Intercostal Catheters (Chest Drains) in Neonates: Nursing Management

Procedure Responsibilities and Authorisation

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Procedure Review History

Version	Updated by	Date Updated	Summary of Changes
5	Joyce Mok & Jenni Richards	Jan 2014	3-yearly Update
6	Richard Pagdanganan	Feb 2017	3-yearly update
7	Richard Pagdanganan	May 2020	3- yearly update
8	Karlena Best Aira Javier	March 2024	Change of title, monitoring, removed insertion and taping section, added in troubleshooting table

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Contents

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1 Overview

1.1 Purpose

- To ensure the chest drain functions properly and minimise risks of complications and infection.
- To provide safe and competent management of infants with chest drains.
- See also Intercostal Catheters in the Neonate Ref 6396

1.2 Staff group

Waikato staff working in NICU.

1.3 Patient / client group

Neonates and infants in NICU.

1.4 Definitions

Chest Drain or intercostal drain (IDC)	It is inserted to allow draining of the pleural spaces of air, blood or fluid, allowing expansion of the lungs and restoration of negative pressure in the thoracic cavity, and prevents evacuated fluid and air from returning to the pleural space.
CNS	Clinical Nurse Specialist
Chylothorax	Collection of lymph fluid in the pleural space
NNP	Neonatal Nurse Practitioner
Pneumothorax	The collection of air in the pleural space, which may be unilateral or bilateral. Treatment includes intercostal drain with suction.
Pneumomediastinum	Air is accumulated in the anterior mediastinum and will resolve spontaneously unless associated with pneumothorax
Pneumopericardium	Air is trapped between the heart and the pericardial sac and may present with cardiac tamponade. Treatment includes aspirating/tapping pericardial space or placing pericardial drain
Pneumoperitoneum	Air enters peritoneal space via the posterior mediastinal openings in the diaphragm. Treatment is same as for pneumothorax. Differentiate between air from a ruptured abdominal organ or an extension of a pneumothorax.
Pulmonary Interstitial Emphysema (PIE)	The collection of gas outside of the normal air passages and inside the connective tissue of the peribronchovascular sheaths, interlobular septa, and visceral pleura. This collection develops as a result of alveolar and terminal bronchiolar rupture. It is more frequent in premature infants who require mechanical ventilation for severe lung disease
Tension Pneumothorax	It can lead to rapid deterioration and it is a medical emergency where free pleural air continues to accumulate in pleural space with compression of lung(s) and heart.

2 Clinical Management

2.1 Competency required

Registered nurses who have completed Continuous Positive Airway Pressure (CPAP) or Ventilator orientation.

2.2 Procedure

2.2.1 Prior to insertion of intercostal catheter (chest drain)

- Inform parents about the rationale of the procedure to lessen their anxiety.

Immediate care

- Position the baby supine to facilitate air removal. It is easiest to lay the baby supine, using rolled towels or a blanket to slightly rotate the upper body in a side-lying position, with the arm of the affected side raised above the head.
- Alternatively, elevate head of the bed to 30-40 degrees to facilitate fluid drainage, to decrease work of breathing, to localise air in the upper lobes, and push the abdominal organs downward away from diaphragm to localise in lower lobes.
- Administer oxygen, sometimes need up to 100% to improve oxygenation and/or manually ventilate infant by Neopuff if infant deteriorates due to pneumothorax.
- Obtain transilluminator, turn off nursery lights and examine baby with transilluminator to identify quickly the possibility of air leak.
- Assist medical staff/CNS/NNP with emergency treatment, e.g. aspirating air using butterfly cannula.

Assemble chest drain system

NB: Maintain sterility of connectors during preparation or change of the drainage system or alterations of any of the connections to avoid introducing pathogens into the pleural space.

- Clean the trolley with disinfectant wipes.
- Remove the plastic dust cover, which is not sterile.
- Perform hand hygiene.
- Open the blue wrap, which is not sterile.
- Perform hand hygiene and put on sterile gloves.
- Handle contents of the drainage system using sterile technique.
- Fill water seal to 2cm line
    - Use the water ampoule that can be found on the side of the chest drainage system.
    - Twist top off and insert the tip into the suction port.
    - Squeeze the contents into the water seal until fluid reaches 2cm line.

Rationale: the 2cm water seal acts as a one-way valve that allows air or fluid to be drained from the pleural space but not returned to it.

Water will be tinted blue to provide visibility of air leaks and monitoring of baby's intrathoracic pressure.

