

Pleural infection in children: Management Guidelines

Introduction

Parapneumonic effusion occurs in approximately 3 per 100,000 children per year¹ but there has been a significant increase in incidence over the last decade². Currently we receive up to 45 referrals per year from the South West region. It occurs more frequently in pre-school and teenage children, and more commonly in winter and spring³. Parapneumonic effusion and empyema lie on a continuum: the stage of the effusion is best assessed using chest ultrasound. Simple effusions have free flowing pleural fluid; more complex effusions have fibrin strands and loculations, whereas an empyema has multiple loculations and a thick pleural rind. The term empyema is used as an umbrella term throughout this guideline. Despite the introduction of the conjugate Pneumococcal vaccine, we may not see a reduction in the incidence of empyema in children, as the current vaccine does not include the most commonly responsible serotypes^{4,5}.

These guidelines are based on national guidelines written in 2005 on behalf of the British Thoracic Society⁶. They are designed to be used in the Children's Hospital, but they will be of use to other centres in the region, particularly for initial management.

Presentation and clinical features

- Children usually present with a severe pneumonia, or a pneumonia that does not respond well to initial therapy
- However they may also present unwell with a fever but no clear focus, or with chest or abdominal pain
- The clinical features are usually that of pneumonia and accompanying pleural effusion, i.e. fever, tachypnoea, hypoxia, respiratory distress, decreased or bronchial breath sounds, and dullness to percussion.
- They may also be septic, dehydrated and hyponatraemic, or in respiratory failure.
- If a child remains pyrexial or unwell 48 hours after admission for pneumonia, an effusion should be looked for with further imaging.
- The white cell count (with neutrophilia) and CRP are typically very high – if these are low, this should prompt consideration of an alternative cause.

Regional referrals

- We recommend that all children with pleural infection should be discussed with either the respiratory or the surgical team at the Children's Hospital.
- From Monday to Friday (0900 to 1700) referral should be made to the Paediatric Respiratory Registrar (Bleep 2357 or Bleep 3679); outside normal hours referral should be made to the Paediatric Surgical Registrar.
- Children referred for further management should be sent with copies of all imaging and should usually be transferred "nil by mouth".
- Children can be admitted to wards 31, 33 or 35. Out of hours referrals should be admitted under the surgical team; they may be subsequently transferred to the respiratory team during normal hours, but only after acceptance by the respiratory consultant on service.

Imaging

- There is usually no need for a lateral CXR.
- Ultrasound should be used to confirm the presence of a pleural fluid collection, and can be used to stage the complexity of the effusion. The radiologist should comment on depth and position, the presence of loculations, and lung mobility.

- For regional referrals, we would recommend requesting a further ultrasound examination at the Children's Hospital before deciding on the appropriate intervention.
- There is usually no need for chest CT, unless there is an apparent parenchymal abscess, or the pleural collection is suspected to be non-pneumonic.

Antibiotic therapy

- Blood cultures should be performed in all patients with parapneumonic effusion, and if sputum is produced, it should be sent for culture.
- The majority of parapneumonic effusions are due to *Streptococcus pneumoniae*. However consider other organisms if there are any atypical features or an unusual response to initial management.
- All children with parapneumonic effusion should be initially treated with intravenous antibiotics, following local antibiotic prescribing policy. Currently, we use intravenous cefuroxime at 30 mg/kg three times per day (up to 50mg/kg three times per day in some cases).
- Flucloxacillin may be added if there is the suspicion of abscesses or cystic lesions, or with some risk factors such as cystic fibrosis. A macrolide such as oral azithromycin can be added when atypical pneumonia is suspected (e.g. bilateral pneumonia in school aged children or atypical features of pneumonia).
- Broader spectrum cover is required for hospital acquired infections, as well as those secondary to surgery, trauma, and aspiration.
- Where possible, antibiotic choice should be guided by microbiology results; discuss with microbiology if any unusual organism has been isolated.
- Intravenous antibiotics should be continued until after the chest drain has been removed and usually for 24 hours after fever has settled or removal of the chest drain.

Therapeutic options

1. Conservative management (antibiotic therapy alone)

- Small effusions that are not associated with significant respiratory compromise (i.e. no need for oxygen therapy, the child is quite well, does not have high fever, has no significant respiratory distress and is not in pain) may be managed conservatively, but consider early active treatment if the clinical status changes. Small effusions may be regarded as being less than 1 cm in depth for children under 2 years of age, and under 2 cm in depth for older children.
- An effusion which is enlarging and/or compromising respiratory function should not usually be managed by antibiotic therapy alone.
- Pleural taps are not usually recommended.

