Guideline

Empyema

Management of pleural empyema in previously well children

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Primary Document			
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Custodian	Director of Respiratory and Sleep Medicine	**Review date**	20/11/2026

HUMAN RIGHTS

This governance document has been human rights compatibility assessed. No limitations were identified indicating reasonable confidence that, when adhered to, there are no implications arising under the *Human Rights Act 2019.*

PURPOSE

This document is intended to provide guidelines for identification and management of parapneumonic effusions and empyema in previously well children.

SCOPE

This guideline applies to previously well children in the QCH catchment. Please refer to local guidelines for patients from North Queensland and Gold Coast region. This current guideline is developed from a consensus from the Respiratory, Paediatric Surgical, General Paediatric, Infectious Disease, Anaesthetics, Interventional Radiology, Intensive Care and Emergency Department teams at Queensland Children's Hospital (QCH), supported by evidence where available.

TABLE OF CONTENTS

GUIDELINE

KEY POINTS

- The most common causative organism is *Streptococcus pneumoniae*.
- Empyema should be considered in children with pneumonia who remain febrile after 48 hours of appropriate IV antibiotics.
- All patients should receive high dose IV empirical antibiotics (benzylpenicillin and lincomycin) ensuring coverage for both *Streptococcus pneumoniae* and *Staphylococcus aureus*.
- CXR and Chest USS are first line radiological investigations; CT chest is not routine.
- Children with moderate-large parapneumonic effusions or empyema should be managed by the Respiratory team at QCH.
- Patients with moderate-large effusions should be considered for pleural drainage.
- Most children will make a full recovery without long term sequalae.

BACKGROUND

Parapneumonic effusion and empyema are rare complications of pneumonia, and represent a continuum of pleural infection and inflammation. Empyema occurs in approximately 1% of children hospitalised with pneumonia, and incidence has increased in the last decade[1,2]. Parapneumonic effusions typically progress from a simple exudative stage (fluid typically sterile) to a fibro purulent stage through to an organisational stage[3] across the course of hours to days. When there is pus in the pleural cavity, it is called an empyema. *Streptococcus pneumoniae* is the most common organism responsible for paediatric empyema. Other common organisms include S*treptococcus pyogenes* (GAS) and *Staphylococcus aureus* (including MRSA)[1]. Other organisms are rarely seen in children without underlying risk factors or comorbidities. Tuberculosis and other mycobacterium should also be considered in those at risk.

INITIAL ASSESSMENT

Clinical features

- Children typically present with signs and symptoms consistent with community acquired pneumonia, but may appear more unwell, with decreased breath sounds and chest expansion on the affected side with a dull percussion note[4].
- Parapneumonic effusion or empyema may also evolve during an admission. If a child remains febrile or unwell 48hr after appropriate management for pneumonia [see: Community Acquired Pneumonia - Emergency management in children] a parapneumonic effusion or empyema must be considered[4]

Disposition

- All children with a parapneumonic effusion or empyema should be considered for admission to hospital and commenced on IV antibiotics.
- Children with parapneumonic effusions or empyema with severe sepsis or severe respiratory distress, should have IV antibiotics given as soon as possible, and consultation for consideration of urgent intervention to drain pleural fluid (see below). Consider consultation with PICU. [see: Sepsis –

Recognition and emergency management in children; and: Empiric Antimicrobial Guidelines for Paediatric Intensive Care Unit (PICU)]

- Patients with community acquired pneumonia and a small effusion (<20mm maximal depth) can be admitted under their local general paediatric team. Patients with moderate-large effusions or significant respiratory distress should be discussed with the Respiratory fellow or consultant on call at QCH.
- Patients who may require pleural drainage should be discussed with the Respiratory team at QCH. Previously well patients requiring pleural drainage are typically admitted under the Respiratory team who will then liaise with the Surgical team and/or Interventional Radiology. Patients with underlying co-morbidities are out of the scope of this guideline.
- Patients who are likely to require urgent pleural drainage should be kept nil-by-mouth whilst awaiting Respiratory review (if coming from another hospital, can have clear fluids until arrival at QCH).