2.2.2 Insertion of chest drain

Pain relief/Sedation:

- Administer pain relief/sedation to promote comfort, in order of preference:
  - sucrose solution 25%, Sucrose Oral Liquid for Analgesia in Neonates and Infants (Ref. 2906)
  - lidocaine 1% (locally), Lidocaine 1 Percent for Neonates (Ref. 6368)
  - fentanyl, Fentanyl for neonates (Ref. 2916) or
  - midazolam (intranasal preferred). Midazolam for neonates (Ref. 2939)

Positioning

- Position baby comfortably with affected side uppermost to enable easy and safe insertion of chest drain by medical staff.
- Raise the bed to waist level prior to the procedure.

Insertion of chest drain by medical staff (registrar/CNS/NNP/consultant)
See Intercostal Catheters in the Neonate Ref 6396

- Medical staff are responsible for the insertion of chest drains and the following actions:
  - Use sterile procedure: put on a cap, mask, sterile gown and gloves, and prepare sterile field.
  - Administer local anaesthetic, e.g. lidocaine 1%, as needed.
  - Assemble chest drain tube: 3-way tap, 10ml syringe and a multi-purpose connector.
  - Insert chest drain.
  - Cut drainage tubing to the appropriate length before connecting to the 3-way tap to avoid dependent loops which can reduce the likelihood of increased negative pressure.
- Connect chest drain to drainage system
  - Connect chest drain to patient prior to initiating suction.
  - Connect suction source to the wall suction control.

- Set wall suction at minus 80mmHg, set higher if necessary: Expansion of the bellows will be seen in the monitor window. NB: Bellows need not extend to the mark.
- Make sure a spare suction is ready for use.

Special notes:

- Use the dial on the left side of the drain, **dial down to -10 cm water** to ensure adequate and safe level of negative pressure to drain the pleural space.
- Suction regulator of chest drainage system comes pre-set at -20 cm water. -20cm is not the correct level for this NICU procedure.

Position of drainage tubes

- Position drainage tubes flat on the bed and angled toward the baby's head to encourage drainage.
- Ensure absence of kinking or pressure of the drainage tubing that can produce back pressure, impede drainage or force drainage back in the pleural space.
- Wrap Elastoplast plaster around the drainage tubes, make a tail of the plaster and secure safety pin to the bed linen to prevent pulling or dragging on the insertion site resulting in accidental tube dislodgement.
- Ensure the tubing remains at the level of the baby to prevent fluid flowing back into the pleural space.

Position of drainage system

- Place the chest drainage system below the level of the chest in an upright position, at least 30cm below the baby's chest.
- Hang the drainage system from the bed with holder provided or place on the floor using attached stand to avoid accidentally knocking over the device.

2.2.3 After insertion of chest drains

Comfort and safety of the infant

- Position the baby comfortably and turn every 4 hours, if condition allows.
- Baby is not usually nursed prone.
- Positioning is determined by the area of leak.
- Assess pain and comfort of infant and administer pain relief as required as per Neonatal Pain and Sedation - Assessment and Nursing Management in NICU (Ref. 1684)
- Check all the connections are secure to ensure the system is leak free and functioning.
- Keep chest forceps with rubber-tips (at least one for each chest drain) at the bedside to clamp chest tube in case the drainage system cracks or in an emergency.

- **NOTE:**
  - Do not clamp the drain or tubing (unless it is an emergency or as directed by the medical team) because whenever the chest tube is clamped, air or fluid can't escape from the pleural space. Clamping chest drain suction is not required for routine shift safety checks.
  - Prolonged clamping of a chest drain that is inserted to resolve a pneumothorax can lead to tension pneumothorax.
- NEVER "strip" a chest tube because intraluminal pressures can rise dangerously high, which may convert a simple pneumothorax to a life threatening pneumothorax and cause tissue trauma and unnecessary discomfort.
- During transport, keep the chest tube drainage system below the chest level.
- Do not clamp the chest tube during transport.
- Do not tip the chest tube drainage system.
- Cuddles with parents can be facilitated depending on baby's clinical condition in discussion with the medical team. This must be at least a two person transfer with one nurse solely responsible for the chest drain to avoid tube dislodgement or disconnection.
- When air is completely drained and chest drain is no longer bubbling, on Consultant's instructions, chest drain may be clamped before removal to evaluate the patient's tolerance. No need for chest x-ray unless there are signs of clinical deterioration.
- Keep parents informed of baby's condition.