2. Intercostal chest tube drainage

- Most children with parapneumonic effusions can be managed by chest tube drainage with the use of fibrinolytic therapy. There has been a major shift away from performing thoracotomy as a primary intervention in most centres over the last decade.
- However some children may still require a thoracotomy as the first procedure (see below).
- The decision to place a chest drain should be made by either a senior member of the respiratory or surgical team; they are inserted by either the respiratory team (usually during normal hours only) or by the surgical team.

- A coagulation screen is only recommended in patients with known risk factors; any coagulopathy or platelet defect, when known, should be ideally corrected before chest drain insertion.
- The initial diagnostic ultrasound should be used to guide drain insertion, but we would recommend borrowing the small portable ultrasound machine from PICU and using this in theatre to confirm final placement.
- Most children should have chest drains inserted under general anaesthesia; however sedation may be suitable in some teenagers, using local sedation policies, including the following recommendations:
 1. Adequately trained staff and appropriate space must be available.
 2. There must be a separate member of staff supervising the sedation (bleep Sarah Parry, Pain Specialist Nurse Practitioner on Bleep 3974, or the Outreach Team).
 3. Oral analgesia should be given prior to starting (e.g. oral morphine, 200 micrograms/kg (usually around 5-10 mg in most adolescents) twenty minutes prior to the procedure).
 4. Use local anaesthesia (1% Lignocaine (10 mg/ml) to a maximum dose of 3 mg/kg).
 5. Appropriately used Entonox can provide good sedation for the procedure.

Chest drain insertion, securing the drain and suction

- We prefer to use small bore percutaneous drains; there is now rarely any need to use a large chest drain. We use 12-14 Fr Thalquick (Cook) drains; there is a 10 Fr Thalquick but we find this is very prone to twisting; pigtail catheters are an alternative.
- Drains should only be inserted by appropriately trained personnel.
- Drains should be directed posteriorly and inferiorly; it is however difficult to ensure appropriate placement with percutaneous drains. They should not be inserted over the back as this is uncomfortable.
- Pleural fluid should be sent for analysis at drain insertion (see below).
- Intercostal blocks using bupivacaine are often a useful adjunct to post operative analgesia.
- **Securing the drain correctly is vital.** The drain should be sutured (however do not use a purse string) and covered with an adhesive dressing. The drain should be laid flat on the chest wall in the direction of insertion (this usually means that the exposed end should be directed superiorly and anteriorly to avoid kinking the drain). There should be further fixation of the drainage tubing to the abdomen. **Proper fixation must be obsessively ensured through the whole duration of the drain.** However strapping with large amounts of tape is unnecessary.
- If there is rapid drainage we would recommend that the drain should be clamped once 10 ml/kg is initially removed; further drainage is at the discretion of the attending medical or surgical team. Occasionally, children can decompensate with rapid drainage of pleural fluid.
- All chest tubes should be connected to a unidirectional flow drainage system (such as an underwater seal bottle) which must be kept below the level of the patient's chest at all times. The drain should be placed on 5 kPa suction on the ward.
- Request a CXR after drain insertion.

Diagnostic analysis of pleural fluid

- Pleural fluid must be sent to microbiology for Gram stain and bacterial culture, and also to cytology, for differential cell count (a lymphocytosis should prompt further investigation for TB or malignancy).
- If there is an indication the effusion is not secondary to infection, an initial small volume diagnostic tap for cytological analysis may be considered in some children, avoiding general anaesthesia whenever possible.

- Biochemical analysis of pleural fluid is not useful in the management of parapneumonic effusions in children; however, in atypical cases, pleural fluid should be sent for analysis of protein, amylase, triglycerides and lipid concentration.
- If the pleural fluid is culture negative, it should be sent for Pneumococcal PCR (to Manchester HPA via the Bristol lab) – this is now part of the Pneumococcal National Surveillance programme. Please speak to the lab on each occasion if the culture is negative.