INVESTIGATIONS

Initial investigations

Imaging

- AP (or PA) chest x-ray should be taken. There is no role for routine lateral CXR.
- If there is suspicion of an effusion on CXR, ultrasound (US) chest should be used to confirm the presence of pleural fluid.
- Chest US can help determine the quality of the pleural fluid – simple, complex, loculated; there is poor inter-rater reliability in grading pleural effusions (including volume/maximal depth), so ultrasound should be used to guide decision making, rather than dictate management[5]. Maximal depth is a more useful clinical indicator compared to estimated volume in determining safety of placing a chest drain.
- There is no role for routine CT chest, even in children planned for surgical intervention. This can be at the discretion of the interventional team as required.

Blood tests

- Blood culture, blood Strep. pneumoniae PCR (requires a separate EDTA tube; n.b. do not send pneumococcal serology), FBC, CHEM20 and CRP should be collected in all patients with suspected empyema or parapneumonic effusion.
    - Consider SIADH and fluid restriction if hyponatraemic.
- In the seriously ill child, coagulation studies should also be collected.
- Thrombocytosis is common and does not require anti-platelet therapy[6].

ALERT

Haemolytic uraemic syndrome (HUS) is a serious condition which can rarely be associated with pneumococcal pneumonia and empyema – consider if platelet and haemoglobin levels are low, request blood film (schistocytes and helmet cells may be seen on blood film). (n.b. anecdotally, mild anaemia is common in severe pneumonia with empyema and is not generally a sign of HUS in isolation).

Other

- Nasopharyngeal swab for respiratory viruses PCR (RESP11), and *Mycoplasma Pneumoniae* PCR.
- MRO screening swabs (nasal, skin) for MRSA
- In the expectorating child, a sputum sample should be collected if possible.
- Streptococcal urine antigen, in children older than 5 years.
- There is no role for routine bronchoscopy.

Subsequent investigations

- Pleural fluid should be sent for MCS, pneumococcal PCR and cytology (cell count and differential). If lymphocytosis is detected, malignancy or tuberculosis should be considered[6].
- There is no role for routine regular blood tests or imaging – this is individualised, and clinically based. If inflammatory markers are being repeated, wait ≥48hr between samples.
- If no microorganism is identified from the above investigations, additional testing can be considered (e.g. paired ASOT (for GAS) or *M. pneumoniae* serology, pleural fluid 16S after discussion with ID).

INITIAL MANAGEMENT

Empirical antibiotics (first 48 hours then review)

All cases should be treated with IV antibiotics and must include cover for *S. pneumoniae* and *S. aureus.* Suggested empirical antibiotics: *(Townsville and Gold Coast – please consult local guidelines)*

- IV benzylpenicillin 60 mg/kg/dose 6 hourly (maximum 2.4 g/dose) *[if penicillin allergy (delayed non severe type, i.e. rash), use IV cefazolin 50 mg/kg/dose 8 hourly (maximum 2 g/dose)]*
    - If < 5yo and not fully vaccinated for HiB, use IV cefotaxime 50 mg/kg/dose 6 hourly (maximum 2 g/dose)
- **AND** IV lincomycin 15 mg/kg/dose 8 hourly (maximum 1.2 g/dose)
- In those with life-threatening pneumonia:
    - IV cefotaxime and lincomycin (doses as above)
- For those with sepsis [see: Sepsis – Recognition and emergency management in children] and severe life-threatening pneumonia, addition of:
    - IV vancomycin 15 mg/kg 6 hourly (maximum 750mg/dose initial dose) for patients with normal renal function. Perform therapeutic drug monitoring [see: Intravenous Vancomycin]
    - If *M. pneumoniae* suspected, add in oral Azithromycin 10 mg/kg once daily (maximum 500 mg daily).

