriate ongoing support and advice while the patient is under the surgical service.

**Patients referred from out of region:**
Patients receiving care in other hospitals may be referred for ongoing medical or surgical care at Starship. Which service they are referred to will depend on their clinical setting – if the request is for surgical intervention then the referral may be directly to the surgical team whom will involve a medical team as appropriate. Often care will shift directly back to the out of region medical team once drains have been removed.
Empyema

Algorithm:

Clinical assessment
Chest X-ray

Empyema / parapneumonic effusion

IV antibiotics, supportive cares, baseline investigations

Small effusion
Mild distress
Responding to IV antibiotics

Large effusion, or
Moderate-severe distress, or
Persistent fever

Chest ultrasound

Refer to surgical team

Surgical intervention

Drain management

Drain removal

Medical management

Patients with known or suspected underlying lung disease, relevant co-morbidities or not making appropriate clinical progress should be referred to the respiratory service.

Patients under surgical team for duration of surgical intervention (shaded boxes)

Discharge & follow-up
Clinical Features

Children with empyema present in a similar fashion to those with pneumonia but may be more unwell than expected, have pleuritic chest pain and/or prefer to lie on the affected side. Pleural effusion is suggested on examination by unilaterally decreased breath sounds and chest expansion, dullness to percussion and scoliosis. It may evolve after treatment for pneumonia has commenced and should be suspected in any child with persistent fever or failure to improve. Risk factors are as for pneumonia (see Pneumonia Guideline).

Children suspected of parapneumonic effusion or those with pneumonia who have persistent (>48hr) fever on IV antibiotics should have a chest x-ray.

Causative Organisms

Streptococcus pneumoniae (particularly serotypes 1,3 & 19A), Staphylococcus aureus and Streptococcus pyogenes are the most common pathogens but it is important to consider other organisms especially Mycobacterium tuberculosis and MRSA if the child has risk factors or doesn’t respond to empiric therapy.

Investigations

Baseline investigations in children with parapneumonic effusion:
- Oximetry (SpO2) & temperature.
- Full blood count & CRP (baseline inflammatory markers)
- Electrolytes and renal function (risk of SIADH, possibility of haemolytic uraemic syndrome)
- Blood culture (low yield but invaluable when positive)
- Sputum culture (if available)
- Coagulation studies: perform in patients with known risk factors or suggestive history. Correct abnormalities, where possible, before any surgical intervention.

Chest ultrasound
- Confirms, characterises and quantifies pleural effusions. The need and timing of chest ultrasound will vary – it may be unnecessary if there is neither diagnostic uncertainty nor need for surgical intervention (eg small parapneumonic effusion responding well to intravenous antibiotics).

- Routine thoracocentesis (pleural taps), bronchoscopy and/or computer tomography are not recommended for parapneumonic empyema.
- Children with apparent non-infective pleural effusions (eg malignancy) require different investigations / management and should be discussed with the respiratory service.
Subsequent investigations
- Pleural fluid (if drained): cytology, microscopy, culture & sensitivities, and a *Streptococcus pneumonia* antigen test. Consider mycobacterial culture
- Computer tomography is better able to define parenchymal lung abnormalities. While not routine it may be appropriate pre-intervention in complex or atypical cases. It is especially useful in complex cases who have not responded to initial invasive intervention.
- Consider tests for underlying disease / risk factors if the history, examination or cultures are suggestive. Most children with empyema are otherwise healthy with no relevant past medical history and no further investigations may be indicated. In other circumstances it may be prudent to screen for immunodeficiency and/or cystic fibrosis.

Management
All children with parapneumonic effusions should be admitted to hospital on intravenous antibiotics and appropriate supportive care. Further management will depend on the size of effusion, response to antibiotics and degree of respiratory compromise. General goals of therapy are:
- Control sepsis
- Return normal pleural circulation
- Restore normal respiratory function
- Minimise morbidity, mortality and long term complications
- Minimise cost and invasive interventions

1. Supportive care:
   a. Oxygen to maintain \( \text{spO}_2 \geq 93\% \)
   b. Analgesia for comfortable respiration and mobilisation
   c. Antipyretics
   d. Fluid and nutritional management (beware dehydration, SIADH and catabolism)
   e. Mobilisation (improves respiration and pleural circulation) should be encouraged but there is otherwise no specific role for physiotherapy.

2. Antibiotics:
(a) Intravenous:
All children with empyema should be commenced on empiric intravenous antibiotic therapy until culture results are available at which point antibiotics should be rationalised if possible. Cover for less common or multi-resistant organisms (including tuberculosis) should be considered depending on the child’s history and subsequent clinical progress. In those cases, early consultation with Respiratory and Infectious Diseases services is advised. Consider inserting a PICC line early in treatment if a long course is envisaged.

