



Crumlin | Temple Street | Tallaght | Connolly

CHI NURSING PRACTICE GUIDELINE ON THE MANAGEMENT OF CHEST DRAINS FOR INFANTS & CHILDREN

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1.0 INTRODUCTION

Effective nursing care of the child with a chest drain must be informed by evidence based nursing practice guidelines (Magner 2009).

Nurses should only care for a child with a chest drain having received the necessary theoretical and practical instruction to practice competently, within their scope of practice. (HSE 2011, NMBI 2015, Li 2018, Porritt 2018).

2.0 DEFINITION OF GUIDELINE

A chest tube is inserted via chest wall / ribs into the pleural or mediastinal cavities; to allow drainage of air (*pneumothorax*), fluid (*pleural effusion*), blood (*haemothorax*), pus (*empyema*) or chyle (*chylothorax*) out of the chest. (Porritt 2018, Slade 2019). It also allows lung re-expansion and prevents air from entering the chest cavity (Leonard *et al*, 2023).

3.0 TYPES OF DRAINS:

Pleural drain(s), which are placed in the thoracic cavity and have two functions:

- To allow fluid drainage,
- To allow air from a pneumothorax to escape from the pleural space and re-establish the negative pressure necessary for lung expansion and respiration. Chest tubes can also be placed to treat a pneumothorax unrelated to surgery.

Mediastinal drain(s) are placed in the mediastinum after open-heart surgery, to drain blood and to prevent cardiac tamponade and promote healing (Laker, 2010).

Indication for Insertion

- Pneumothorax
- Tension Pneumothorax
- Haemothorax
- Haemopneumothorax
- Pleural Effusion
- Chylothorax
- Empyema (pus) and complicated parapneumonic pleural effusion
- Post Thoracic Surgery (Hazinski 2013, Woodrow 2013, Porritt 2018)
-

Contraindications

- Need for immediate thoracotomy
- Risk of bleeding due to anticoagulation therapy/ patient has predisposition to bleeding or abnormal clotting profile (relative)
- Dermatologic disorder (relative) (Dev *et al*. 2007, Royal Children's Hospital Melbourne 2019).

Hands must be washed thoroughly before and after all contact with the patient, the chest drain or chest drain equipment (as per infection control guideline). Antiseptic non-touch technique (ANTT) to be used at the appropriate level for all procedures detailed in this document, as per hospital guideline (CHI 2022a).

Equipment

- Dressing Trolley
- Scalpel Size 11
- Sharps bin
- Chest Drain Insertion Pack
- Sterile drapes
- Small Suturing pack (Available from CSSD / Theatre)
- Sterile Water for Irrigation (1000mls)
- Chest Drain Clamps- *1 per drain*
- Steristrips
- Chest Drain, Thoraseal 3 (*As per doctors instructions, prepare as per manufacturer's instructions*)
- Analgesia and sedation Consult local protocols and Clinibee
- Local Anaesthetic applied as prescribed at least 30mins before i.e. Tetracaine (Ametop®).
- Orange needle
- 1, 2 and 5 ml syringes
- Sterile Gauze Swabs
- Suturing material i.e. anchor suture – 2/0 Sofsilks™ (silk) and purse string suture 3/0 Monosof™ (nylon).
- Sterile gloves
- Cleaning agent as per local policy
- Sterile Surgical Gown
- Drain Connection(s)
- Cooke Seldinger Chest Drain Set (selection per infant/ child's age)

Guide Only

- Neonate 8-12 fg
- Infant 12-16 fg
- Child 16-24 fg
- Adolescent 20-32 fg (Royal Children's Hospital Melbourne (RCH), 2019)
- Disposable "Inco" Pad

4.0 INSERTION OF A CHEST DRAIN

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>Preparation Explain procedure to patient/parents as appropriate</p>	<p>To inform patient / parents and gain co-operation To ensure consent for procedure Promotes patients/ parent's understanding and trust (Sasa 2019).</p>
<p>Consult chest x-ray</p>	<p>To verify the indication for insertion of the tube</p>
<p>Check patient's platelets and coagulation status in high-risk groups i.e. post cardiac patients as medically directed.</p>	<p>It is good practice to ensure any coagulopathy has been treated prior to insertion of chest drain (Anderson and Herring, <i>et al.</i>, 2022, Slade 2021).</p>
<p>Record base line vital signs i.e. temperature, heart rate, respirations, blood pressure and oxygen saturation. Document in PEWS Chart</p>	
<p>Ensure emergency equipment available i.e. oxygen, suction and ambu bag / rebreathing circuit and mask available at bedside or nearby.</p>	<p>To monitor effects of analgesia / sedation, and also enable accurate assessment of the patient during and post procedure.</p>
<p>NB: Ward patients may require a general anaesthetic for the insertion of a chest drain, and should be prepared for theatre as per hospital guidelines.</p>	<p>To ensure a safe environment for procedure (Slade 2021).</p>
<p>Administer analgesia and sedation as prescribed prior to procedure</p>	
<p><u>Patients in PICUs</u> Refer to local procedure analgesia protocol and Clinibee For example: '<i>Procedural Analgesia and Sedation in PICU/HDU</i>' on the PICU i-drive. '<i>Analgesia Guidelines on the TS idrive</i>'.</p>	<p>To promote comfort and adequate pain relief for the patient.</p>
<p><u>Patients on General Wards</u> Refer to local procedure analgesia protocol and Clinibee</p>	<p>To ensure correct medication is administered. (NMBI 2020).</p>
<p>Immediately before the procedure the patient should be reassessed and the site / side for the insertion of the chest drain confirmed by reviewing clinical signs and the chest x-ray.</p>	<p>To ensure that risks of error / risks of inserting a chest drain is minimised. (Leonard <i>et al.</i>, 2023). To ensure correct site surgery policy is followed.</p>
<p>Provide privacy for the patient during the procedure</p>	<p>To maintain the patients' privacy and dignity.</p>
<p>Position and Insertion Site Position child (supine or semi recumbent position), maximally abduct the child's arm or place behind their head or as indicated by doctor.</p>	<p>To allow easy accessibility to insert tube (Dev <i>et al</i> 2007)</p>
<p>The Doctor/Surgeon/ANP will prepare the skin around the proposed site with cleansing agent as per local policy.</p>	<p>Reduces transfer of micro-organisms Royal Children's Hospital Melbourne 2022, Sasa 2019, Slade 2021).</p>

A local anaesthetic is applied at least 30 minutes pre procedure i.e. Tetracaine (Ametop)	Intercostal drain placement is a very painful procedure because pleural intercostal, subcutaneous pain receptors are stimulated (Allegaert <i>et al.</i> 2004). Local anaesthetics prevent pain transmission by anaesthetising sensory nerves and blocking nerve conduction of a small area. Onset of action is within 2 minutes and lasts between 1-3 hours following subcutaneous infiltrate. When adrenaline is added to lignocaine it acts as a vasoconstrictor that limits perfusion and keeps anaesthetic localised and minimises any bleeding. It also increases lignocaine's duration of action by up to 50%(Joanne Briggs Institute 2021b)
Wash hands using appropriate aseptic non-touch technique (ANTT).	To prevent cross infection and standard precautions (CHI, 2022a; 2019)
Procedure Assemble chest drain ensuring the Water for Irrigation is filled to level as marked on the underwater seal chamber, as per manufactures instructions. Do not overfill the water seal chamber beyond 2cms. NB: Water seal chamber MUST be checked by 2 Registered Nurses.	It is more difficult for the patient to get air out of pleural space (<i>when level of water in underwater seal is greater than 2cms</i>) due to increased pressure and resistance (Joanne Briggs Institute 2021a). Failure to fill waterseal chamber may result in tension pneumothorax in the child, which is a medical emergency.
The doctor or ANP will usually make a small incision and dissect into the pleural space. The drain will be inserted and clamped close to the chest wall until attached to the underwater seal drain.	To ensure adequate drainage of air or fluid (Royal Children's Hospital Melbourne 2019). To secure chest drain and ensure that the tube does not become displaced. A chest drain open to air at the time of insertion will result in a pneumothorax (Nettina 2018).
Assist the doctor with the insertion of the drain into the proposed site.	
The doctor will attach the intercostal tube to the chest drain once inserted into the pleural cavity and unclamp the tube.	To ensure that the drain does not become displaced during patient movement or lung expansion (Nettina 2018).
Ensure chest drain is positioned minimum 30cms below the level of the patient.	This position encourages drainage and prevents siphoning of fluid, debris or air back into the pleural space (Joanne Briggs Institute 2021a)
The tube is then sutured in place with a 'stay' suture and also a purse string suture applied. The drainage tube may be secured in place with extra tape or elastoplast.	To ensure drain is in a satisfactory position and prevent displacement. The purse string suture is used during removal to seal the skin opening (Briggs 2021a, Nettina, 2018).
Wash hands using appropriate aseptic non-touch technique (ANTT).	To prevent cross infection. (CHI, 2022a)
Observe chest drain for: <ul style="list-style-type: none"> Bubbling (pneumothorax). Pleural drainage (pleural effusion). 	Evaluates effectiveness of chest drain (Li 2018, Slade 2021).
Post Chest drain insertion chest x-ray required	To ensure a pneumothorax has not developed and ensure correct tube positioning (Li 2018, Slade 2021).