Monitoring of infant and documentation

- Assess and note the baby's respiratory status
  - Respiratory rate
  - Quality of respirations
  - Deterioration, e.g. cyanosis, subcutaneous emphysema or bleeding
  - Shallow breathing
- Auscultate breath sounds, e.g. 4-8 hourly and as needed, to assess air exchange, change in sounds may indicate that the lung has not re-expanded.
- Continuous monitoring and hourly recording of observations such as heart rate, respiratory rate, SpO_2, blood pressure (if arterial line is available), or cuff BP 1-4 hourly as indicated, and peripheral temperature.
- Assess dressing & insertion site minimum 4-6 hourly with cares or more frequently as required.
- During care time, palpate the area surrounding the site for crepitus or subcutaneous emphysema, which is an indication of air leak into the subcutaneous tissue surrounding the insertion site.

- If you hear air leaking from the insertion site, ask for assistance to inform the medical staff immediately and prepare for insertion of a new chest tube.
- Observe for complications:
  - Accidental drain dislodgement
  - Infection
  - Pain
  - Air leak from the insertion site
  - Tubing disconnection
  - Chests drain occlusion with subsequent tension pneumothorax.

Report to medical staff/CNS/NNP if baby's condition changes.

Monitoring of drainage and air leak

- Monitor and record hourly the character, consistency and amount of drainage in the drainage collection chamber.
- Mark the drainage level in the drainage collection chamber by noting the time and date at the drainage level on the chamber at least once every shift to know the amount of drainage.
- Check and record hourly air-leak monitor for right-to-left bubbling and fluctuations:
  - An initial air leak is expected when a chest tube is inserted to treat a pneumothorax.
  - Continuous bubbling indicate persistent air leak.
  - Intermittent bubbling with swinging indicates intermittent air leak.
  - Fluctuation of water in the air leak chamber is a normal reflection of pressure changes in the pleural cavity during respirations.
- For the baby on a ventilator with positive end-expiratory pressure (PEEP), continuous bubbling typically occurs because PEEP maintains positive pressure in the alveoli: thus air will continually flow through the lungs. However, lack of continuous bubbling for baby on PEEP is not abnormal.

- Monitoring of chest drain system
  - Observe the integrity of the drainage tubing and chest tube hourly to ensure that the system is intact, with no air leaks, kinks or clot formation.
  - Verify that the rotary dry-suction control dial is turned to the ordered suction mark at -10cm water pressure, as per NICU procedure.
  - The correct suction is being delivered when the bellows reach the calibrated triangular mark in the suction monitor bellows window.
  - **NOTE:** Bellows need not extend to the mark.

- Check hourly the water-seal level is at 2cm line to ensure underwater seal is maintained at a safe level.

2.2.4 Changing drainage system

Indications:

- When the drainage chamber is full, e.g. for baby draining such as chylothorax, haemothorax.

Equipment

- Chest drainage system
- Sterile gloves
- Elastoplast tapes
- Safety pin
- Trolley, cleaned with disinfectant wipes
- Bandage scissors

Before change

- Notify medical staff of the change in the event the baby deteriorates during the procedure.
- Gather the necessary supplies.
- Clean the trolley with disinfectant wipes.
- Ask another nurse to assist you in changing the drainage system to ensure the safety of the patient.
- Put on personal protective equipment as needed.

Preparation of drainage system

- Open the plastic dust cover of the drainage system and blue cover.
- Perform hand hygiene
- Put on sterile gloves.
- Ensure contents are sterile and keep the end-cap of drainage tubing in place.
- Fill water seal with water provided to 2 cm line.
- Assistant to hang the drainage system from the bed with the holders provided or place on the floor using attached floor stand to avoid accidentally knocking over the device.

Changing the drainage system

- Maintain sterility of the patient connection by keeping an end-cap in place.

- Use sterile dressing scissors to cut drainage tubing to the appropriate length to avoid creating dependent loops.
- If suction is being used: assisting nurse must turn off the suction to the drainage system.
- Before changing the drainage system, clamp drain at 3-way tap closest to the baby for a short period.
- NB: Clamp the drain as short time as possible, therefore it should not be clamped for longer than 1 minute. If clamps remain in place for too long, air and fluid can accumulate in the pleural space or additional pneumothoraces/tension could develop.
- Disconnect the old drainage tubing from the chest drain using sterile technique.
- Connect the drain to new tubing.
- Re-open the 3-way tap.
- Check the baby's condition throughout the procedure.
- Secure tubing using Elastoplast tape and secure it on the bed linen using a safety pin to avoid tube dislodgement.