Chest drains: ongoing management

- See the section below on the use of fibrinolytic therapy.
- Good analgesia is extremely important. Children should receive regular paracetamol and NSAIDs; additional oral analgesia and/or morphine infusion may be necessary in some children.
- Children with chest drains should only be managed on wards by staff trained in chest drain management.
- A clamped drain should be immediately unclamped and medical advice sought if a child has any unexplained deterioration, becomes breathless or has chest pain.
- If there is a sudden cessation of fluid drainage, the drain should be checked for obstruction (blockage or kinking); the drain may need to be manipulated or flushed.
- If there is still significant remaining pleural fluid, and a drain is not draining, consider replacing it.
- Consider obtaining further imaging (initially CXR and then ultrasound) if there is no clinical improvement and / or failure to drain the effusion. CT may be sometimes be useful – discuss with radiology and the surgical / respiratory team.
- Consider removing a chest drain when: drainage is minimal (e.g. less than 30 mls per 24 hours) and there has been significant clinical progress alongside some radiological improvement.
- Request a CXR approximately 4 hours after chest drain removal (see separate chest drain guidelines).
- A bubbling chest drain should prompt the consideration of a bronchopleural fistula and discussion with the surgical team. Never clamp a bubbling chest drain.

2. Intrapleural fibrinolytic therapy (see separate Urokinase administration guidelines)

- Intrapleural fibrinolytic therapy shortens hospital stay⁷ and should be used for all cases of parapneumonic effusion or empyema given intercostal tube drainage.
- Urokinase should be given twice daily for 3 days (6 doses in total), ideally at 10:00hrs and 22:00hrs. Further doses can be given depending on the response. Urokinase can now be given by the outreach team and some of the ward nursing staff. **Do not give urokinase unless you are familiar with how to give intrapleural medication.**
- Dose: < 10 kg: 10 000 units diluted to 10 ml with 0.9% saline.
≥ 10 kg: 40 000 units diluted to 40 ml with 0.9% saline.

3. Further surgical intervention (thoracotomy or VATS)

- Failure of chest tube drainage, antibiotics, and fibrinolytic therapy should prompt early discussion with the surgical team.
- Children should be considered for surgical intervention if they have persisting respiratory distress, fever or sepsis in association with a persistent pleural collection.

- Video-assisted thoracoscopic surgery (VATS) may be an appropriate alternative to thoracotomy. Early VATS, as a primary procedure, does not appear to offer benefit over a chest drain and urokinase⁸, but is routinely used in some centres and in the US.
- Fibrinolytic therapy is usually not used following VATS or thoracotomy.
- Recovery can be rapid following thoracotomy; surgery may be an appropriate primary procedure in some children with a complex empyema, i.e. when there are extensive loculations, a thick pleural rind and severe lung entrapment in a sick child.
- A lung abscess coexisting with an empyema does not usually require surgical drainage; chest CT is appropriate imaging when an abscess is suspected.
- Good post-operative analgesia is extremely important after thoracotomy; epidural regional anaesthesia is often used, or a NCA/PCA morphine infusion.
- At least one chest drain will be placed at thoracotomy; see the above section for the ongoing management of children with a chest drains.

4. Other management

- Antipyretics should be given as necessary.
- Chest physiotherapy is not generally beneficial and is usually not needed in the early course of a child with empyema.
- Early mobilisation and exercise is recommended.
- Blood tests (FBC, CRP, electrolytes, LFTs) should be repeated at least once during the child's admission; they may need to be performed more often in some children, e.g. when hyponatraemia is present. Secondary thrombocytosis (platelet count $>500 \times 10^9/L$) is common but benign; anti-platelet therapy is not necessary
- Secondary scoliosis noted on the chest radiograph is common but usually transient; no specific treatment is required but resolution should be confirmed on the follow up imaging.
- Underlying diagnoses, e.g. immunodeficiency or cystic fibrosis, are uncommon but should be considered in some children and may need investigation (e.g. with unusual organisms or with an atypical course).

5. Alternative diagnoses

- Particularly if there are atypical features, consider alternative aetiology for a pleural effusion, e.g. malignancy (such as neuroblastoma), congenital lung lesions, pancreatitis (there may be a raised pleural fluid amylase), lymphatic drainage abnormalities (there may be raised pleural fluid triglycerides and cholesterol), rheumatological disorders, or immunodeficiency.

6. Discharge / Follow up

- Oral antibiotics should be given at discharge for 2 weeks (up to 4 weeks in some cases), dependent on culture results and local microbiological guidelines; we mostly use oral Augmentin.
- Children should be usually seen at their local centre approximately 2 weeks after discharge. A discharge summary must be produced and sent to the local centre, ideally with a copy / print out of the last CXR. They should be followed up in Bristol by the respiratory team 2 months after discharge, with a CXR on that day.

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