Record and document respiratory status and vital signs following insertion of chest drain. Document in PEWs chart	To monitor patient's condition, early detection and timely intervention of any complications (Hazinski 2013).
Check air entry by auscultating the chest.	Early detection of worsening or improving respiratory status (Advanced Life Support Group (ALSG) 2023).
Palpate skin around site for subcutaneous emphysema. Report same.	To monitor for air leak.
Document procedure in patient's nursing notes.	To maintain an accurate record of nursing care and to facilitate communication. To ensure safe practice and maintain accountability (NMBI 2015)

5.0 COMPLICATIONS OF CHEST DRAIN INSERTION

- Pain
- Bleeding
- Haemothorax (*intercostal artery perforation*)
- Perforation of visceral organs (*heart, lung, diaphragm or intra-abdominal organs*)
- Perforation of aorta / subclavian vessels
- Pneumothorax / Subcutaneous emphysema
- Reexpansion pulmonary oedema (*uncommon, dramatic and unpredictable*)
- Infection (*site / pleural cavity i.e. empyema*)
- Pneumonia
- Technical problems (*intermittent blocking of tube i.e. pus, clotted blood or debris*)
- Incorrect positioning of drain (*ineffective drainage*)
- Intercostal neuralgia (*trauma of neurovascular bundles*)
- Chylothoracic (*damage to thoracic duct*)
- Cosmetic (*scar*)

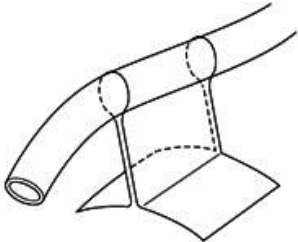
(Dev *et al.* 2007, Royal Children's Hospital 2019).

6.0 CARE OF A CHILD WITH A CHEST DRAIN



ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>Monitoring Report and document any abnormalities / concerns to the medical team as clinical condition indicates. Document all vital signs in the PEWS Chart</p>	<p>To ensure timely and appropriate intervention of any complications (Moola 2021).</p>
<p>Assess rate, depth, rhythm and effectiveness of respirations. Minimum 4 hourly or as condition indicates.</p>	<p>To establish baseline and detect changes in a timely fashion (Royal Children's Hospital Melbourne 2022, Sasa 2019). Breathlessness may be a sign of pneumothorax (ALSG, 2023)</p>
<p>Monitor colour and oxygen saturations to establish parameters of same. Minimum of 4 hourly or as condition indicates. Observe for equal chest expansion / symmetry, increased respiratory effort and signs of respiratory distress.</p>	<p>Deterioration in colour or drop in saturations may be a sign of hypoxia or worsening pneumothorax or air leak (Royal Children's Hospital Melbourne 2022).</p>
<p>Monitor temperature 4 hourly or as condition indicates.</p>	<p>Early detection of pyrexia and possible infection (Moola 2021).</p>
<p>Observe air entry by listening to both sides of the chest with a stethoscope (PICU / HDU). Record and report any abnormalities.</p>	<p>Unequal air entry may indicate worsening respiratory compromise i.e. pneumothorax. (ALSG, 2023)</p>
<p>Monitor heart rate and blood pressure, minimum 4 hourly or as condition dictates</p>	<p>Bradycardia may be a sign of hypoxia. Tachycardia or haemodynamic instability may be a sign of tension pneumothorax (Royal Children's Hospital Melbourne, 2022)</p>
<p>Monitor acid-base balance (as per medical team) PICU / HDU only</p>	
<p>Observe patient's conscious level utilising the AVPU (Alert, Voice, pain, Unresponsive) scale.</p>	<p>Agitation and restlessness may be a sign of hypoxia (Woodrow 2013). Drowsiness may be a sign of hypercapnia (high pCO₂), indicating inadequate ventilation.</p>
<p>Pain Relief / Position Nurse the patient in a comfortable semi-upright sitting position, well supported by pillows or in a chair.</p>	<p>To promote lung expansion and aid chest drainage. Also to prevent stiffening of shoulder joints (GOSH 2014).</p>
<p>Ensure regular position changes.</p>	<p>An upright position, well supported by pillows or sitting in a chair has been reported as the most comfortable position for patients (Royal Children's Hospital Melbourne 2022).</p>
<p>Monitor the child's pain score using a validated and age appropriate tool, minimum 4 hourly or as clinically indicated.</p>	<p>To assess child's pain objectively without personal bias (Royal Children's Hospital Melbourne 2022, Porritt 2018, Moola 2021).</p>
<p>The child will usually require an opiate analgesic of choice i.e. either by infusion, NCA / PCA or orally e.g. Oramorph® to ensure comfort and effective pain relief. Liaise with CNSp Acute Pain.</p>	<p>Considerable discomfort has been experienced whilst a chest drain is in situ, (Royal Hospital Melbourne 2022, CHI, 2023)</p>

Consult CHI PCA/NCA Protocols	(CHI, 2023)
Administer analgesia or encourage PCA/NCA bolus as indicated prior to any intervention.	Pain has been reported as most marked when patient trying to mobilise, get out of bed or during physiotherapy (CHI, 2023)
Administer regular multimodal analgesia around the clock.	To ensure child is pain free and comfortable
Use non-pharmacological methods of pain control i.e. play / distraction, as clinically indicated. Liaise with play specialist.	These alternative strategies of pain management are known to complement pharmacological ones
Encourage deep breathing, coughing and the use of incentive spirometry. Blow bubbles may be useful in the young child. Liaise with Physiotherapist.	These strategies will aid full lung expansion and prevent respiratory complications i.e. pneumonia (Slade 2019).
Encourage child to mobilise as able within room for pneumothorax and within unit / playroom with physiotherapist as clinically indicated.	To encourage air / fluid drainage.
Liaise with physiotherapist if chest x-ray changes present.	Chest physiotherapy may be indicated.
Psychological support should also be provided for both the child and their parents / guardians.	To reduce / allay anxiety

7.0 CARE OF THE INSERTION SITE

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>Observe for oozing. The nurse may apply a keyhole Mepore dressing as clinically indicated.</p>	<p>To prevent infection by keeping insertion site clean and dry (Leonard <i>et al.</i>, 2023).</p>
<p>Dressing should be left in place if clean and dry. Surgeons will often use extra steristrips to secure chest drain at the time of incision. This additional taping may be reapplied as clinically indicated if it becomes loose.</p>	<p>(Slade 2019)</p>
<p>Check insertion site daily. Observe for signs of infection i.e. inflammation, oedema, discharge, pyrexia. Ensure clean, dry and free from odour.</p>	<p>Early detection of inflammation / infection (Leonard <i>et al.</i>, 2023)</p>
<p>Report any abnormalities to the medical team.</p>	<p>Chest drains can act as a retrograde conduit and skin contaminants can pass to deeper layers of the insertion site (Moola 2021)</p>
<p>Ensure sutures remain secure and intact.</p>	<p>Sutures may erode over time especially in the child with long term chest drain (Royal Children’s Hospital Melbourne 2022).</p>
<p>Palpate the skin around site for surgical emphysema (<i>feels like Rice Krispies / crackly</i>). Notify Cardiothoracic (<i>medical / surgical team</i>) if present and extends beyond site or travels to patient’s face or neck. Document same.</p>	<p>Surgical emphysema is an early sign that air leak is present or worsening. It may also be a sign associated with a blocked tube and impeding tension pneumothorax (Leonard <i>et al.</i>, 2023, Manuel 2018).</p>
<p>Surgeon/ nurse may occasionally use an ‘omentum’ made from tape strapping as clinically indicated to secure drain to chest skin.</p>  <p>Figure 1: Securing chest drain using ‘omentum’ strapping technique NB: Do not secure chest drain tubing inside a nappy.</p>	<p>To prevent kinking, tension or pulling on the chest drain at the insertion site when moving the patient (Royal Children’s Hospital Melbourne 2022, Sasa 2019).</p> <p>This may restrict tension on the chest drain tube and cause iatrogenic loss of chest drain on movement resulting in a tension pneumothorax</p>