<table>
<thead>
<tr>
<th>≥3 months*</th>
<th>Amoxicillin / Clavulanic acid</th>
<th>30mg/kg/dose (max 1.2g/dose q6h)</th>
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<td></td>
<td>Cefuroxime</td>
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*Empyema in infants < 3 months is uncommon – consult with respiratory and surgical services. Empiric therapy in that setting is likely to be cefotaxime and flucloxacillin.
(b) Oral
Children may be switched to oral antibiotics when they have:
- had any drains removed,
- been afebrile for ≥48 hours, and
- are making good clinical progress ('well' looking, off oxygen, mild work of breathing).

Options include amoxycillin-clavulanic acid syrup/tablets or cephalexin syrup/tablets. Oral therapy should be continued for 2-6 weeks depending on the severity of disease, length of stay in hospital, complications and causative organism.

Note: International guidelines recommend switching to orals when afebrile for 24 hours. The more conservative recommendation above reflects the generally higher complexity / severity encountered at Starship. Shorter duration may be appropriate in mild cases.

3. Pleural Drainage:
Antibiotic and supportive therapy is often all that is required for small parapneumonic effusions and where children are making good clinical progress. In more severe cases, drainage of the pleural cavity hastens recovery and may reduce long term complication (lung entrapment). The decision to intervene will be based on the child's condition, any co-morbidities and their initial response to therapy.

Indications for intervention include:
- Large effusion / empyema with significant respiratory impairment (respiratory distress, hypoxia, etc) and / or
- Persistent fevers after 48hr IV antibiotics

Where further intervention is indicated, referral should be made to the oncall general surgical team who, having accepted the patient, will take over as nominated care team until completion of the intervention (ie last drain removed).

Recommended pleural drainage options include
a. Chest drain without fibrinolytics (urokinase)
b. Chest drain with fibrinolytics (urokinase)
c. Video-assisted Thorascopic Surgery (VATS)
d. Open thoracotomy

Choice of intervention is case by case depending on the child, complexity of empyema, and availability of appropriate surgical support. Most cases will be treated with either a chest drain & fibrinolytics or with VATS. Where empyema fluid is non-echogenic non-loculated (ultrasound findings) and thin (gross sample) a simple drain alone may be appropriate. Open thoracotomy / decortication may be necessary in advanced or long-standing cases. Chest drains may be inserted by either percutaneous (Seldinger pigtail catheters) or open technique. When using fibrinolytics, small bore (8-12Fr) drains are recommended (more comfortable and fibrinolytic prevents blockage).
Drain management

Drain set-up:

- The drain should be clamped for 1 hour once 10 ml/kg are initially removed (reduce risk of re-expansion pulmonary oedema).
- A chest x-ray should be obtained following drain insertion to ensure appropriate drain placement.
- Drains should be placed on 10 cmH\(_2\)O controlled suction.
- See ADHB policy and procedures for paediatric drain management (reference below).

Drain Maintenance:

- For urokinase installation see Appendix.
- An accurate record of the drain’s status must be kept including where it is static, swinging or bubbling and how much fluid is draining (usually an hourly record with tallies each morning).
- Bubbling drains should never be clamped (or removed) and any clamped drain should be immediately unclamped if the patient develops breathlessness or signs of worsening respiration.
- If a drain suddenly stops swinging or draining fluid the medical staff should be notified as it may be obstructed. The patient may need to be re-positioned, the drain unkinked or the drain flushed (10-20ml 0.9% saline) to return it to patency. Once patency and position has been checked, non-functioning drains (neither swinging nor draining fluid) should be removed. Depending on the clinical setting the drain may need to be replaced. Discuss this with the child’s primary clinician before removal.

Drain Removal:

- If two drains are placed at surgery, one should be removed the following day.
- The last drain should be removed when less than 2ml/kg/day of fluid is draining (regardless of effusion size or clinical status). NB: A bubbling drain should not be removed.
- See Appendix and ADHB policy for drain removal procedure.
- Clamping of drains prior to removal is not routinely recommended.
- A chest x-ray should be performed within 4 hours of drain removal to check for pneumothorax. A small pneumothorax is not uncommon and will usually spontaneously reabsorb.

4. Urokinase

See appendix for urokinase instillation protocol

Urokinase contraindications:

- ongoing air leak
- active pleural bleeding
- known urokinase hypersensitivity
- age < 6 months (relative contraindication)
- recent major surgery including open thoracotomy (relative contraindication)

Urokinase is not routinely given post VATS procedure but may be considered.
### Discharge and follow up

Children may be discharged when:

- they have minimal respiratory distress,
- they are eating, drinking and mobilising freely,
- they have a SpO2 consistently $\geq 93\%$,
- they are afebrile for $\geq 48$ hours,
- they had their last drain removed $\geq 12$ hours ago, and
- clinical staff are confident child is on the mend and that family are competent with child’s ongoing care.