Supportive care

- Supplemental oxygen to maintain oxygen saturations >93%.
- For children fasting whilst awaiting pleural drainage, IV fluids containing 5% glucose should be initiated. Consider fluid restriction in those with severe disease (small risk of SIADH). Cease IV fluids and change to enteral feeds once recovered from anaesthetic.

Nutrition

- Hypoalbuminaemia is multifactorial and common[7], and enteral feeding should be encouraged. The available literature does not support the use of albumin infusions to correct hypoalbuminaemia in this setting[6].
- Nasogastric feeds are typically required for nutrition and hydration purposes. Children with pneumonia and empyema have higher metabolic requirements and often cannot maintain adequate nutrition on their own. Standard enteral feeds (such as Nutrini or Osmolite) are appropriate.

Analgesia

- All children with empyema should be given regular analgesia (paracetamol and ibuprofen charted regularly rather than PRN if not contraindicated).
- Acquired (temporary) scoliosis (curving towards the affected side) can be seen and is typically a sign of poorly controlled pain.
- If pleural drainage is required, consultation with the Acute Pain Service (APS) is required (call to APS registrar on 4406 and "consult to APS" in ieMR) as many children require opiates via Nurse- or Patient-Controlled Analgesia (NCA/PCA).
- Fibrinolytics administered via chest drain can be very painful; instillation of intrapleural bupivacaine should be given for all children having alteplase dwells [see: Alteplase for Empyema].

Physiotherapy

- Early mobilisation is recommended. Encouragement of deep breathing and coughing is also advised.
- There is no role for routine chest physiotherapy in children with empyema.

PLEURAL DRAINAGE

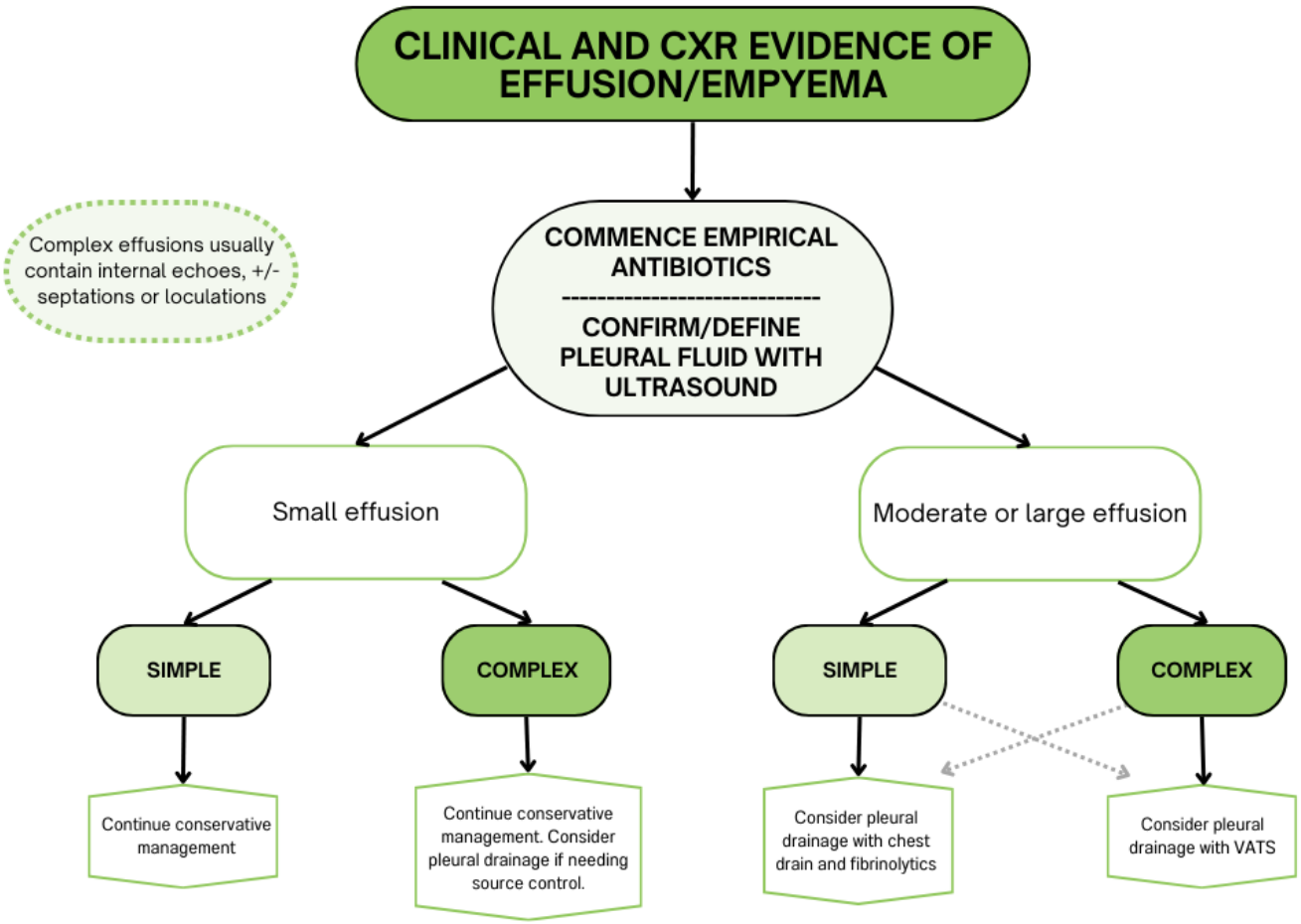
Some patients can be managed conservatively (with antibiotics and other supportive measures). Pleural drainage should be considered in patients with large effusions and respiratory distress (drainage enables full expansion of the lung), or for source control in those with ongoing fevers despite appropriate conservative management. Pleural fluid drainage is also considered when required for diagnostic purposes.

