Critical Care Guideline

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Title	Finger Thoracostomy
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1. Scope

1.1 This SOP outlines the procedure for the practice of finger thoracostomy by air ambulance paramedics and other authorised clinicians.

2. Background and Definitions

2.1 Finger thoracostomy is a surgical procedure indicated for the management of tension pneumothorax or the suspicion of pneumothorax and/or haemothorax with cardio-respiratory compromise in a patient who is receiving positive pressure ventilation. Thoracostomy is literally creating a hole in the thoracic cage. It is a fundamental surgical skill and consists of incision, blunt dissection into the pleural cavity, followed by a finger sweep.

3. Eligible Clinicians

3.1 Finger thoracostomy is not considered a core paramedic/nurse skill within the Trust. Clinicians must fulfil the following requirements prior to practicing the intervention:

- Registered Paramedic or Nurse.
- Successfully complete specific education requirements.
- Hold written authorisation from the Executive Medical Director, following a successful application to practice the intervention under the Enhanced Skills Policy (evidenced by a letter and entry onto the Trust's Register of Enhanced Practice.
- Successfully complete a twelve monthly reassessment OR provide portfolio evidence of successful completion within 12 months. Failure to complete re-assessment within 13 months of the previous assessment or present portfolio evidence to training department within this time frame will result in automatic removal of the skill, until an assessment is successfully completed.
- Employed as an air ambulance paramedic or other authorised role.

4. Responsibility

4.1 The Executive Medical Director is responsible for the approval of all enhanced skills SOPs, and for the individual authorisation of all clinicians who practice within them.

4.2 It is the responsibility of all clinicians practicing under this SOP to ensure that they continue to fulfil the requirements of Section 3 and are authorised by the Trust to do so. Clinicians must ensure that they are fully aware of the SOP and that it is applied in all cases.

5. Indications

5.1 Patients in respiratory or cardio-respiratory arrest receiving positive pressure ventilation, ideally via a cuffed ET tube, but alternatively via a well seated supraglottic device with good seal where a tension pneumothorax is suspected who present with:-

- Chest trauma
- Asthma
- Following a SCUBA diving incident

5.2 Unresponsive Patients

5.2.1 Tension pneumothorax is suggested by one or more of the following findings:

- Unexplained hypoxia
- Unexplained hypotension
- Chest wall asymmetry
- High peak ventilation pressures (> 40cm H20)
- Reduced or absent lung sounds and hyper resonance over the affected hemithorax

- Tachycardia
- Tracheal deviation (late manifestation)
- Neck vein distension (un-reliable manifestation)

5.2.2 The principal management of a tension pneumothorax is immediate pleural drainage to provide decompression of the pleural cavity. Whilst needle decompression may afford the patient vital additional time until a more definitive intervention can be delivered, the technique has a number of limitations. The short length of intravenous cannulae compared to the depth of the chest wall in the mid-clavicular line, can result in failure to enter the pleural space, and therefore failure to treat the tension. The use of a large bore cannula reduces, but does not completely resolve this problem. Needle decompression is only a temporary measure and the tension may reoccur, as the cannula may kink, block or become dislodged.

5.2.3 Needle decompression may still be useful in patients in extremis with a tension pneumothorax when setting up and performing a thoracostomy will represent an unacceptable delay in treatment, is not feasible due to limited access to the patient or is contraindicated. In these cases, needle decompression using an approved device should be performed at the mid-clavicular line in the 2nd intercostal space on the affected side. If this does not result in satisfactory decompression, the procedure should be repeated using a lateral approach via the 4th or 5th intercostal space between the anterior and mid-axillary lines (this is identical to the thoracostomy landmarks).

5.2.4 If an intubated patient has reduced chest movement on the left side together with moderately low oxygen saturations (~95%), this may represent intubation of the right main stem bronchus resulting in failure to ventilate the left lung. Slightly withdraw the ET tube under direct laryngoscopy and re-assess the patient to assess for an improvement.

5.2.5 Once needle decompression has been used to treat the tension pneumothorax a formal finger thoracostomy should be performed as soon as practical if the patient is being positively ventilated.

5.2.6 A simple pneumothorax may develop rapidly into a tension pneumothorax once intubation has occurred and positive pressure ventilation commences. This may result in profound cardio-respiratory compromise. The findings suggestive of tension pneumothorax in the intubated patient are unexplained hypoxia, hypotension and/or high ventilation pressures.