8.0 CARE OF THE CHEST DRAIN / EQUIPMENT

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>The Tubing Check tubing from chest tube to drainage system for leaks, kinks or obstructions</p>	<p>To ensure:</p> <ul style="list-style-type: none"> • Connections are secure • Drainage flows freely (Hazinski 2013, Joanna Briggs Institute 2021a)
<p>Avoid dependent and ascending loops (<i>hanging down below the top of the chest drain or lying on the floor</i>).</p> <p>Figure 2: AVOID dependent and ascending loops.</p> 	<p>Dependent and ascending loops can alter intrapleural pressure thereby increasing resistance, which impedes effective drainage. A column of fluid accumulating in the loop may seal and obstruct the drain and prevent effective drainage (Sasa 2019).</p> <p>NB: Predisposes the patient to a Tension Pneumothorax (Lampotang <i>et al.</i> 2011).</p>
<p>Secure excessive tubing by coiling flat on the cot/ bed and periodically straighten to promote drainage</p>  <p>Figure 3: Coiled chest drain (Audiovisual Dept. OLHSC, 2010)</p> <p>Remaining tubing should be in a straight line to the chest drain</p> <p>When the child is sitting in a low chair and dependent loops can't be avoided resulting in tubing coiled on floor. The tubing must be lifted every 15 minutes.</p>	<p>Coiled and straightened tube positions are optimal for draining fluid from the pleural space (Sasa 2019).</p> <p>Pressures + 38 have been reported with dependent loops. To prevent increased resistance, back pressure, obstructed flow and decreased drainage (Hazinski 2013).</p> <p>This will aid and ensure adequate drainage is maintained (Lampotang <i>et al.</i> 2011).</p>

<p>Do NOT manipulate the tubing by routine milking</p> <p>NB: In exceptional circumstances (PICU 2 only) it may be necessary to milk frequently and ONLY if drain likely to block due to clots i.e. fresh bleeding / haemorrhage post cardiac surgery.</p> <p>Clamping Chest Drains POTENTIALLY UNSAFE AND HIGHLY DANGEROUS Chest drains should not be routinely clamped when moving or transferring a patient.</p> <p>NB: A bubbling chest drain should NEVER be clamped Chest drains should only be clamped when changing bottles or after accidental disconnection</p>	<p>There is no evidence in the literature to support the need to routinely manipulate chest drains.</p> <p>Milking can cause excessive suction (Royal Children's Hospital Melbourne (2022) which is centre of controversy. It is not performed by nurses in Children's Health Ireland</p> <p>Chest drain pressures of -400cms H₂O have been demonstrated. The longer the section milked the higher the suction created (Duncan and Erickson 1982*; Dixon 2006, Slade 2019).</p> <p>High pressures during milking can also suck lung tissue into drainage holes and cause trauma to mediastinum or pleural space (Dixon 2010). New chest drains contain a non-thrombogenic coating thus decreasing the potential for clotting (Nettina 2018).</p> <p>Active bleeding may increase risk of clot formation and development of cardiac tamponade post cardiac surgery (Loughan 2019, Sasa 2019, Moola 2020).</p> <p>Clamping the drain can cause a build-up of pressure in the pleural space if air is draining. Predisposes to subcutaneous emphysema and Real Danger of Life Threatening Tension Pneumothorax. Tension pneumothorax occurs when air can enter alveoli but can not leave the pleural space. This increases pressures to a dangerous level, resulting in mediastinal shift. The heart, great vessels, lungs and trachea are pushed to the other side. This shift causes lung expansion to be severely decreased, venous return impeded, decreased cardiac output and results in sudden circulatory collapse (Lazzara 2002, Tang <i>et al.</i> 2002, Allibone 2003, Royal Children's Hospital Melbourne 2022 Sasa 2019, Slade 2019). (Appendix I)</p> <p>NB: Gravity of this complication outweighs the risk of disconnection. (Kirkwood 2002, Moola 2021).</p> <p>This indicates an air leak is present and is hazardous with the potential of converting a simple pneumothorax into life threatening tension pneumothorax (Laws <i>et al</i> 2003, Balfour-Lynn <i>et al.</i> 2005, Roskelly and Smith 2011, Royal Children's Hospital Melbourne 2022, Slade 2019).</p>
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THORASEAL III

Collection Chamber (1st Compartment)

The collection chamber acts as a reservoir for fluid draining from the chest drain i.e. pleural fluid or blood. The chamber is marked with graduations to record drainage.

NB: This drainage chamber is not emptied and the complete Thoraseal chest drain is replaced when chamber is full.

Monitor the collection chamber for drainage including the presence of blood

- Amount
- Colour (*blood, haemoserous, serous, chyle*)
- Consistency
- Flow

Check the volume of fluid drainage for the first 2 hours a minimum of every 30 minutes post insertion and hourly thereafter or as patients condition dictates. Document same.

Report and document any sudden changes in volume loss to the **cardiothoracic surgical team immediately**.

Post-operative cardiac patients should be closely monitored a minimum of half hourly until the patient has re-warmed and is stable

Significant postoperative bleeding is:

- > 3ml/kg/hour for three hours
- 5ml/kg/hour in any one hour.

This should be immediately reported to the Cardiothoracic surgical team for review

NB: Do not clamp the chest drains

Under Water Seal Chamber

(2nd Compartment)

This middle chamber allows air to escape from chest cavity but prevents air from entering the chest.

Ensure that there is sufficient Water for Irrigation in the chamber, as per markings on the chamber i.e. 2cms and the chest drain is submerged.

Some bloody drainage can be expected immediately following insertion of the drain or following chest surgery (Manuel 2018).

The amount of drainage will vary depending on the initial indication for the chest drain.

A mediastinal drain inserted following heart surgery is expected to yield more than a pleural drain inserted to treat pneumothorax (Moola 2021).

Close monitoring of losses aids early detection of bleeding. Sudden increase may indicate haemorrhage. (Hazinski 2013)

Sudden reduction may indicate kinked tubing or formation of clots (post open heart surgery), predisposing to cardiac tamponade.

The underwater seal chamber is only effective when there is sufficient water in chamber and chest drain is submerged. It then creates a one-way valve, allowing air to drain but preventing air re-entering the pleural space (Lazzara 2002, Tang *et al.* 2002).

Excessive submersion increases hydrostatic pressure which means that intrapleural air must exceed this and makes it more difficult for the patient to get air out of pleural space (Carroll 2000, Briggs 2010).

<p>Water seal chamber should not be overfilled beyond 2 cms.</p> <p>Observe for bubbling in the water seal chamber, on expiration and coughing</p> <p>Observe water level closely in the water seal chamber in response to respiration, i.e. swinging / oscillating. NB: This may be minimal/ difficult to observe in the infant</p> <p><i>NB: CLPS (Continuous low pressure suction) needs to be disconnected temporarily to observe swinging.</i></p> <p>The water seal chamber should be placed 30cms below the child's chest.</p> <p>Suction Chamber (3rd Chamber)</p> <p><i>CLPS- Continuous Low Pressure Suction</i></p> <p>Fill suction chamber to 10 -15 cms of water, using Water for Irrigation i.e. 10cm in infants and 15cms in child. This may be increased to 15-20 cms of water in the adolescent / adult.</p> <p>Refill water in suction chamber periodically as required to maintain negative pressure.</p> <p>To activate suction, adjust low pressure suction device at wall, until slow gentle continuous bubbling is observed. The bubbling should only be seen in the suction chamber.</p>	<p>Intermittent bubbling in the underwater seal chamber confirms an air leak. A minor leak causes bubbling on coughing when peak airway pressures are reached. Continuous bubbling indicates a massive air leak (Royal Children's Hospital Melbourne, 2022, Sasa 2019).</p> <p>This indicates that the chest tube is patent. If not present the lungs may have reexpanded or the tube needs to be checked for obstruction i.e. loops / kinks (Leonard, <i>et al</i>, 2023) Increased water level implies an increase in negative pressure within the pleural space.</p> <p>Decreased water level implies less negative pressure. In a self-ventilating child when system is open to atmospheric air, swinging will occur on inspiration as intrapleural pressure is below atmospheric pressure and decreases with expiration NB: This is reversed when the child is on mechanical ventilation i.e. water level decreases during inspiration and increases during expiration (Briggs 2010, Dixon 2010).</p> <p><i>NB: Swinging does not occur if the child's chest drain is on continuous low pressure suction.</i></p> <p>This positioning encourages drainage and prevents siphoning of fluid, debris or air back into the pleural space (Dixon 2010, Laker 2010).</p> <p>Amount of water in the suction chamber controls the low pressure suction, minus length of water seal tube below water level Negative pressure can not go above set level {safety feature}. (Henry <i>et al</i> 2003, British Thoracic Society 2010, Frasier 2012, Schlosser 2013). High negative pressures can cause damage to lungs i.e. parenchyma injury (Loughran 2019).</p> <p>Water may evaporate (Frazer 2012, Sasa 2019).</p> <p>Bubbles vent excess vacuum pressure (Carroll 2000). Turbulent bubbling caused by high airflow has been reported as generating excessive negative pressures under certain conditions i.e. up to 37cms H₂O. This should be considered a warning sign of potential high negative pressures in the chest (Bar-El <i>et al</i>. 2001). Also excessive bubbling will cause increased evaporation and noise for the infant / child or parents/ guardians. Evaporation also decreases low pressure suction (Frasier 2012, Sasa 2019).</p>
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<p>Chest drain suction (CLPS) is routinely applied to chest drains following open heart surgery. It is not usually applied to pleural drains initially but may be added by the medical team later, for collection of fluid, persistent air leak or failure of a pneumothorax to expand.</p> <p>NB: Once suction is discontinued the suction connection tubing to the drain should be disconnected.</p> <p>a) CHANGING OF CHEST DRAIN UNIT The system should only be changed, as per manufacturer's guidelines.</p> <p>Explain procedure if appropriate to child / parents.</p> <p>Wash hands using an aseptic non-touch technique (ANTT) and put on sterile gloves and appropriate PPE.</p> <p>Assemble new chest drain, ensuring water seal filled with sterile water to within 2 cm of marked line and also suction chamber to desired level. Be careful not to touch the sterile tip of the chest drain tubing. NB: Water seal chamber must be checked by 2 nurses, one of whom is a senior Registered Nurse</p> <p>Remove suction from chest drain.</p> <p>Wrap gauze around chest drain and double clamp chest tubing close to chest wall.</p> <p><i>NB: Only clamp tubing for minimal time necessary to quickly disconnect and reconnect the chest tube.</i></p> <p>Reconnect new chest drain tubing ensuring the connection is secure.</p> <p>Remove clamps.</p> <p>Reattach suction until gentle bubbling in the suction control chamber.</p> <p>Auscultate the chest and observe respiratory status Document in the PEWs Chart</p>	<p>Suction enhances the removal of excessive blood from the mediastinum preventing cardiac tamponade. Also excessive air / fluid drainage from the pleural space, restores negative pressure and enhances lung expansion (Allibone 2003).</p> <p>A closed system can potentially generate positive pressure if an air leak is present and may precipitate a tension pneumothorax (Tang <i>et al.</i> 2002, Leonard <i>et al.</i>, 2023)</p> <p>Once the system is two thirds full or if in situ for more than 1 week (Durai Hoque and Davies 2010, Joanna Briggs Institute 2021c). More frequent changing may precipitate cross infection. It may also need to be replaced if tubing disconnects and becomes contaminated.</p> <p>To allay anxiety (Anderson and Herring, 2023).</p> <p>(CHI, 2022a)</p> <p>Failure to fill waterseal chamber may result in tension pneumothorax in the child.</p> <p>To protect chest drain tubing from damage.</p> <p>To prevent air entering the pleural space through the tubing (Joanna Briggs Institute 2021c). Clamping can cause air to accumulate the pleural cavity and predisposes to tension pneumothorax (Moola 2021).</p> <p>To assess for pneumothorax</p>
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<p>Disposal of Equipment To discard chest drain, secure drain tip in a disposable glove and fasten with sleek tape</p> <p>The chest drain is then placed in a large leak proof yellow sharps container in the sluice</p> <p>Remove gloves and aprons and dispose of them in clinical waste bin. Wash hands.</p> <p>Documentation Document in nursing notes:</p> <ul style="list-style-type: none"> • Fluid level in drainage chamber of discarded chest drain • Reason for change of chest drain • Evaluation of patient. 	<p>To prevent spillage and contamination of chest drainage from the chest drain unit.</p> <p>To adhere to hospital waste policy</p> <p>To reduce transmission of organisms. Standard precautions (CHI 2019)</p> <p>Continuity of nursing care (NMBI 2016)</p> <p>To maintain an accurate record of nursing care and to facilitate communication. To ensure safe practice and maintain accountability (NMBI 2015).</p>
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9.0 TAKING A SAMPLE OF CHEST DRAINAGE

