Guideline for Chest Drain Insertion, Care and Removal in paediatric patients within PICU, CICU & East Midlands Congenital Heart Centre.

Scope

This guidance can be used as an aid and learning tool by medical, nursing and allied health professional staff involved in the insertion of a chest drain, care of the chest drain, and safe removal of a chest drain inserted into a paediatric patient within PICU, CICU & East Midlands Congenital Heart Centre.

- For guidance regarding chest drain insertion care and removal for patients within the Children’s Hospital please see separate guideline – UHL Chest Drain Care Children’s Nursing Guideline

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Introduction/Background

In paediatric patients with a chest drain, a chest drain will be inserted as an invasive procedure to:

- Remove the fluid or air from the pleural space or mediastinum
- Re-expand the lungs and restore normal negative intra-pleural pressure and respiratory function.

Conditions requiring a chest drain insertion include:

- pneumothorax
- haemothorax
- pleural effusion
- chylothorax
- empyema
- post-operative cardiac or thoracic surgery

The National Patient Safety Agency recently raised concerns about the reported risks associated with chest drain insertion. NPSA reported 12 deaths relating to chest drain insertion and 15 cases of serious harm between January 2005 and March 2008.

The Medicines and Healthcare Products Regulatory Agency (MHRA) reported nine incidents between 2003 and 2008, all but one relating to the use of Seldinger type drains.

Common themes from a review of incidents reported to the NPSA, MHRA, local investigations and literature included lack of supervision of junior doctors, the level of experience of clinicians inserting chest drains, inadequate imaging and lack of knowledge of existing clinical guidelines.

Section 1: Chest Drain Insertion Technique

Pre-drainage assessment

- The person inserting the chest drain is personally responsible for carrying out all the pre-insertion checks though supervision should still be given as appropriate.
- Where possible, any coagulopathy or platelet defect should be corrected prior to chest drain insertion. Platelet levels of at least 50x10^9/L are acceptable as per the current UHL Blood Transfusion guideline.
- The differential diagnosis between a pneumothorax and bullous disease requires careful radiological assessment.
- Lung densely adherent to the chest wall throughout the hemithorax is an absolute contraindication to chest drain insertion.
- The drainage of a post pneumonectomy/ lobectomy space or space following congenital diaphragmatic hernia repair should only be carried out by or after consultation with surgeon/surgical team.

Equipment
Sterile gloves, gown and facemask.
Skin antiseptic solution, e.g. iodine or chlorhexidine in alcohol
Sterile drapes
Gauze swabs
A selection of syringes and needles (21–25 gauge)
Local anaesthetic, e.g. lignocaine (lidocaine) 1% or 2%
Scalpel and blade
Suture
Instrument for blunt dissection/ cut down set
Chest tube / Seldinger chest drain set
  o Newborn: 8-12 FG
  o Infant 12-16FG
  o Child 16-24FG
  o Adolescent 20-32FG
Connecting tubing
Closed drainage system (including sterile water if underwater seal being used)
Dressing

Patient Position and Insertion site

The preferred position for drain insertion is on the bed, slightly rotated, with the arm on the side of the lesion behind the patient’s head to expose the axillary area.

Insertion should be in the “safe triangle” illustrated in figure below. This is the triangle bordered by the anterior border of the latissimus dorsi, the lateral border of the pectoralis major muscle, a line superior to the horizontal level of the nipple with the below the axilla. Drains are usually placed in the 4th or 5th intercostal space just anterior to the midaxillary line – roughly level with the nipple or the lower border of the scapula. In emergency situations the second intercostal space in the midclavicular line is accessed but, due to cosmetic reasons, a more permanent drain is placed in the usual position.

When draining fluid an ultrasound should be used to guide thoracocentesis or drain placement- use a skin marking pencil if necessary.

Aseptic Technique
An aseptic technique should be used for insertion of the chest drain.
**Insertion of Chest Drain**

Insertion of a chest tube should never be performed with any substantial force since this risks sudden chest penetration and damage to essential intrathoracic structures. This can be avoided either by the use of a Seldinger technique or by blunt dissection through the chest wall and into the pleural space before catheter insertion.

The approach depends on the experience of the user though blunt dissection is preferred for insertion of bigger drains. The Seldinger technique results in less discomfort and scarring for the patient as well as there being a better seal around the drain.

**Seldinger technique**

Small bore chest tubes are usually inserted with the aid of a guidewire by a Seldinger technique. Blunt dissection is unnecessary as dilators are used in the insertion process.

Identify surface landmarks and infiltrate insertion site and deeper tissues with local anaesthesia

Use a Seldinger needle and syringe to localise the position for insertion by the identification of air or pleural fluid

Insert the needle over the top of the lower rib in the space at approximately a 60-90° angle.

Create a small amount of negative pressure with the syringe as the needle is advanced.