5.3 Respiratory Arrest

5.3.1 Consider in intubated patients, particularly when flying under IFR regulations at higher altitude than those normally encountered on VFR HEMS missions.

5.3.2 In those patients with a small pneumothorax, intubation and positive pressure ventilation can result in the formation of a tension pneumothorax very rapidly. Patients at risk of having a small or hidden pneumothorax (e.g. positive pressure ventilated patients with chest trauma, asthma COPD) who are to be transferred by air should have thoracostomy **considered** prior to packaging in the aircraft. There is limited access to the patient's chest wall once packaged; the procedure can only be reliably performed prior to loading.

5.4 Cardiac Arrest

5.4.1 Cardiac arrest secondary to blunt trauma has a very poor prognosis. One of the potentially reversible causes of cardiac arrest in these circumstances is tension pneumothorax. If there is clinical evidence or suspicion of chest trauma, then tension pneumothorax is a potential cause or contribution to the cardiac arrest. Bilateral finger thoracostomies should be performed to rule out the possibility of tension pneumothorax. These can be performed in any order or simultaneously, though if there is clinical evidence of asymmetry the apparently affected side should be managed first.

5.4.2 Where a clinician with the skills to perform a finger thoracostomy is on-scene or immediately available, resuscitation of the traumatic PEA cardiac arrest should not be abandoned until bilateral thoracostomies have been considered.

5.4.3 Cardiac arrest in the asthmatic patient that has been unresponsive to bronchodilator therapy may also be caused by a tension pneumothorax, particularly if there has been vigorous positive pressure ventilation. The increased risk of tension pneumothorax is caused by high ventilation pressures and friable lung tissue. The diagnosis of tension pneumothorax in asthmatic patients can be particularly difficult due to the global reduction in air entry, together with hyper-expansion due to poor expiration. Therefore bilateral thoracostomies should be considered in all asthmatic patients who go into cardiac arrest, as soon after intubation as practicable.

6. Equipment

6.1 The following equipment is required for a thoracostomy:

- Gloves
- Skin preparation agent
- Scalpel
- Spencer-Wells forceps

6.2 Sterile gloves are not required for the procedure, but contaminated gloves should be changed beforehand. The use of skin preparation agent to prepare the skin prior to incision is thought to reduce infective complications.

7. Procedure

7.1 Patient Preparation

7.1.1 The pre-existing condition of the patient makes the possibility of hypoxia very high; the maximum possible inspired concentration of oxygen should be given prior to intubating. Once the airway is secured (ideally with a cuffed ET tube) the patient must receive positive pressure ventilation.

7.1.2 The patient should be fully monitored with pulse-oximetry, ECG, non-invasive blood pressure and end-tidal CO2 ($ETCO_2$) monitoring.

7.1.3 Optimal patient positioning facilitates the identification of the anatomical landmarks, and reduces the chance of incorrect incision placement. Ideally the patient should be placed supine on an ambulance trolley, however in practice this procedure is often undertaken on the ground. Any cut clothing should be removed from around the lateral chest wall and axilla. The arm on the side of the thoracostomy should be abducted to at least 90 degrees with the elbow flexed to 90 degrees. This opens up the area of the incision and helps define the axillary line landmarks. The arm may need to be supported in this position.

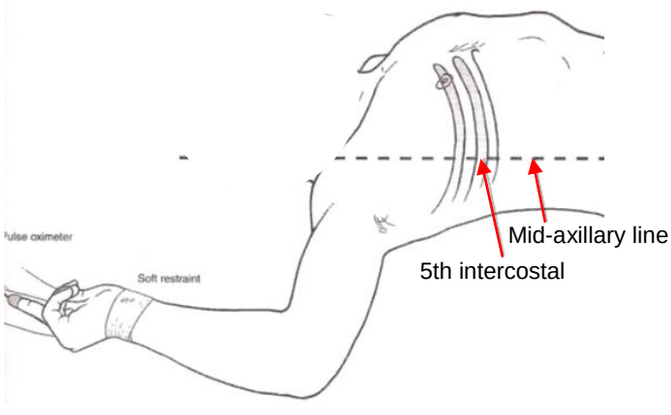
7.1.4 The two key landmarks are the mid-axillary line and the anterior axillary line.

7.1.5 The anterior axillary line is formed by the lateral border of pectoralis major; it is seen and felt at the front of the axilla (armpit). The posterior axillary line is formed by the lateral border of latissimus dorsi: it is seen and felt at back of the axilla (armpit). The midaxillary line is an imaginary line drawn midway between the anterior and posterior axillary lines.