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>A self-sealing mechanism on the chest drain tubing of the Thoraceal III enables a sample of chest drain fluid to be obtained without opening the drainage system. DO NOT OPEN CHEST DRAINAGE SYSTEM TO OBTAIN SAMPLE</p>	
<p>Equipment</p> <ul style="list-style-type: none"> • 10 ml luer lock syringe • Sterile orange needle • Specimen jar and form • Clinell wipe • Non sterile gloves • PPE i.e. eye protection • Dressing pack • 	<p>(Royal Children’s Hospital Melbourne 2022, Joanna Briggs Institute 2017, Joanna Briggs Institute 2021d),.</p>
<p>Explain procedure to child / parent if appropriate</p>	<p>To gain child’s trust and help alleviate child / parents anxiety (Anderson and Herring, 2023).</p>
<p>Allow chest drain tubing to hang in loop and drainage fluid to collect.</p>	<p>To ensure sufficient fluid for chest drain fluid sample (Royal Children’s Hospital Melbourne 2022, Joanna Briggs Institute 2017).</p>
<p>Decontaminate hands using ANTT and put on appropriate PPE</p>	<p>To prevent contamination of the sample (CHI, 2022a)</p>
<p>Clean insertion site with Clinell and allow to dry.</p>	

Using a 10 ml luer lock syringe and orange needle aspirate a minimum of 2-5mls from the chest drain tubing loop, at 45-degree angle, using ANTT Transfer aspirate to specimen container	To maintain a closed system and prevent cross infection 90 degree angle insertion angle may damage the tube (Joanna Briggs Institute 2017). (Joanna Briggs Institute 2021d)
Perform hand hygiene	
Label specimen jar and request form. Send to the laboratory	To ensure analysis is carried out correctly. To obtain microbiological / biochemical analysis of the sample as directed by medical team
Document the intervention in the child’s nursing notes: <ul style="list-style-type: none"> • Time and date of sample • Colour, volume and consistency of drainage fluid. 	To maintain continuity of care and accountability through accurate recording of the nursing care (NMBI 2016)

10.0 CARE OF A CHEST DRAIN VALVE

10.1 HEIMLICH VALVE

A Heimlich Valve may be used for transportation instead of a chest drain for a small uncomplicated pneumothorax. Its main advantage is portability. It has a one-way flutter valve (Nettina 2018, Deakin 2021), which is essentially ‘a water-seal chamber’ (Lazzara 2002:38). This is connected to the chest drain tube and evacuates air from the pleural space by removing air as the patient exhales. The valve opens when the pleural pressure is greater than atmospheric pressure and closes when the reverse occurs (Nettina 2018).



Figure 4: Heimlich Valve. **NB: Blue end to chest drain tube**

ACTION	RATIONALE, EVIDENCE & REFERENCE
The devise consists of a flutter valve which is a length of tube flattened at one end. (Figure 1, Appendix IV).	The valve allows air or fluid to pass in one direction only but prevents air / fluid from re-entering the chest (Lazzara 2002).
Valve is encased in a plastic cylinder.	To protect the flutter valve from external compression and occlusion (Joanna Briggs Institute 2021c)
Specific Nursing Considerations Attach proximal BLUE END of Heimlich Valve to the chest drain. Embossed on valve is: ‘connect chest drain to this end’ and ARROW.	To ensure correct direction for air flow. <i>NB: Valve only functions if correctly positioned, and increased risk of pneumothorax if incorrectly placed</i> (Deakin 2021).
Maintain sterility	Prevent cross infection.
Ensure nothing blocks the flow of air at the distal end.	

<p>Check valve hourly for fluttering.</p>	<p>Fluttering indicates that the tube is patent and air can escape.</p> <ul style="list-style-type: none"> • No fluttering: Indicates that Pneumothorax has resolved. • No fluttering and signs of respiratory distress: May indicate that the valve is occluded and should be replaced (Gordan and Lorenz 1986).
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10.2 ATRIUM PNEUMOSTAT™ CHEST DRAIN VALVE.

The Atrium Pneumostat™ is a disposable single patient use chest drain valve with a 30 ml collection chamber. A needleless fluid sample port provides fluid removal by syringe (Atrium 2010, Sasa 2019).



Figure 5: Pneumostat™ Chest Drain Value

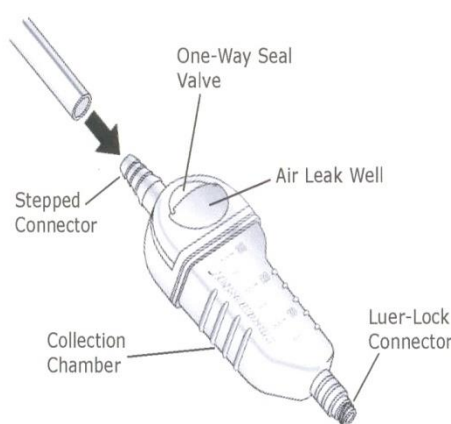




Figure 6: Main Parts of Pneumostat Chest Valve

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>Indications To evacuate air from chest cavity i.e. simple pneumothorax. Transition from traditional chest drain to a smaller and more mobile device.</p>	
<p>Warnings</p> <ul style="list-style-type: none"> • Pneumostat must not be used for fluid collection over 30mls • Keep air leak well free of obstruction • Do not clamp chest drain during use. • Do not use or puncture device with a needle. • Do not leave syringe attached to needleless fluid sample port. • Do not connect any open luer-lock connector to needleless luer port on bottom of device 	<p>May cause tension pneumothorax (Maquet 2020) Damage may occur to the luer lock seal and open pleural space to atmospheric air, thereby compromising respirations (Maquet 2020)</p> <p>Damage to sealing may occur (Maquet 2020) This may result in opening pleural space to atmospheric air, thereby compromising respirations (Maquet 2020)</p>