- Effusions with a maximal depth <20mm on ultrasound are typically not considered large enough to easily place a chest drain.

Careful consideration must be taken prior to deciding which pleural drainage procedure is performed. Type of intervention is determined in a collaborative approach between the relevant treating teams (Respiratory, Surgery, Intensive Care and Interventional Radiology). Evidence suggests that type of procedure shows no difference in mortality outcomes in children[8,9]. There is evidence favouring both procedures (chest drain + fibrinolytic (CDF) vs primary VATS) but data must be interpreted with caution as local expertise and standard practice differs, and the landscape of empyema has changed in the last decade[1,2,8,10]. There are no ultrasound characteristics that predict patients who fail CDF[5] which is why this needs to remain a collaborative decision between teams.

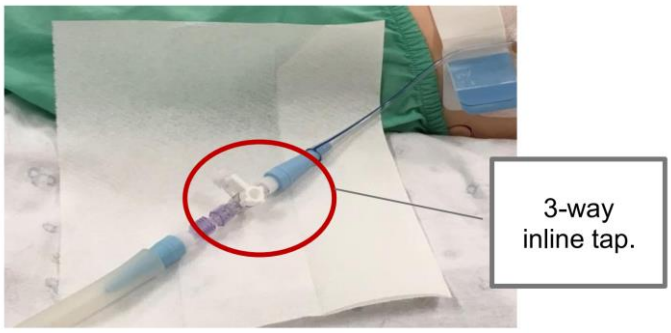
The length of the illness and antibiotic therapy prior to presentation to QCH should also be taken into consideration when choosing the treatment option. In general CDF works better in the early phase of disease.

- All patients going to theatre for a pleural drainage procedure should be considered for a PICC or long PIVC insertion by the anaesthetist (time and skill dependent). [See: Request and Consent for Central Venous Access Devices]
- A nasogastric tube (NGT) should also be inserted at time of surgery if not placed prior.
- All patients with a pleural drain should be referred to the Acute Pain Service (APS). This includes patients who are in PICU.
- All drains should be placed under sedation or general anaesthetic.
- All drains should be connected to a chamber with an underwater or dry seal.
- There is a very small risk of re-expansion pulmonary oedema in very large effusions. This risk is highest with initial drainage. Consider clamping ICC for 1hr post initial drainage if >10mL/kg in a short time frame [n.b. paucity of paediatric data regarding actual volumes – adult literature suggests risk is highest if initial drainage is >1.5L][4,11].