Observations after change

- Ensure that all clamps are open.
- Ensure the drainage tubing has a straight flow to the chest tube drainage collection device and has no dependent loops or kinks.
- Connect the suction tubing to the drainage system and the suction regulator.
- Verify dry suction control set at -10cm water pressure.
- Verify water seal is at 2cm line.
- Check the status of the drainage tubing.
- Reassess the baby after the procedure and baby's response to and tolerance of the procedure.
- Measure and record amount of fluid in old drainage chamber.
- Obtain fluid specimen, as needed, before discarding the drainage system.

Disposal of used drainage system

- Dispose the used system into the large yellow Biohazard bin in the sluice room.
- Remove gloves, and perform hand hygiene.
- Document the procedure

2.2.5 Obtain samples for analysis via patient tubing and luer port of drainage system

Equipment

- Chlorhexidine-alcohol pads
- Needles, size 20 gauge for aspiration
- **NOTE:** Do not use 18 gauge or larger needle as the hole will not seal adequately
- Some selected models include a needleless luer port on the patient tube connector for sampling. Use chlorhexidine-alcohol pad to clean the luer port prior to syringe attachment, do no use needle.
- Syringe
- Specimen container

Method

- Perform hand hygiene
- Swab the area to be sampled with chlorhexidine swab, and wait until it is dry.
- Create a temporary dependent loop of patient tubing of drainage system.
- Insert needle at an oblique angle into patient tubing.
- Obtain the specimen and send to laboratory with correct patient label and lab form.
- Dispose used equipment and sharps into appropriate containers.
- Perform hand hygiene and document the procedure.

2.2.6 Removal of chest drain - two people procedure

- Chest drain is removed by medical staff.
- Chest drain can be removed by nurses under the guidance of the medical staff.

Equipment

- Dressing pack
- Suture set: scissors and forceps, as needed
- Pain relief
- Alcohol-free Chlorhexidine cleansing agent – for skin
- Water proof dressing, e.g. Opsite
- Trolley cleaned with disinfectant wipes

Preparation:

- Assess baby: record vital signs and perform a respiratory assessment
- Administer pain relief and provide appropriate non-pharmacologic comfort measures.
- Position baby comfortably on the unaffected side.
- Open dressing pack and suture set, if needed, onto cleaned trolley surface.

Removal of chest drain

- Perform hand hygiene and put on sterile gloves.
- Check the chest drain from the point of origin (insertion site) to the baby to ensure that the correct drain will be removed.
- Assisting nurse should remove the duoderm/dressing.
- Clean the site with alcohol-free chlorhexidine cleansing agent.
- Remove suture if present.
- Withdraw gently the chest drain during the baby's exhalation.
- Cover the insertion site with gauze and an airtight dressing to seal the insertion site from air entry.

Monitoring of Infant after removal of chest drain

- Monitor during and after the procedure to determine infant's response and tolerance of it.
- Record hourly vital signs, including respiratory rate, pattern, and effort.
- Monitor colour, perfusion, oxygen requirements, and hemodynamic stability.
- Assess for signs and symptoms of pneumothorax, subcutaneous emphysema, or infection.
- Assess the chest tube insertion site for bleeding and make sure that the dressing is intact.
- Chest x-ray may be ordered to ensure lung expansion. It must be performed if there is a significant change in the patient's clinical condition following the removal.
- Document the procedure.

2.3 Troubleshooting

(From Lippincott Procedures: Chest tube insertion, assisting, paediatric: August 2023

https://procedures.lww.com/lnp/view.do?pId=729020

TROUBLESHOOTING CHEST TUBES		
Use this table to determine possible causes of and interventions for common chest tube problems.		
Problem	**Possible causes**	**Intervention**
Water level in the water-seal chamber not rising and falling with breathing	Clot in the chest tube or the child's chest	• If available, incorporate an active chest tube clearance device into the drainage system to help prevent clot formation. • Avoid fluid-filled dependent loops in the drainage system tubing • Avoid routinely stripping and milking the tubing *because doing so creates high negative pressure and can damage lung tissue*
	Dependent loop or kink in the chest tube with fluid occlusion	• Straighten the catheter and tubing along its length to its connection with the collection device.
	Dislodgment of the chest tube from the child	• If the chest tube dislodges accidentally and the child has an air leak from the chest tube, • Immediately cover the site with a sterile dressing and tape it on three sides, allowing air to escape on the fourth side to help reduce the risk of tension pneumothorax. • Alternatively, cover the site with a sterile occlusive dressing with a one-way valve (if available). If your previous assessment didn't detect an air leak, • Place a sterile occlusive dressing over the site and closely monitor the child closely for signs of respiratory distress. • Stay with the child and have a colleague immediately call the practitioner. • Assess for signs and symptoms of tension pneumothorax (such as hypotension; distended jugular veins; absent or decreased breath sounds; tracheal shift; hypoxemia; weak, rapid pulse; dyspnea; tachypnea; diaphoresis; and chest pain).