<p>Precautions Replace Pneumostat chest drain valve if:</p> <ul style="list-style-type: none"> • It is damaged • Volume exceeds 30mls • There is evidence of occlusion having occurred • Needleless Luer-Lock port becomes clogged 	<p>(Maquet 2020)</p>
<p>Ensure Pneumostat is securely fastened to the chest drain</p>	
<p>Two drains must not be connected to the Pneumostat with a Y connection device.</p>	
<p>Set Up Chest drain is inserted firmly into the stepped connector of Pneumostat using ANTT Level 2</p>	<p>(Maquet 2020)</p>
<p>Air Leak Detection Water 1ml is inserted into the air leak well. Bubbling in the water will confirm an air leak. NB: Air leak well needs to be emptied after use.</p>	
<p>Emptying the Pneumostat Pneumostat is kept in the upright position, with tubing attached to end of chest drain.</p>	<p>To prevent leakage from pneumostat (Maquet 2020)</p>
<p>Empty before pneumostat completely fills with fluid.</p>	
<p>Apply non-sterile gloves.</p>	
<p>Swap needleless sample port with Clincell swap before and after syringe attachment.</p>	
<p>Firmly screw a luer-lock syringe to the port on the bottom of the Pneumostat™</p>  <p>Figure 7: Attach 50 ml syringe</p> <p>Aspirate fluid into the syringe. Unscrew the syringe and empty the fluid into a suitable receptacle. Repeat PRN.</p>  <p>Figure 8: Aspirate chest drainage (Figure 5-8 used with permission, Atrium 2010)</p>	<p>(Atrium 2010, Maquet 2020)</p> <p>(Atrium 2010, Maquet 2020)</p>

<p>Disconnection Clamp off chest drain prior to removal.</p>	<p>(Atrium 2010, Maquet 2020)</p>
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11.0 REMOVAL OF CHEST DRAINS: NURSING RESPONSIBILITIES

Introduction

A chest drain should be removed once there is clinical resolution of reason for initial chest drain insertion (Leonard *et al.*, 2023). Long term drainage may be required for chronic air leak in patients with pulmonary disease and in some patients with pleural effusions, chylothorax and empyema.

ACTION	RATIONALE, EVIDENCE & REFERENCE
<p>Verify doctor’s order for chest tube removal.</p>	<p>The decision to remove the chest drain(s) is guided by the cardio-thoracic surgical team.</p>
<p>Indications for Chest Drain Removal</p> <p>When drainage is minimal</p> <ul style="list-style-type: none"> Residual air leak / fluid is no longer evident. When chest x-ray, pulse oximetry and arterial blood gases are within normal limits for the individual patient. Coagulation blood results are within normal limits. <p>The cardiothoracic surgeon has ordered chest tube to be removed.</p>	
<p>Pre Procedure</p>	
<p>Fasting Fast patient prior to procedure as clinically indicated.</p>	<p>To prevent aspiration.</p>
<p>Procedure will usually performed pre feed/ following holding feed. Consult medical team/anaesthetist as appropriate.</p>	<p>Patients especially in PICU / HDU will usually be given anaesthetic / sedative medication.</p>
<p>A play therapist may be utilised for preparation and / or distraction if appropriate</p>	<p>To relieve fear, anxiety and foster trust, understanding and cooperation for the procedure.</p>
<p>Anticoagulation Therapeutic Heparin Infusions are usually held 4-6 hours prior to chest drain removal.</p> <p>Prophylactic Heparin infusions for CVC patency in PICU please refer to the anti Thrombotic Central line guideline (OLCHC, 2012). CHI@Crumlin PICU only</p> <p>NB: Liaise with Cardiothoracic team regarding holding heparin and target coagulation results for removal.</p> <p>The Heparin infusion is recommenced following a post procedure Chest X ray and if there is no bleeding.</p> <p>LMWH (Low Molecular Weight Heparin e.g. Tinzaparin) is usually held the morning of chest drain removal. This is done in liaison with the cardiothoracic team</p>	<p>Chest Drains should only be removed after therapeutic heparin has been discontinued as per anti-thrombotic guidelines (OLCHC 2012b) (CHI Cardiothoracic Surgeons, 2023a)</p>

<p>IV Access Ensure patient has a patent intravenous cannula insitu prior to the procedure.</p>	<p>To provide a route for analgesia, sedative or emergency medication as necessary.</p>
<p>Monitoring Record the child's observations, recorded prior to removal i.e. temperature, pulse, respirations, SaO2 and blood pressure</p>	<p>To establish baseline observations for comparison post procedure.</p>
<p>Safety The nurse will ensure emergency equipment is working and available at the bedside</p> <ul style="list-style-type: none"> • Amubag / rebreathing circuit (PICU/ HDU) and appropriate mask • Oxygen and mask • Suction equipment and suction catheters 	
<p>Non Pharmacological interventions Ensure to explore non pharmacological methods applicable to the clinical area, examples include play and distraction.</p>	
<p>Pain Relief</p> <ul style="list-style-type: none"> • Administer multimodal analgesia and sedation prescribed by the medical team • Ensure medication is appropriately timed to have peak effect. • Sedation will always be given in conjunction with analgesia. <p>NB: An anaesthetist will always be present in the PICU if an anaesthetist agent is used.</p>	<p>It is a painful procedure for children (Leonard 2023, Clinibee, 2023)</p> <p>Utilise local area procedural pain protocols E.g 'Procedural Analgesia and Sedation in PICU/HDU' on the PICU CHI@Crumlin i-drive. Analgesia Guidelines on the TS idrive. (CHI, 2022b)</p>
<p>Apply topical Tetracaine Gel (Ametop®) around each chest drain site avoiding incision site as per protocol</p>	<p>Subcutaneous nociceptors may play a significant role in pain during chest drain removal. Topical and transdermal analgesics have been demonstrated to blunt the pain of chest drain removal. Local anaesthesia will remain effective, in most patients for between 4-6 hours. Clinibee (2023)</p>
<p>Positioning The child will be positioned comfortably either supine or alternatively at 30o angle as clinically indicated for the procedure where there is a good access to the drain</p>	<p>To ensure correct positioning for chest drain(s) removal (Leonard <i>et al.</i>, 2023).</p>
<p>Procedure</p>	
<p>Responsibility for Removal of Chest Drains Appropriately trained medical/nursing staff may carry out removal of the drain(s).</p>	
<p>Equipment Required</p> <ul style="list-style-type: none"> • Dressing Pack • Sterile Gloves. • Goggles and plastic apron. • Cleaning solution as per local policy • Stitch cutter. • Occlusive dressing i.e. Op-Site™ Post Op (6.5cms x 5cms), one for each chest drain site. • Chest drain clamps x 2 for each drain 	

<ul style="list-style-type: none"> • Incontinent ‘Inco’ pad. • Sterile prep towel • Slick adhesive tape. • Sterile Scissors. 	
<p>Verify doctors order for chest tube removal</p> <ul style="list-style-type: none"> • Put on personal protective equipment • Prepare trolley for procedure. • Assist / set up the sterile dressing pack. • Place protective pad i.e. incontinent ‘inco’ pad underneath the drains • Wash hands using aseptic non-touch aseptic technique (ANTT) • Place sterile dressing prep towel over incontinent pad. • The second nurse remove steristrips and / or dressing from around drain site(s). <p>Identify sutures present:</p> <ul style="list-style-type: none"> • Anchor suture • Purse-string suture, expose the end sutures. 	<p>To reduce the risk of contamination. Face shield / goggles should be worn to protect face / eyes and plastic apron to protect clothing as splashes can occur on removal of drains. (CHI, 2019; Hunter 2008).</p> <p>(CHI 2022a)</p> <p>To absorb any ooze from the drain. To reduce risk of contamination of the patient and bed clothing</p> <p>To inspect the drain insertion site and prepare for drain removal (Hunter 2008).</p>
<p>Both nurses repeat hand washing and apply sterile gloves, using ANTT</p>	
<p>Clean drain site with cleansing agent as per local policy as clinically indicated.</p> <hr/> <p>Thoraceal 1 Drain Drain must be clamped prior to removal if not on continuous low-pressure suction.</p> <p>Thoraceal III Drain Remove drain with continuous low-pressure suction (CLPS) on and clamp remaining drain(s). Repeat procedure for each remaining drain(s) as above, also ensuring any drain(s) already removed are also clamped.</p> <hr/> <p>Anchor suture is cut, at the site, of the drain that is being removed. <i>NB: Remember to cut the anchor suture below the knot and flush with skin.</i> The nurse ensures the drain is mobile and ready to be removed.</p> <p>In an older cooperative child (wards), the nurse may ask the child to do deep breathing exercises as clinically indicated.</p> <p>Nurses agree their roles for removal of drains.</p> <ul style="list-style-type: none"> • First nurse prepares purse string suture ready to be tied. • 2nd nurse removes the drain swiftly on count of 3 at the beginning of the child’s third expiratory breath 	<p>To reduce the risk of infection.</p> <p>To prevent air entering the pleural space.</p> <p>Continuous low-pressure suction will remove any air whilst removing the drain. Clamping of other drains stops air re-entering the pleural space. (GOSH 2014).</p> <p>This frees the drain from the skin (Leonard <i>et al.</i>, 2023).</p> <p>To reduce anxiety and nurses may be able to coordinate removal of drain with the child’s own breathing pattern. To minimise risk of air influx through chest drain site and development of pneumothorax (Bell <i>et al.</i> 2001).</p> <p>To aid and prepare for drain removal. (Anderson and Herring, 2023)</p> <p>To prevent air entering the pleural space through the tract causing a pneumothorax. (Leonard <i>et al.</i>, 2023).</p>