Chest drain and fibrinolytics (CDF)

- A pigtail catheter may be inserted by the Surgical Team, PICU, or the Interventional Radiologist. It may be useful to ask the sonographer to mark the spot with maximal fluid depth. Note, Interventional Radiologist (IR) availability during business hours can be determined by contacting the IR contact (via switch). Out of hours, there is no formalised IR on-call service.
- Confirm position of chest drain clinically (i.e. drain swinging). If drain not swinging or draining, an initial CXR post insertion is suggested prior to instillation of first dose of alteplase.
- Drains should have a 3-way tap installed at time of chest drain insertion, to allow instillation of fibrinolytics on the ward. [See: Alteplase for Empyema, Appendix 1]



- All chest drains should have a fibrinolytic instilled once the patient is stable post procedure.
- At QCH, Alteplase is the only fibrinolytic available. It is a serine protease that binds to fibrin and activates plasmin. Plasmin breaks down fibrin strands thereby thinning the pleural effusion allowing drainage out the existing chest drain. [See: Alteplase for Empyema]
    - Dose is 0.1 mg/kg (maximum 6 mg) 12 hourly (for 4 to 6 doses), dwell time of 1 hour[12–15]
    - Alteplase dwells can be very painful – addition of intra-pleural bupivacaine is strongly suggested (0.25% bupivacaine – 0.5 to 1 mL/kg immediately prior to alteplase).

ALERT

Alteplase is contraindicated in bronchopleural fistula (bubbling drain) or if frank blood draining.

- Approximately 5-30% of primary CDF will progress to VATS due to treatment failure[5,8,10,15]. Current QCH experience would be at the lower end of this range.
- Patients should be considered for progression to VATS if they have persisting fever/sepsis in association with a persistent pleural collection, despite chest tube drainage and antibiotics.

Video-assisted thoracoscopic surgery (VATS)

- Video-assisted thoracoscopic surgery (VATS) achieves debridement of fibrinous pyogenic material, breakdown of loculations, and drainage of pus from the pleural cavity under direct vision.
- In the very unwell child, or a child with bilateral pneumonia, CDF may be lower risk than VATS.
- Typically 2-3 incisions are made at time of VATS and 2 chest drains are left in situ – these do not require fibrinolytic instillation.

ONGOING MANAGEMENT

Antibiotics

- Rationalisation of antimicrobials should occur if and when an organism +/- sensitivities are known.
- *S. pneumoniae* – benzylpenicillin IV 60 mg/kg/dose 6 hourly (maximum 2.4 g/dose)
- MSSA – flucloxacillin IV 50 mg/kg/dose 6 hourly (maximum 2 g/dose)
- If no pathogen is confirmed, continued antimicrobials should provide both streptococcal and staphylococcal cover (not MRSA unless risk factors; see Box 1):
    - Cefazolin IV (50 mg/kg 8 hourly, maximum 2 g/dose).
    - If under 5 years and not fully immunised against HiB continue cefotaxime 50 mg/kg 6 hourly, max 2 g/dose.
- IV antibiotics should be continued until the patient has remained afebrile for >24 hours. Some patients will have a transient fever after drain removal, presumably due to an inflammatory response.
- Appropriate oral antibiotics depends on the organism – typically, high dose oral amoxicillin (30 mg/kg/dose 8 hourly, maximum 1 g/dose), oral cefalexin (30 mg/kg/dose 8 hourly, maximum 1 g/dose) or oral Amoxicillin/clavulanate (22.5 mg/kg/dose 12 hourly, maximum 875 mg/dose amoxicillin component) are used. [see: Early IV to oral switch].
- Total antibiotic duration (IV and Oral) 3 to 4 weeks.