Advance the needle until a ‘pop’ is felt. This will indicate pleural penetration. Air flows into the syringe when the pleural space is entered.

Disconnect the syringe and pass a guidewire through the hub of the needle.

Remove the needle, keeping the guidewire in place and make a tiny incision in the skin to accommodate the dilator. Pass a dilator over the guidewire into the pleural space. The entire dilator does not enter the pleural space.

A small bore tube can then be passed into the thoracic cavity along the wire after removing the dilator.

Remove the guidewire after an adequate amount of chest drain has been inserted. **DISCONNECT THE PATIENT FROM THE VENTILATOR (if applicable) DURING INSERTION OF CHEST TUBE TO PREVENT LUNG PENETRATION.**

*This procedure has been successfully used for pneumothorax, effusions, or loculated empyemas*

**Blunt dissection**
Once the anaesthetic has taken effect an incision is made. The incision should be made just above and parallel to a rib. The incision for insertion of the chest drain should be similar to the diameter of the tube being inserted.

*Many cases of damage to essential intrathoracic structures have been described following the use of trocars to insert large bore chest tubes.*

‘....If a trocar comes with a chest drain it should be discarded or only used to hold up tomato plants....’

Blunt dissection of the subcutaneous tissue and muscle into the pleural cavity has therefore become universal and is essential.

- Using a Spencer-Wells clamp or similar, make a path through the chest wall by opening the clamp to separate the muscle fibres. For a large chest drain similar in size to the finger, this track should be explored with a finger through into the thoracic cavity. The creation of a patent track into the pleural cavity ensures that excessive force is not needed during drain insertion and ensures safety of underlying structures.
- After dissecting down to the pleura, hold the forceps near the tip to control its entry into the pleura.
- Pierce the pleura by pushing the forceps over the lower rib and through the pleura using a twisting motion. A 'pop' is felt as the pleura is breached.
- Maintain the forceps in place and return the grip to the handle. Use the forceps to enlarge the pleurotomy.
- **DISCONNECT THE PATIENT FROM THE VENTILATOR.** Remove the forceps and insert the drain preferably angled anteriorly to drain air, posteriorly to drain fluid.

**Position of tube tip**

- The position of the tip of the chest tube should ideally be aimed apically for a pneumothorax or basally for fluid. However, any tube position can be effective at draining air or fluid and an effectively functioning drain should not be repositioned solely because of its radiographic position.
Securing the drain

Two sutures are usually inserted—the first to assist later closure of the wound after drain removal and the second, a stay suture, to secure the drain (see illustration below).

A transparent dressing allows the wound site to be inspected by nursing staff for leakage or infection. An omental tag of tape (as shown in the picture above) allows the tube to lie a little away from the chest wall to prevent tube kinking and tension at the insertion site.
After Care

- A chest radiograph should be performed after insertion of a chest drain.
- All chest tubes should be connected to a unidirectional flow drainage system (such as an underwater seal bottle) which must be kept below the level of the patient’s chest at all times.
- Document drain insertion in patient notes and also insert completed ‘PICU/CICU Chest drain insertion’ pink sticker into notes
- Appropriately trained nursing staff must supervise the use of chest drain suction.
- Avoid taking too much fluid too quickly. In cases of massive effusion or empyemas consider clamping the drain for 1 hour once 10 ml/kg are initially removed to prevent cardiovascular instability. POST-OPERATIVE SURGICAL PATIENTS ARE NOT INCLUDED IN THIS CATEGORY.
- A bubbling chest drain should never be clamped.
**Section 2: Chest Drain Care**

In this section we provide guidance for nurses undertaking the care of a child with a chest drain. This includes student nurses who have been assessed by their mentor as competent to carry out this task and performing this procedure under the supervision of a registered children’s nurse.

This guidance needs to be performed in conjunction with relevant infection control and consent policies to ensure the child receives safe care and children and families are able to understand the reasons for care to facilitate co-operation.

**Resources required:**
- Closed under water seal drainage system 2 chest tube clamps
- Sterile dressing for drain insertion site if oozing fluid
- Tape to secure tubing to patient’s side (particularly on mobilising)
- Low pressure wall suction (as directed by medical staff)
- Fluid balance/Chest drainage chart

The table below describes procedure/process for chest drain care:

<table>
<thead>
<tr>
<th>No</th>
<th>Action</th>
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<tr>
<td>1</td>
<td>At least two chest drain clamps must accompany the child at all times. Ensure bed space is free tidy and access to emergency equipment is available at all times. If low suction is required (this should be documented by medical staff) then ensure high suction is also available at the beds pace.</td>
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<tr>
<td>2</td>
<td>Ensure child / young person is in a comfortable lying or sitting position prior to manipulation of the tubing or bottle. Always keep the level of the drain below patient’s chest height. (if this is not possible refer to section below on chest drain clamping.) Record drainage hourly on fluid balance</td>
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<tr>
<td>3</td>
<td>Immediately following insertion of drain, perform ¼ - hourly recording of drainage <em>(noting type and amount)</em>. Reduce these recordings to hourly as</td>
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</table>
| 4  | Ongoing observations for duration of chest drain:  
Chest drain site:  
- Skin condition  
- Signs of infection  
- Signs of fluid leakage  
- Audible air leak  
Four hourly recordings of the following vital signs.  
- Temperature  
- Heart rate  
- Respiration rate  
- Oxygen saturations  
- Blood pressure |
| 5  | Ensure child receives appropriate pain assessment and analgesia as needed to minimise pain of having drain in situ |
Section 3: Chest Drain Removal

The indications for removing chest drains include:

- Lung re-expansion on chest x-ray.
- No evidence of air leak for 24 hours.
- Fluctuations in water seal chamber stop.
- Drainage diminishes to little or nothing.
- Comfortable respiratory effort.
- Normal breath sounds over both lungs on auscultation

Prior to removal of chest drain ensure that drain losses are minimal and that the medical and surgical teams have requested and agreed for removal of chest drains.

Analgesia

Removal of chest drains is a painful procedure and the patient will usually require analgesia. Consider IV Morphine bolus 5-15mins prior to procedure or Oromorph thirty minutes before. (Refer to the latest BNF for children for dosage). Distraction therapy by an appropriate by a member of staff may be useful.

In PICU/CICU they may also require conscious sedation (PICU consultant decision, patient will need to be NBM for at least 2hrs before administration of sedative agents)
**Procedure**

Chest drains to be removed by two nursing/medical staff. The patient will require at least continuous ECG and oxygen saturations monitoring throughout until post procedure CXR has been reviewed. Personal protective equipment including goggles must be worn as per hospital policy, and a strict aseptic non-touch technique must be applied during the procedure.

If more than one is drain is present isolate the drain being removed. Continue with suction, if it is being applied, during the removal procedure.

Ensure there is a usable mattress/purse string suture to seal the wound site and free the ends of the purse string suture with a safe sharp stitch cutter. If there is no usable purse string suture available, inform the intensivist or surgical team who will make a decision on whether a purse string suture is necessary (occasionally a steri strip may be adequate).

Free the fixing/stay suture from the skin with a safe sharp stitch cutter and with a gloved fore finger place the tip of the finger in line with the top of the wound site.

Count three breaths from patient and on the third inspiration when the lung reaches full inflation (ventilated or non-ventilated), the **same nurse/medic who is applying pressure with the gloved finger pulls the drain with a free unrestricted motion**. As it exits the wound site (felt by the finger tip) apply pressure with the fingertip to seal the wound.

The two free ends of the purse string suture are raised with tension by the 2nd member of staff to ensure the wound is sealed and then tied under tension with at least 5 knots. The site is then inspected for any leaks and is cleaned with 0.9% saline on sterile gauze. The site is dried and protected with a
padded softpore dressing. The same routine will continue until the requisite number of drains are removed.

Disposal of the chest drain and the tubing is facilitated by double bagging with the orange waste bags.

A post drain removal chest x-ray must be performed and reviewed within one hour. In the event of sudden patient deterioration post chest drain removal, request urgent CXR, senior help and consider needle thoracocentesis (risk of pneumothorax).

Continue regular observation of vital signs for at least four hours post drain removal. Skin suture needs to be removed after seven days. If patient is discharged prior to this, ensure it is documented in the discharge plan.

3. Education and Training

No new teaching or education is required to implement this guideline

4. Monitoring & Audit Criteria

<table>
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<th>How will compliance be monitored</th>
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<th>Frequency</th>
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5. References and Supporting Information


6. Practical Paediatric Procedures Henderson,Nichani

8. Chest Drain Insertion Guideline for Paediatric ICU. *Birmingham Children’s Hospital Guidelines April 2009*

9. UHL Blood Transfusion Policy 2004


6. Keywords

PICU/CICU, Insertion, Chest drain, Pneumothorax, Seldinger technique, Blunt dissection, Haemothorax, Pleural effusion, Chylothorax, Empyema, Post-operative cardiac or thoracic surgery

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## CONTACT AND REVIEW DETAILS

<table>
<thead>
<tr>
<th>Guideline Lead (Name and Title)</th>
<th>Executive Lead:</th>
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<td>Simon Robinson</td>
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## REVIEW RECORD

**Description Of Changes (If Any)**

- Removal of Children’s Hospital from the scope and ref to Nursing guideline added.
- Background added to introduction
- New Section 2: Chest Drain Care added
- New section 3: Chest drain removal
- Reference list updated
- Keywords added
- Format changes