<p>NB: Drain removal and purse string suture tie are performed simultaneously.</p> <p>Purse string suture is ONLY tied to close the skin. 3 knots performed and cut to about 1 cm of site. NB: Avoid over tying.</p> <p>If strong resistance encountered, nurse stops the procedure and inform cardiothoracic surgical team.</p> <p>Examine each drain to verify that all of the drain has been removed.</p> <p>Cover drain site with an air occlusive dressing i.e. Opsite™ dressing for minimum 24-48 hours.</p> <p>Procedure repeated for each individual drain, removing drains one at a time.</p> <p>No Purse String Suture Cover the drain site with an air occlusive dressing i.e. Opsite™ dressing, whilst drain is being removed following the above procedure.</p>	<p>To avoid puckering of the skin and poor cosmetic wound healing. Also to prevent skin necrosis (Leonard <i>et al</i>, 2023).</p> <p>To observe for any retention of the chest drain</p> <p>To compare with initial patient assessment and ensure early detection and timely treatment of any potential complication</p>
<p>Post Procedure</p>	
<p>Patient Assess the patient following the procedure. Record vital signs / respiratory status.</p>	<p>To exclude pneumothorax and lungs reexpanded (GOSH 2014, McGuinness 2022).</p>
<p>Observe for signs of increasing respiratory distress, anxiety or agitation, minimum hourly as clinically indicated.</p>	<p>If a pneumothorax is present after pleural chest drain removal, then it is likely to be a technical problem i.e. air entered during drain removal. When pneumothorax develops 1-2 days later and not present following removal, it is pulmonary air leak. (Breachnach, 2022, Mc Guinness, 2022).</p>
<p>Assist in obtaining a chest x-ray 1 hour post chest drain removal pleural chest drain.</p>	<p>Close observation of the patient for signs of respiratory compromise is the best indicator for accumulation of air or fluid. Chest x-ray has not been demonstrated to result in greater detection of pneumothorax. Routine chest x-ray in asymptomatic child may not be necessary (van Den Boom and Battin 2007, Royal Children’s Hospital Melbourne 2022)</p>
<p>Disposal of Equipment</p>  <p>Figure 9: Thoraseal 3 following removal</p> <p>To discard chest drain, secure drain tip in a disposable glove and fasten with sleek tape</p>	<p>To prevent spillage and contamination of chest drainage from the chest drain unit. To adhere to hospital waste policy</p>



Figure 10: Thoraseal 3 chest drain covered with glove and taped following chest drain removal

The chest drain is then placed in a large leak proof yellow sharps container in the sluice



Figure 11: Disposal unit for Thoraseal 3 chest drain.

Remove gloves, aprons, and dispose of them in clinical waste bin. Perform hand Hygiene.

Wound Site

Remove purse string suture from each chest drain site approximately 5-7 days post removal as per cardiothoracic surgical team.

If the drain site appears inflamed or purulent, a swab should be obtained and sent to lab for culture and sensitivity. Inform cardiothoracic medical / surgical team.

To detect infection.

Documentation

Record drainage on fluid chart and in nursing notes
 Document the procedure in nursing notes including patients’ clinical response, removal of suture(s) and all changes.

To maintain an accurate record of the procedure and nursing care. Documentation provides continuity of care when information is shared and facilitates communication. It also ensure safe practice and maintain accountability (NMBI 2015).

Surgeons Request

Some cardiothoracic surgeons may request that the child’s chest drain be clamped for 4 hours, prior to chest drain removal.

Verify instructions with the patients’ consultant and ensure documented by doctor in the child’s medical notes.

Observe and monitor child vigilantly for signs of increasing respiratory distress whilst the chest drain is clamped.

NB: Child should not leave the clinical environment.

Remove the chest drain clamp immediately and inform medical / surgical cardiothoracic team if there are any concerns about the patients’ clinical condition.

This is a potentially unsafe practice and may predispose child to tension pneumothorax. Although this practise is questioned, it continues (Laws et al. 2003) (CHI Cardiothoracic Surgeons, 2023)

12.0 ASSISTING WITH INTRAPLEURAL ALTEPLASE AND UROKINASE TREATMENT: NURSING RESPONSIBILITIES

Introduction

Intrapleural Alteplase treatment may be medically indicated in a child with a complicated parapneumonic effusion or empyema. (Bishop *et al.* 2003, Walker *et al.* 2003, Weinstein, *et al.* 2004)

Definitions

- **Parapneumonic Effusion:** Collection of pleural fluid associated with underlying pneumonia. Effusion is usually unilateral and the fluid is thick with loculations.
- **Empyema:** The presence of overt pus in the pleural space. It is often the result of progression of a parapneumonic effusion caused by a community acquired pneumonia. There is increased production and decreased reabsorption of pleural fluid. Normal function of fibrinolytic pathways is also decreased and an increased production of fibrin at reabsorption sites occurs. Empyema has a significant morbidity in children and can be therapeutically challenging. Bilateral empyema is unusual.
- **Alteplase** Fibrinolytic agent which in empyema may lyse fibrinous strands and thereby clear the lymphatic pores. This results in effective filtration and reabsorption of the pleural fluid (Walker *et al.* 2003, Weinstein, *et al.* 2004)

Complications Associated with Parapneumonic Effusion or Empyema

Usually uncommon but can include:

- Bronchopleural fistula
- Lung abscess
- Perforation through the chest wall (Empyema necessitates). (Balfour-Lynn *et al.* 2005).

Indications

The management of parapneumonic effusion or empyema includes the insertion of a chest drain. In some instances however, a chest drain will not adequately drain the empyema. In this situation, the intrapleural instillation of Alteplase may be required in combination with chest drainage to allow effective drainage of the pleural cavity. (Balfour-Lynn *et al.* 2005).

In CHI Crumlin the instillation of intrapleural Alteplase must be performed by a medical doctor

Equipment

- Dressing Trolley
- Sterile dressing pack
- Sterile drape
- Non-powdered sterile gloves
- Sterile scissors
- Non-toothed clamp x 2
- Clinell Wipes x 6
- Cutisoft swab x 1
- 10ml syringe x 1
- 23g needle
- 50ml bladder tip syringe
- 100ml bag 0.9% Sodium chloride (> 1year) or 1 x 10ml Sodium Chloride 0.9% miniplasco (< 1 year)
- Withdrawal cannula
- tPA (Alteplase or Urokinase) (as per CHI@Crumlin Drug Formulary)

ACTION	RATIONALE, EVIDENCE & REFERENCE
Pre Procedure	
Coagulation status is checked as clinically indicated.	
Explain procedure to child / parents as clinically indicated. Involve play specialist if appropriate.	To allay anxiety

A prescriber (Doctor or ANP) prescribes Intrapleural Alteplase or Urokinase prescription and administration record" (Drug Kardex) or Electronic Health Record as appropriate as per CHI medication Policy.	To ensure the correct prescription and solution is prepared for the correct child and minimise risk of error, in adherence with Medication Policy (OLCHC 2010a, NMBI 2015)
tPA (Alteplase or Urokinase): Available tPA are Alteplase and Urokinase. Doses administered must be prescribed on the patient's "Prescription and Administration Record" or electronic health record as appropriate. 1mg/kg (Max. 3mg) Twice-daily dose x 3 days (total 6 doses).	CHI Formulary (Clinibee, 2023)
Preparation See CHI Formulary for up to date preparation guidelines	
Procedure Explain the procedure to child and parents/carers as clinically indicated.	To gain child's trust and reduce his / her anxiety and obtain consent from the parents (Anderson and Herring, 2023).
Assess patient's pain using an appropriate tool and ensure adequate analgesia is administered.	To promote comfort and reduce anxiety during procedure (OLHSC 2004)
Wash hands using Aseptic non-touch technique (ANT) (level 3) before commencing procedure.	(CHI 2022b)
Prepare trolley for the procedure with soap and water, and allow to dry; wipe the surface with a Clinell, from the centre outwards in a circular motion. Allow to dry thoroughly.	To create a clean working area and to prevent cross infection (CHI, 2019)
Wash hands using aseptic non-touch technique (ANNT).	To minimize the risk of infection and to have the equipment ready (CHI 2022a)
Assist / set up the sterile dressing pack. Open sterile equipment onto sterile working area.	To create a sterile field (CHI 2019; 2022b)
Doctor will apply sterile gloves.	
Doctor draws up local anaesthetic lidocaine 2% and administers around the chest drain site allowing time to take effect.	
The doctor draws up Alteplase solution. Sterile 'prep' sheet is placed under chest drain. The chest drain is clamped and disconnected from the Thoraseal III drain The proximal end of the chest tube is cleansed with Bethidine solution. Chest drain now unclamped and Doctor administers the urokinase solution slowly	There may be an increase in chest drain losses following urokinase treatment To prevent cross infection