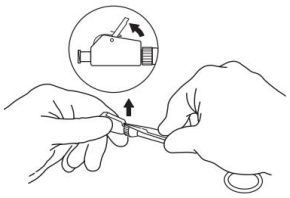
Box 1: MRSA risk factors

- Known MRSA carriage (on previous surveillance swab or other microbiology)
- Household contact of known MRSA carrier
- Recurrent boils or school sores
- First Nation Australian or Pacific Islander children

Chest drains

- Decisions about chest drain management are directed by the surgical team (if placed by them) or the respiratory team (if drain placed by PICU or IR) when patient is on the ward.
    - If the patient is in PICU, drain management is directed by the intensive care team in consultation with the surgical and respiratory teams.
- Chest drains may continue to drain small amounts of physiological pleural fluid which should not delay their removal. Typically, a drain is ready to be removed once output has dropped to 1-2mL/kg/day.
- A bubbling chest drain is a sign of a bronchopleural fistula. Bubbling chest drains should not be clamped or removed.
- A chest drain that is not swinging or draining may be blocked. Troubleshooting for blocked drains in consultation with surgical team:
    - Check the position (clinically and radiographically) and exclude any kinks or blockages.
    - Ensure no leak (at 3-way-tap, at connection to drain).
    - Try a 10mL saline flush – for drains with a 3-way-tap, 10mL into ICC (into pleural cavity) and 10mL into drain/cannister.
    - Consider alteplase dwell into ICC (5-10mL depending on drain) if there are compelling reasons to preserve ICC and above methods unsuccessful.
    - A drain that cannot be unblocked should be removed and replaced (under sedation/general anaesthetic) if significant pleural fluid remains.

- Chest drain removal can be performed by any competent staff member. [see: Chest Drains: nursing assessment, management and removal]. Pigtail drains may have a MAC-LOC clip that needs to be released prior to removal of chest drain. Insert a small, blunt object (such as small forceps) into MAC-LOC release notch.



INVASIVE PNEUMOCOCCAL DISEASE – FURTHER INVESTIGATIONS

- Any child who has a positive culture or PCR of pneumococcus from pleural fluid or blood culture should have further investigation to rule out underlying immunodeficiency. See: Invasive pneumococcal disease: Assessment and initial investigation to exclude immune deficiency.
- At a minimum, children should have the following investigations:
    - FBC and film examination to rule out Howell Jolly bodies as a marker of splenic dysfunction.
    - Immunoglobulin levels (IgA, IgM and IgG).
    - Complement function (CH50 and C3/C4 levels).
    - If possible, collect extra serum for storage in case subsequent serologies are required (e.g. pneumococcal antibodies).
    - Abdominal ultrasound to confirm presence of spleen (this can be requested at the time of chest US during the initial investigations).
- Ideally these bloods should be collected after the resolution of the acute phase of the illness and before discharge.
- All children with invasive pneumococcal disease should have additional vaccinations as per the Immunisation Handbook[16].
    - An additional/4th dose of 13vPCV (or 15vPCV) can be given on the ward, or in QSIS 2G clinic prior to discharge (some children may have already received a primary course of 4 pneumococcal vaccines – these children do not require a 5th dose).
    - A dose of 23vPCV should be given a minimum of 8 weeks after 13vPCV or at age 4 years (for patients <4yo).
    - Another dose of 23vPCV should be given at least 5 years after the first dose of 23vPCV.

DISCHARGE AND FOLLOW UP

- Once all chest drains are out, the patient remains afebrile, and they are tolerating oral antibiotics, they are ready for discharge.
- A baseline CXR should be performed close to the time of discharge (it is not expected to be normal).
- Patients should be asked to come back if they develop new fevers or worsening respiratory distress.
- Patients should continue oral antibiotics on discharge, to complete a total duration (IV and oral) of 3-4 weeks (noting that this duration is an evidence-free zone).
- Follow up should be organised with the Respiratory Team, (or local paediatric team if from a regional area) 3-6 months after discharge, with a repeat CXR at the time.
    - 90% of CXRs will be normal after 3 months with close to 100% normalising by 6 months.