Most of these criteria will be met at the point of changing to oral therapy. Radiological resolution is not required (or anticipated) prior to discharge.

Patients should be advised about completing their course of oral antibiotics, reasons for return (including fever and increased respiratory symptoms/signs) and what follow up plans have been made.

Outpatient review must be arranged and should continue until the child has made a complete clinical recovery and has a near normal chest x-ray. Often clinic review 6 weeks post discharge with a repeat chest x-ray will satisfy these criteria. Children with more severe disease will likely require longer follow up but nearly all chest x-rays are normal by 3-6 months. Children with persistent signs, symptoms, radiological abnormalities (especially persistent lobar collapse / atelectasis) should be discussed early with the respiratory service. Check that scoliosis (if present) has resolved.

### Treatment failure and Complications

- Persistent fever may be an indication of incorrect antibiotic, poor antibiotic penetration or simply severe inflammation. Lung necrosis or abscess may also lead to ongoing fever. In many cases, persevering with intravenous antibiotics may be the best course, especially if fever or inflammatory markers appear to be settling. Consider further imaging including chest x-ray and potentially CT scan if progress is not as expected. Persistent lobar collapse may be a sign of foreign body and bronchoscopy should be considered.
- Secondary scoliosis is common and usually transient. No specific treatment or investigation is necessary but resolution should be confirmed.
- Hypoalbuminaemia and/or thrombocytosis are common and require no specific therapy.
- See also the Complications section of the Pneumonia guideline.
Appendix 1: Urokinase instillation protocol

See contraindications above.

Urokinase is instilled twice daily (between 8am and midnight) for three days (6 doses total) by a medical officer. This is generally well tolerated though sometimes discomfort is experienced during instillation and pleural fluid may be transiently blood stained. Intrapleural bupivacaine (0.25% 0.5-1.0ml/kg) can be added if the child finds it uncomfortable. Urokinase may burn so take care not to get it on the skin and wash away with copious water if this occurs.

Dose:  
<10kg weight 10,000 units in 10ml 0.9% saline  
>10kg weight 40,000 units in 40ml 0.9% saline

Required equipment
- Syringe with Urokinase with small bore needle
- Alcohol wipes
- Two chest drain clamps
- Gloves

Procedure
1. Note baseline observations
2. Explain what you are doing to patient / family as appropriate
3. Check that the drain is in good condition and properly sited within pleural cavity.
4. Position patient supine.
5. Instillation can be uncomfortable – a small morphine dose or bupivacaine (see above) in the urokinase may be helpful.
6. Place clamps about 10cm apart on the soft silicon drain tubing as close to the drain proper as possible.
7. Clean tubing between drains with alcohol wipe
8. Insert syringe needle obliquely between through the tube drains
9. Remove the clamp between the syringe and chest wall
10. Slowly instil urokinase over 5 minutes
11. Replace clamp and leave for 4 hours.
12. Encourage the child to mobilise
13. Instruct nursing staff to remove clamps after 4 hours and return drain to suction (10 cmH₂O) OR if the child develops sudden respiratory distress.
Appendix 2: Chest drain removal protocol

See also ADHB policy and procedures.

In brief:
1. Explain the procedure.
2. Ensure adequate analgesia is given. Local anaesthetic cream applied to the adjacent skin 3 hours before removal is as effective as intravenous morphine.
3. A medical officer (or nurse on 23b / PICU) will remove the drain with nursing assistance
   a. Position child as appropriate to provide good access to the drain
   b. Stop suction and clamp drain
   c. Instruct child (where possible) to take a deep breath in and push or blow out slowly (Valsalva) during the drain removal. If this isn’t possible, ideally the drain is removed during expiration.
   d. While one person cuts the anchoring suture and pulls the drain out (brisk smooth motion), the second person presses (seals) the wound edges together, or a single person can withdraw the drain with one hand whilst sealing the edges with the other.
   e. If there is a closing suture pulls and knots this (not so tight as to pucker the edges).
   f. Apply steristrips as necessary to seal the wound
   g. Apply an occlusive transparent sterile dressing
4. Ensure the child is comfortable and positioned for good chest expansion.
5. Ensure a chest x-ray is arranged and reviewed following removal.
6. Nursing staff will assess respiratory status immediately following drain removal, hourly for four hours and four hourly thereafter.

References