<p>When medication administration is complete, the tube is reconnected to Thoraseal 3 and reclamped.</p> <p>Following administration chest drain is clamped for 4 hours or according to cardiothoracic team instructions.</p> <p>Check doctors instructions regarding positioning of patient i.e. on affected side or back.</p> <p>Unclamp chest drain after 4 hours and reconnect the Thoraseal 3 drain to continuous low-pressure suction (CLPS).</p>	
<p>Record and document chest drainage losses and all care given in nursing notes.</p>	<p>To maintain an accurate record of nursing care and to facilitate communication. To ensure safe practice and maintain accountability (NMBI 2016).</p>
<p>Discard waste and used supplies in Healthcare Risk Waste (i.e. Clinical Waste) if contaminated with blood or body fluids. Otherwise, discard into the Healthcare Non Risk Waste (Household waste). Sharps into sharps bin.</p>	

13.0 KEY STAKEHOLDERS

The following key stakeholders were involved in developing and/or reviewing this document:

Name	Title	Department
Tara Connaughton	CNEF PICU	CHI at Crumlin
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Sarah Flaherty	ANP Pain Service	CHI at Crumlin
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14.0 APPENDICES

APPENDIX I - Key points to be considered before clamping a chest drain

The only indications now accepted for clamping underwater seal drains are:

- Post-operatively following pneumonectomy, to maintain the central mediastinal position.
- When changing chest drain(s) collection unit.
- Following intrapleural tPA (Alteplase® or Urokinase®) treatment chest drains are clamped as per formulary or as per Cardiothoracic consultant.
- In pleuradesis treatment following drug instillation by doctor.
- In some instances, when removing a chest drain (see section on same).
- Following insertion of chest drain and initial rapid drainage of pleural / chyle fluid.
- On accidental disconnection of the chest drain:
 - a) Clamp drain and reconnect new system
 - b) Submerge the disconnected chest drain under water
 - c) Quickly reconnecting the drainage tubes or reassembling a new system, if the previous one has been contaminated.

NB: Either of the above actions will be dependent on the child’s condition and the length of time the tube could be clamped for. (Balfour-Lynn *et al* 2005; Laker 2010, Woodrow 2013).

APPENDIX 2 - Complications of Chest Drain Removal

Complications	Signs and Symptoms	Prevention	Treatment / Intervention
Pneumothorax	<ul style="list-style-type: none"> • Decreased oxygen saturation • Increased work of breathing • Diminished breath sounds on affected side. • Increased restlessness/ complains of chest discomfort (older child) 	<ul style="list-style-type: none"> • Assess for air leakage in water seal chamber before removal • Clamp chest drain before removal (Thoraseal 1 only) • Remove drain with continuous low-pressure suction (CLPS) on. • Remove drain on expiration • If there is no purse string suture, seal the wound with an air occlusive dressing at the time of removal 	<ul style="list-style-type: none"> • Contact medical / surgical cardiothoracic team • Order chest x-ray • Possibly, reinsert chest drain, by medical team
Bleeding <i>(rare)</i>	<ul style="list-style-type: none"> • Persistent bleeding from the chest drain insertion site that repeated saturates the occlusive dressing 	<ul style="list-style-type: none"> • May be unavoidable if the chest tube was against the vein or artery of chest wall before removal 	<ul style="list-style-type: none"> • Apply pressure. Place a tight occlusive dressing over the site. • If bleeding persists, contact medical / surgical cardiothoracic team

<p><i>Skin Necrosis</i> <i>(purse string suture)</i></p>	<ul style="list-style-type: none"> • Chest drain insertion site dark or inflamed, with necrotic areas visible 	<ul style="list-style-type: none"> • Avoid pulling purse string suture too tightly closed when chest drain is removed 	<ul style="list-style-type: none"> • Contact medical / surgical cardiothoracic team
<p><i>Retained Chest Drain</i></p>	<ul style="list-style-type: none"> • Extreme resistance felt with chest drain removal. • Chest drain obviously not intact on removal 	<ul style="list-style-type: none"> • Stop removal efforts if extreme resistance is experienced with removal attempt. • Inspect all chest drain tips following removal for intactness 	<ul style="list-style-type: none"> • Immediately contact medical / surgical cardiothoracic team • Surgeon may consider possible resternotomy
<p><i>Infection</i></p>	<ul style="list-style-type: none"> • Inflammation, tenderness or purulent discharge at site • Pyrexia 	<ul style="list-style-type: none"> • Apply sterile occlusive dressing i.e. mepore if purse string suture not in situ. • An aseptic non-touch technique (ANTT) is used with all clinical procedures. Strict handwashing. 	<ul style="list-style-type: none"> • Contact medical / surgical cardiothoracic team. • Obtain wound swab if clinically indicated

14.0 REFERENCES

- Advanced Life Support Group (2023) *Advanced Paediatric Life Support: The Practical Approach*, 6th Edition. Oxford: Blackwell Publishing.
- Allegaert, K. Nauelaers, G. Debeer, A. Breysem, L. Ferens, I. Vanhole, C. Devlieger, H. and Tibboel, D. (2004) 'The use of methohexital during chest tube removal in neonates'. *Paediatric Anaesthesia* **14**(4): pp 308-312.
- Anderson C. E. and Herring R.A (2022) Pediatric Nursing Interventions and Skills. In *Wongs Essentials of Pediatric Nursing*, 11th edn. (Hockenberry MJ, Rodgers CC & Wilson D, Eds.), St Louis
- APAGBI (2012) *Good Practice in Post-operative and Procedural Pain Management*, 2nd Edition. A guideline from the Association of Paediatric Anaesthetists of Great Britain and Ireland. *Pediatric Anaesthesia*, **22**(s1): pp 1-79.
- Atrium (2010) 'Pneumostat™ Chest Drain Valve. Patient Instructions for Use'. Hodson: Atrium Medical Corporation.
- Balfour-Lynn, I.M. Abrahamson, E. Cohen, G. Hartley, J. King, S. Parikh, D. Spencer, D. Thomson, A.H. Urquhart, D. (2005) 'BTS Guideline: BTS guidelines for the management of pleural infection in children'. *Thorax* **60** (Suppl 1) 1-21.
- Bar-El, Y. Ross, A. Kablawi, A. and Egenburg, S. (2001) 'Potentially dangerous negative intrapleural pressures generated by ordinary pleural drainage systems'. *Chest* **119**: 511-514.
- Bell, R.L. Ovadia, P. Abdullah, F. Spector, S. and Rabinovici, R. (2001) 'Chest tube removal: end-inspiration or end-expiration'? *The Journal of Trauma Injury, Infection and Critical Care* **50**(4): pp 674-677.
- Bishop N. B, *et al.* (2003) 'Alteplase in the treatment of complicated parapneumonic effusion: a case report'. *Abstract: Pediatrics*, **111**: p 423.
- Breatnach, C. (2022) *Verbal and Email Correspondence to Authors. March 2022*'. Dublin: CHI Crumlin.
- Briggs, D. (2010) 'Nursing care and management of patients with intrapleural drains'. *Nursing Standard* **24** (21): pp 47-55.
- Bruce, E.A. Franck, L. and Howard, R.F. (2006) 'The efficiency of morphine and Entonox analgesia during chest drain removal in children'. *Paediatric Anaesthesia* **16**(3): 302-308.
- Carroll, P. (2000) 'Exploring chest drain options'. *RN* **63**(10): pp 50-52, 54.
- CHI Crumlin Cardiothoracic Surgeons (2023a) 'Verbal communication with JMcGuinness February 2023'.
- CHI Crumlin Cardiothoracic Surgeons (2023b) 'Email communication with JMcGuinness November 2023'
- Children's Health Ireland (CHI) (2023) 'STANDARD OPERATING PROCEDURE FOR THE MANAGEMENT OF PATIENT / NURSE CONTROLLED OPIOID ANALGESIA' Dublin: CHI Crumlin.
- CHI (2022a) Nursing Practice Guideline on Aseptic Non-Touch Technique (ANTT) Quick Reference Guide. [ant-guidelines-2022.pdf \(childrenshealthireland.ie\)](https://www.childrenshealthireland.ie/ant-guidelines-2022.pdf). Dublin:CHI.
- CHI Crumlin (2022b) *Procedural Analgesia and Sedation in PICU/ HDU*'. Dublin: Children's Health Ireland at Crumlin.
- CHI (2019) Guideline on Standard Precautions. Dublin:Childrens Health Ireland.