SUPPORTING DOCUMENTS

Supporting documents:

- CHQ-GDL-00759 Community Acquired Pneumonia - Emergency management in children
- CHQ-GDL-60010 Sepsis – Recognition and emergency management in children
- CHQ-GDL-01202 Children's Health Queensland Paediatric Antibiocard
- CHQ-GDL-01057 Antimicrobial treatment: Early intravenous to oral switch
- CHQ-GDL-60819 Invasive pneumococcal disease: Assessment and initial investigation
- CHQ-GDL-01066 Empiric Antimicrobial Guidelines for Paediatric Intensive Care Unit (PICU)
- CHQ-PROC-10010 Chest Drains: nursing assessment, management and removal
- CHQ-PROC-01036 Antimicrobial: Prescribing and Management
- CHQ-PMG-01293 Intravenous Vancomycin
- CHQ-PMG-01267 Alteplase for Empyema
- THHSCLI171128 Paediatric empyema management and treatment (Townsville)
- Request and Consent for Central Venous Access Devices

CONSULTATION

Key stakeholders who reviewed this version:

• Respiratory: A/Prof Sadasivam Suresh, Prof Paul Robinson, A/Prof Tonia Douglas, Dr Miriam Cameron, Dr Matthew Rogers, Dr Cassandra Krogh, Sandra Shilling NP. • Surgical: Prof Craig McBride, A/Prof Bhavesh Patel. • Paediatric Intensive Care SMO group	• Infectious disease: Dr Julia Clark, Nicolette Graham. • General Paediatrics: Dr Anne Kynaston. • Acute Pain Service: Dr Vanessa Rich, Janelle Keyser CNC. • Emergency Department SMO group

DEFINITIONS AND ABBREVIATIONS

Term	Definition
AP	Anteroposterior
CXR	Chest x-ray
Empyema	The presence of pus in the pleural cavity.
FBC	Full blood count/complete blood count
GAS	Group A streptococcus
ICC	Intercostal catheter
MRSA	Methicillin-resistant Staphylococcus aureus.
MSSA	Methicillin-sensitive Staphylococcus aureus.
PA	Posteroanterior

Parapneumonic effusion	Pleural fluid collection associated with an underlying pneumonia, fluid typically sterile.
PICC	Peripherally inserted central catheter
PICU	Paediatric Intensive Care Unit
PIVC	Peripherally inserted venous cannula
QSIS	Queensland Specialise Immunisation Service
SIADH	Syndrome of inappropriate anti diuretic hormone
US	Ultrasound
HiB	Haemophilus influenzae type B

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ASSURANCE STRATEGY

Strategy	An audit of current experience has been performed within the department, the results of which have informed this protocol. As part of the ongoing assessment of this protocol, an audit will be repeated in 2 years time. As part of that audit, we will assess adherence to this protocol and patient outcomes, which will be compared with historical data.

Audit/review tools	Audit/review tools frequency	Key performance indicator
Audit as described above	2 years	Adherence to protocol, patient outcomes and comparison to historical data

GUIDELINE REVISION AND APPROVAL HISTORY

Version No.	Modified by	Amendments authorised by	Approved by	Comments
1.0 20/11/2024	Respiratory fellow	Medication Advisory Committee 10 October 2024	Executive Director Clinical Services & Executive Director Medical Services	Content informed by discussions with key stakeholders above, and approved by their respective departments.
1.1 03/01/2024	Respiratory fellow			Minor amendment to wording to aid in clarification

Key words	Pneumonia, empyema, effusion, chest drain, ICC, alteplase, VATS, 01082
Accreditation references	The National Safety and Quality Health Service (NSQHS) Standards (1-8): • NSQHS Standard 1: Clinical Governance • NSQHS Standard 3: Preventing and Controlling Infections • NSQHS Standard 4: Medication Safety • NSQHS Standard 6: Communicating Safety Standard