7.2 Incision

7.2.1 A thoracostomy incision is placed between the anterior and mid-axillary lines in the 4th or 5th intercostal space (Figure 1).

7.2.2 Figure 1 - Landmarks



7.2.3 Once the anterior and mid-axillary lines have been identified, the 5th intercostal space (ICS) should be found. This can be accurately located by counting down from the 2nd ICS. The 2nd ICS can be found by palpating were the body of the sternum meets the manubrium and forms a definite ridge (the angle of Louis). The 2nd ICS is immediately adjacent to this landmark. Once the 2nd ICS is identified the intercostal spaces can be counted down and tracked around the chest by palpation.

7.2.4 If uncertainty remains or circumstances prevent this method, the 5th ICS is level with the nipple in a male. In a female the 5th ICS is level with the crease of the breast fold, where the breast meets the chest wall. This area is ideal for thoracostomy, because the thickness of muscle and subcutaneous tissue is less than elsewhere on the chest. The thoracostomy should not be placed lower than the 6th ICS, as the diaphragm can rise to this level on deep expiration.

7.2.5 The thoracostomy should not be placed higher than the 4th ICS as there is an increased risk of damaging the neurovascular structures within the axilla, and the curve of the thoracic cage makes dissection difficult. The incision must not extend behind the mid-axillary line toward the posterior axillary line, as this will increase the risk of damaging the long thoracic nerve. In pre-hospital practice there is a tendency to place the incision too far toward the front of the chest, due to the presence of cut clothing and the curve of the scoop or trolley forcing the operator too far anteriorly.

7.2.6 Accurate placement of the thoracostomy at the same level between the anterior and mid-axillary line is essential, particularly if a clamshell thoracotomy may be performed by a Doctor confident and competent to practice the procedure. Placing the thoracostomy too far forward in these cases will result in an inability to open the clamshell sufficiently to expose the pericardium. The incision should be made in the line of the rib and directly down onto the rib at the lower border of the target intercostal space. Incising down directly onto the rib allows the skin and subcutaneous tissues to be cut in one move reducing the amount of blunt dissection required, whilst preventing inadvertent penetration into the pleural cavity. Incising over the rib below the target ICS aids the positioning of any chest drain inserted, as it will tend to direct the drain toward the apex of the chest.

7.2.7 The incision must be at least 3-4cm long and long enough to easily accommodate the gloved finger and a set of Spencer-Wells forceps. If the incision is too small it is very difficult to perform an adequate thoracostomy with sufficient speed. Remember a wound can always be closed later, whereas it is very difficult to extend the wound once dissection has begun. If the patient is very obese or there is extensive surgical emphysema the distance to the thoracic cage will be increased and a longer incision is required.

7.2.8 Blunt dissection should be used to enter the pleural cavity, because this reduces damage to underlying structures. This should be performed with Spencer-Wells forceps. The instrument should be inserted closed, then opened to spread the tissue. This can be repeated in horizontal and vertical planes. The amount of dissection required will depend on the thickness of the fat layer. Once contact is made with the rib below the target ICS, the technique can be modified slightly. Run the tip of the forceps over the upper surface of the rib to strip muscle off the rib periosteum. Passage through the intercostal muscles can be helped by inserting the closed forceps and opening to split the muscle. The pleura should then be gently pierced using the forceps. This may result in a hiss of air or gush of blood if the contents of the chest cavity are under tension.

7.2.9 A high pressure release of air or blood confirms that a tension pneumothorax has been decompressed. An open pneumothorax has now been created. The gap in the muscle and pleura must be sufficient to accept a gloved finger. Dissecting over the upper border of the rib reduces the chance of damaging the neurovascular bundle which lies just beneath each rib. Leave closed forceps in place to maintain the track into the chest cavity.

7.2.10 The next stage is to perform a finger sweep. Gently insert a gloved finger into the chest cavity alongside the closed forceps. Once in the chest cavity the finger is gently rotated to feel for the lung. If the lung is inflated and ventilating properly, it will be felt to move against the gloved finger with each breath. The finger sweep also allows the detection of other structures that may be palpable following significant trauma such as bowel (due to rupture of the diaphragm). Additionally, it will free any adhesions between the pleura that may be present from previous pleural pathology.

7.2.11 Care should be taken during the finger sweep as any fractured rib ends can result in a sharps injury to the clinician. If the thoracostomy is performed during active chest compressions the finger can be pinched during compression when the intercostal spaces close down.