Deakin, L. (2021) Evidence Summary, *Chest Drains: Heimlich Valve*. The Joanna Briggs Institute. : EBP Database JBI-ES-2787-1.

Dev, S.P. Bartolomeu, B. Simone, C. and Chien, V. (2007) 'Chest tube insertion'. *The New England Journal of Medicine* **357**: p e15.

Dixon, M. (2010) 'Chest Drainage' In: Trigg, E. and Mohammed, T.A. (eds) *Practices in Children's Nursing. Guidelines for Hospital and Community*, 3rd Edition. Edinburgh: Elsevier: Churchill Livingstone, pp 163-169.

Dougherty, L. and Lister, S (eds) (2015) *The Royal Marsden Hospital Manual of Clinical Nursing Procedures, Professional Edition*, 9th Edition. Chichester: John Wiley and Sons Ltd.

Duncan, C.R. and Erickson, R.S. (1982) 'Pressures associated with chest tube stripping'. *Heart and Lung* **11** (2): pp 166-171.

Durai, R. Hoque, H. and Davies, T.W. (2010) 'Managing a chest tube and drainage system'. *AORN*, **91**(2): pp 275-283.

Frazer, C.A. (2012) 'Managing chest tubes'. *Academy of Medical-Surgical Nurses: Newsletter*, **21**(1): pp 9-12.

GOSH (2014) 'Chest Drain Management'. Great Ormond Street Hospital. Available online: www.gosh.nhs.uk/health-professionals/clinical-guidelines/chest-drain-management. (Accessed October 21st 2014).

Hazinski, M.F. (ed) (2013) 'Nursing Care of the Critically Ill Child', 3rd Edition. St Louis: Mosby.

Health Service Executive (2011) *HSE Standards & Recommended Practices for Healthcare Records Management*. Dublin: Health Service Executive..

Leonard E, et al. (2023) Respiratory Care. In *The Great Ormond Street Hospital Manual of Children and Young People's Nursing Practices*, 2nd edn. (Bruce EA, Williss J & Gibson F, Eds.), Wiley-Blackwell, Hoboken, N.J., 645-682.

Hunter, J. (2008) 'Chest drain removal'. *Nursing Standard* **22**(45): pp 35-38.

Joanna Briggs Institute (2016) *Chest Drains: Bottle and Tubing Changes*. Adelaide: The Joanna Briggs Institute.

Joanna Briggs Institute (2017) *Chest Drains: Specimen Collection*. Adelaide: The Joanna Briggs Institute.

Joanna Briggs Institute (2021a) *Recommended Practice: Chest Drain Insertion*. The JBI EBP Database. JPI-RP-4824-2.

Joanna Briggs Institute (2021b) *Recommended Practice: Chest Drain Dressing*. The JBI EBP Database. JPI-RP-4639-1.

Joanna Briggs Institute (2021c) *Recommended Practice: Chest Drains: Underwater Seal Drain Changes*. The JBI EBP Database. JPI-RP-4642-1.

Joanna Briggs Institute (2021d) *Recommended Practice: Chest Drains: Specimen Collection*.. The JBI EBP Database. JPI-RP-4638-1.

Lago, P. Garetti, E. Merazzi, D. et al. (2009) 'Guidelines for procedural pain in the newborn'. *Acta Paediatrica*, **98**(6): pp 932-939.

Laker, S. (2010) 'Invasive cardiothoracic support'. In: Glasper, A. Aylott, M. and Battrick, C. (eds) developing *Practical Skills for Nursing Children and Young People*. London: Hodder Arnold, pp 456-462.

Lampotang, S. Lampotang, K. Lizdas, D.E. Schwab, W.K. and Gravenstein, N. (2011) 'Fluid Filled Dependent Loops in Chest Drainage Systems Attenuate Set Vacuum Levels and Impede Lung Re-inflation in an In-vitro Model' The Annual Anesthesiology Annual Meeting, American Society of Anesthesiology. Available online:

<http://www.asaabstracts.com/strands/asaabstracts/abstract.htm?year=2011&index=18&absnum=4767> (Accessed April 30th 2021).

Laws, D. Neville, E. and Duffy, J. (2003) 'British Thoracic Society guidelines for the insertion of a chest drain'. *Thorax* **58**: pp 53-59.

Lazzara, D. (2002) 'Eliminate the air of mystery from chest tubes'. *Nursing* **32**(6): pp 36-45.

Leonard E, et al. (2023) Respiratory Care. In *The Great Ormond Street Hospital Manual of Children and Young People's Nursing Practices*, 2nd edn. (Bruce EA, Willis J & Gibson F, Eds.), Wiley-Blackwell, Hoboken, N.J., 645-682.

Li, Y. (2018) *Chest Drain: Insertion*. Adelaide: The Joanna Briggs Institute.

Loughran, P. (2019) Stripping or milking of chest drains. *Critical Care Nurse*, **39**(3): pp 72-73.

Magner, C. (2009) 'Nurses' Knowledge of Chest Drain Management in an Irish Paediatric Hospital'. Unpublished MSc. Thesis. Dublin: RCSI.

Manuel, B. (2018) *Chest Drains: Monitoring*. Adelaide: The Joanna Briggs Institute.

Mbinji, M. (2021) *Chest Drains: Maintenance*. Adelaide: Joanna Briggs Institute.

Maquet (2020) 'Chest Drain Valve: Instructions for use'. Solna, Sweden: Maquet Critical Care.

McGuinness, J. (2022) 'Email Correspondence to Authors February 22nd 2022'. Dublin: CHI Crumlin.

Moola, S. (2020) *Evidence Summary, Cardiac Tamponade, Prevention: Mediastinal Chest Drain Clearance*. The JBI EBP Database. JPI-ES-273-1.

Moola, S. (2021) *Chest Drain (Child): Nursing Management in the Care of the Chest Drain*. Adelaide: Joanna Briggs Institute.

Nettina, S.M. (ed) (2018) *Lippincott Manual of Nursing Practice*, 11th Edition. Philadelphia: Wolters Kluwer.

NMBI (2020) *Guidance for Registered Nurses and Midwives on Medication Administration*. Dublin: Nursing and Midwifery Board of Ireland.

NMBI (2015) *Scope of Nursing and Midwifery Practice Framework*. Dublin: Nursing and Midwifery Board of Ireland.

NMBI (2016) *Recording Clinical Practice, Guidance for Nursing and Midwifery*. Dublin: Nursing and Midwifery Board of Ireland.

OLCHC (2012) 'Anti Thrombotic Central Line Guideline'. Dublin: Our Lady's Children's Hospital Crumlin.

Porritt, K. (2018) *Chest Drains (Child): Nursing Management and Care of Chest Drains in Children*. Adelaide: The Joanna Briggs Institute.

Roskelly, L. and Smith, A.P. (2011) Respiratory care. In: Dogherty, L. and Lister, S. (eds) *The Royal Marsden Hospital Manual of Clinical Nursing Procedures*, 8th Edition. Oxford: Wiley-Blackwell, pp 534-614.

Royal Children's Hospital Melbourne (2022) *'Chest Drain: Management'*. Royal Children's Hospital Melbourne. Available online: [Nursing guidelines : Chest drain management \(rch.org.au\)](https://nursingguidelines.rch.org.au) (Accessed November 22nd 2022).

Royal Children's Hospital Melbourne (2019) *'Thoracentesis and Chest Drain Insertion'* Royal Children's Hospital Melbourne. Available online: www.rch.org.au/clinical_guideline/guideline-index/Thoracocentesis-andchest-drain-insertion/ (Accessed (February 2nd 2022).

Sasa, R.L. (2019) 'Evidence based update on chest tube management'. *American Nurse Today*, **14**(4): pp 10-14.

Slade, S. (2019) *'Chest Drain: Maintenance'*. Adelaide: The Joanna Briggs Institute.

Slade, S. (2021) *Evidence Summary. Chest Drains: Insertion*. The JBI EBP Database, JBI-ES-2012-1.

Tang, A.T.M. Velissaris, T.J. and Weeden, D.F. (2002) 'An evidence-based approach to drainage of the pleural cavity: evaluation of best practice'. *Journal of Evaluation in Clinical Practice* **8**(3): pp 333-340.

Van den Boom, J. and Battin, M. (2007) 'Chest radiographs after removal of chest drains in neonates: clinical benefit or common practice'? *Archives of Diseases of Childhood, Fetal Neonatal Edition*, **92**: pp F46-F48.

Walker, J. (2007) 'Patient preparation for safe removal of surgical drains'. *Nursing Standard* **21**(49): pp 39-41.

Walker CA, et al. (2003) 'Intrapleural alteplase in a patient with complicated pleural effusion. *Annals of Pharmacotherapy*, **37**:pp 376-9.

Weinstein M, et al. (2004) Effectiveness and safety of tissue plasminogen activator in the management of complicated parapneumonic effusions. Abstract: *Pediatrics*, **113**: p 610.

Woodrow, P. (2013) 'Intrapleural chest drainage'. *Nursing Standard*, **27**(40): p 49.

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