		• Have your colleague gather the equipment needed to reinsert the chest tube.
	Disconnection of the chest tube from the chest tube connector	• If the drainage system cracks or a tube disconnects, momentarily clamp the chest tube close to the insertion site • *Because no air or liquid can escape from the pleural space while the tube is clamped, closely observe the child for signs and symptoms of tension pneumothorax while tube is clamped.* • As an alternative to clamping the chest tube, submerge the distal end of the tube in a container of sterile water to help create a temporary water seal while you replace the drainage system. • Notify the practitioner immediately.
	Closed tube clamp	• Clamp the tube only when indicated; otherwise, leave the tube open.
	Chest drain not positioned sufficiently below the child's chest	• Lower the chest tube *to enable gravity drainage.*
	Inline connectors not properly secured, enabling an air leak	• Make sure that inline connectors are properly secured and sealed at all times; check for loose connections periodically.
Constant bubbling in the water-seal chamber	Air leak	• Determine the source of an air leak (child or catheter connection), by momentarily clamping the chest tube close to the chest drain and observe the water seal. If the bubbling stops, the air leak may be from the catheter connections or the child's chest. • Check the catheter connections and child's dressing for a partially withdrawn catheter. • If the catheter is dislodged, follow the catheter dislodgment procedure above. • Bubbling that continues after clamping the tube temporarily, indicates a system leak which requires system replacement.
Overfilled water-seal level (water above 2-cm limit line) or overfilled suction-control chamber	Too much water in the chamber	• Press and hold the negative-pressure relief valve at the top of the chest drainage system *to vent excess negative pressure in the water-seal chamber.* • Release the valve when the level of the water returns to the 2-cm mark. • Do not lower the water level in the water-seal chamber if the child's chest tube is draining by gravity drainage (not suction), • *To remove water from the suction- control chamber,* insert the syringe and withdraw the excess.

Not enough water in the water-seal or suction-control chamber	Evaporation versus underfill or spillage	• Add additional sterile water to the suction-control chamber by turning off the suction source temporarily, removing the rubber stopper, and adding sterile water to the desired level. • Add additional sterile water to the water-seal chamber with a 20G or smaller needle and syringe by injecting sterile water into the grommet on the back of the water-seal chamber.[31]
Suction control chamber is not bubbling or is bubbling too vigorously	Possible disconnection of the suction source or too much suction source pressure in the system	• Ensure that the suction tubing is connected and that the suction source is turned on. A constant, gentle bubbling is normal. Vigorous bubbling causes quicker evaporation. • Adjust the suction- control source for gentle bubbling.
Chest drainage system accidentally knocked over	Human error	• Set the system upright, secure it, and check the fluid levels in the water-seal and suction-control chambers for proper volumes. • Adjust volumes accordingly. Most units have a baffle system that prevents fluids from mixing between chambers, allowing for proper function after setting the system upright again.
Specimen collection required	Practitioner's orders for laboratory analysis	• Remove fluid with a needle and syringe from the self-sealing portion of the drainage tubing or with a needleless syringe from the needleless site of the drainage tubing after disinfecting the tubing fluid collection site.

2.4 Potential complications

- Pericardial tamponade, hemothorax, pleural effusion, decreased cardiac output, and death. In the presence of air production, chest tube clogging can cause tension pneumothorax, and in the setting of infection, empyema or bleeding.

3 Audit

3.1 Indicators

There is documented evidence of:

- physiological observations as per this guideline
- a correct water pressure of - 10cm, at all times
- analgesia administered as per NICU procedures

4 Evidence base

4.1 References

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- Chest drain management (2022) Royal Children's Hospital Melbourne, Retrieved on March 2023 https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Chest_drain_management/

4.2 Associated Health NZ Waikato Documents

- NICU Service Specific Drug Manual
- Intercostal Catheters in the Neonate guideline (Ref. 6396)
- Neonatal Pain and Sedation - Assessment and Nursing Management in NICU guideline (Ref. 1684)
- Fentanyl for neonates medicine guideline (Ref. 2916)
- Lidocaine 1 Percent for Neonates medicine guideline (Ref. 6368)
- Midazolam for neonates medicine guideline (Ref. 2939)
- Sucrose Oral Liquid for Analgesia in Neonates and Infants medicine guideline (Ref. 2906)