7.2.12 Do not dress or occlude the incision in an patient receiving effective IPPV. The wound should only be dressed if the patient's LOC improves such that they are no longer able to tolerate the airway device used and IPPV becomes impossible, and where the option to anaesthetise the patient to maintain such a state is not available or inappropriate.

7.2.13 If a possible tension pneumothorax reoccurs the finger sweep will need to be repeated. If this is the case, there is clearly a risk of introducing further sources of infection, so it must be done as aseptically as possible, ideally with a fresh pair of gloves if available, but at least clean gloves.

8. Complications

8.1 Fractured Ribs

8.1.1 Extreme caution should be exercised in patients with rib fracture; this risk is significantly increased by the presence of a flail segment. During the finger sweep sharp bone may penetrate the glove resulting in a sharps injury.

8.2 Infection

8.2.1 This may range from superficial infection at the incision site, to deep infection resulting in empyema. The use of the skin preparation agent reduces this risk. There is currently no evidence to suggest that prophylactic intravenous antibiotics reduce the possibility of significant infection following pre-hospital thoracostomy.

8.3 Haemorrhage

8.3.1 Minor bleeding from the skin wound is rarely important, but significant haemorrhage or haemothorax can occur if the intercostal vessels are damaged, or the underlying lung lacerated during the procedure. The risk of intercostal vessel damage is greatly reduced if dissection is performed over rather than under the rib.

8.4 Incision Placement

8.4.1 Inaccurate placement of the incision will increase morbidity. If the incision is placed too posteriorly, behind the mid-axillary line, the long thoracic nerve may be damaged resulting in permanent loss of some scapula movements. Placing the incision below the 5th intercostal space increases the chance of damage to the diaphragm or abdominal organs. Placing the incision too high can result in damage to neurovascular structures in the axilla.

8.5 Occlusion

8.5.1 Tension pneumothorax may occur if the thoracostomy is occluded by a dressing or by firmly pressing the patient's arm to their side during packaging. It is essential that easy access to the thoracostomy is maintained during transfer to allow rapid repeat finger sweep to be performed if signs of a tension pneumothorax occur. Occlusion will also result in an increased amount of surgical emphysema.

8.6 Obesity/Surgical Emphysema

8.6.1 If the patient is obese or if there is swelling due to surgical emphysema or haematoma the area may be distorted, and the thickness of tissue between the skin and intercostal space greatly increased. Sometimes it is necessary to make a larger incision in the correct location before the underlying ribs can be clearly identified.

8.7 Flail Chest

8.7.1 If the target intercostal space is part of a flail segment, dissection through the intercostal muscles can be challenging. These problems may be compounded by inadequate incision length.

8.8 Spontaneously Breathing Patients

8.8.1 There may be circumstances where finger thoracostomy is performed in a ventilated patient who then regains spontaneous respiratory effort. In spontaneously ventilating patients the thoracostomy must be covered by a chest deal used for an open pneumothora to prevent a sucking chest wound causing a large open pneumothorax, which would compromise respiration. But as air is still entering the thoracic cavity from an injury to the lung, rather than the sucking chest wounds these dressings were designed for, there is a high likelihood that the tension pneumothorax may recur or respiratory effort will at least be compromised, so the patient must be monitored closely for deterioration.

9. Onwards Management

9.1 The patient must be accompanied to hospital by at least one clinician who has been authorised to practice this procedure.

9.2 In some cases, a finger thoracostomy may lead to the application of a clam shell thoracotomy. This procedure may only be performed by suitably experienced and competent pre-hospital doctors. The initial thoracostomy incisions are joined across the anterior chest to form the clamshell. Therefore to avoid complication, the same practitioner should mark the intercostal spaces chosen for the thoracostomy on both sides of the patient, even if only one side is to be incised. This will minimize the chance of thoracostomies being performed in different intercostal spaces. If this asymmetry occurs there is increased difficulty in cutting through the sternum.

10. Documentation

10.1 In line with Trust Policy, a Patient Clinical Record must be completed and annotated appropriately. There is currently no specific tick box for a finger thoracostomy, therefore its use should be documented within the notes section. Any deviation from this SOP must be recorded.

11. Cleaning and Decontamination

11.1 All equipment used for the procedure is single use and disposable. Scalpels must be disposed of within a sharps bin, with all other waste disposed of as contaminated (orange bag) waste.