Queensland Health

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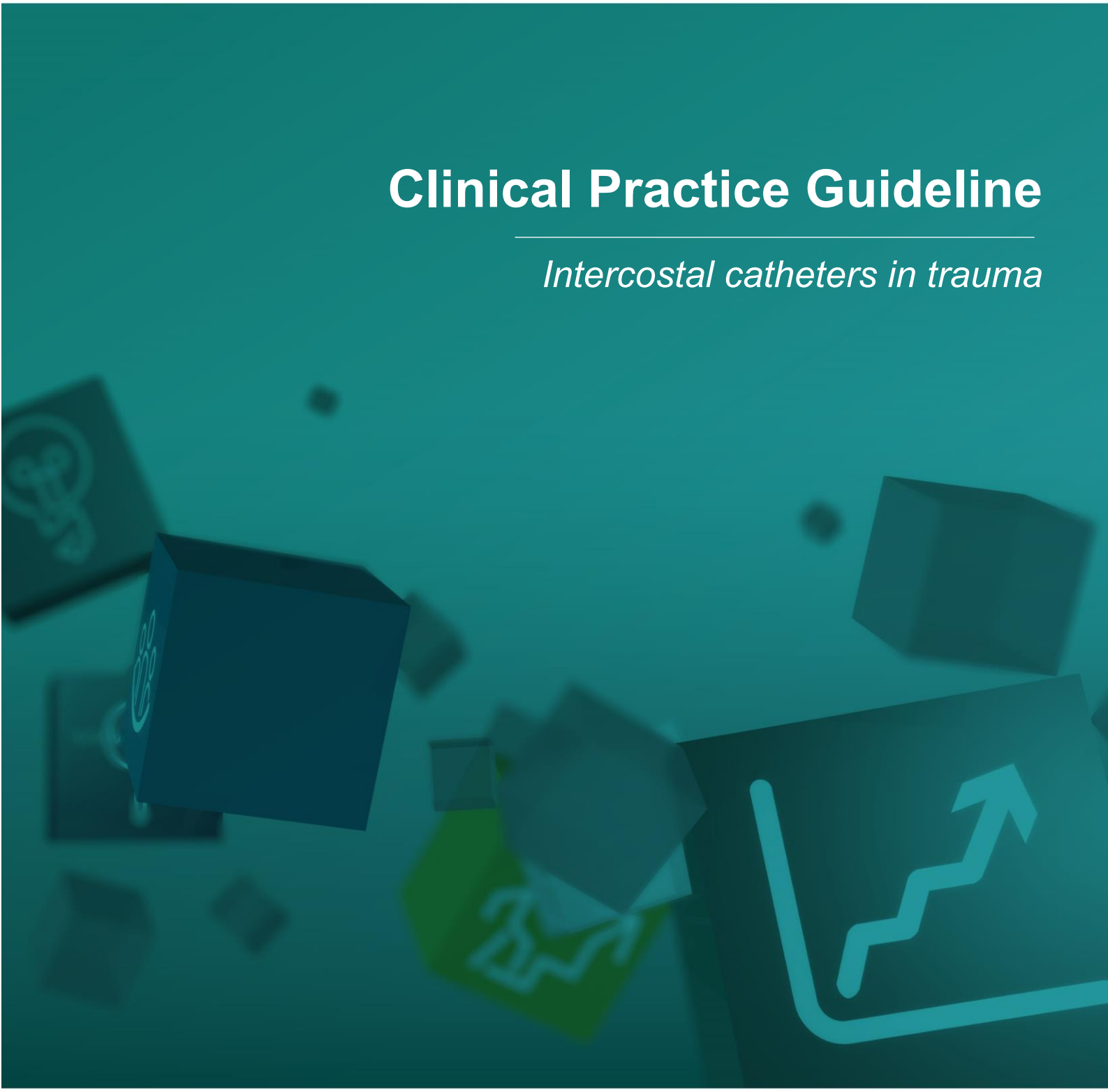
Clinical Practice Guideline

Intercostal catheters in trauma



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Queensland Government

Intercostal Catheters in Trauma

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An electronic version of this document is available on the intranet, at https://qheps.health.qld.gov.au/caru/networks/trauma

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This guideline does not address all elements of standard practice and accepts that individual clinicians are responsible for:

- Providing care within the context of locally available resources, expertise, and scope of practice
- Supporting consumer rights and informed decision making, including the right to decline intervention or ongoing management
- Advising consumers of their choices in an environment that is culturally appropriate, and which enables comfortable and confidential discussion. This includes the use of interpreter services where necessary
- Ensuring informed consent is obtained prior to delivering care
- Meeting all legislative requirements and professional standards
- Applying standard precautions, and additional precautions as necessary, when delivering care
- Documenting all care in accordance with mandatory and local requirements

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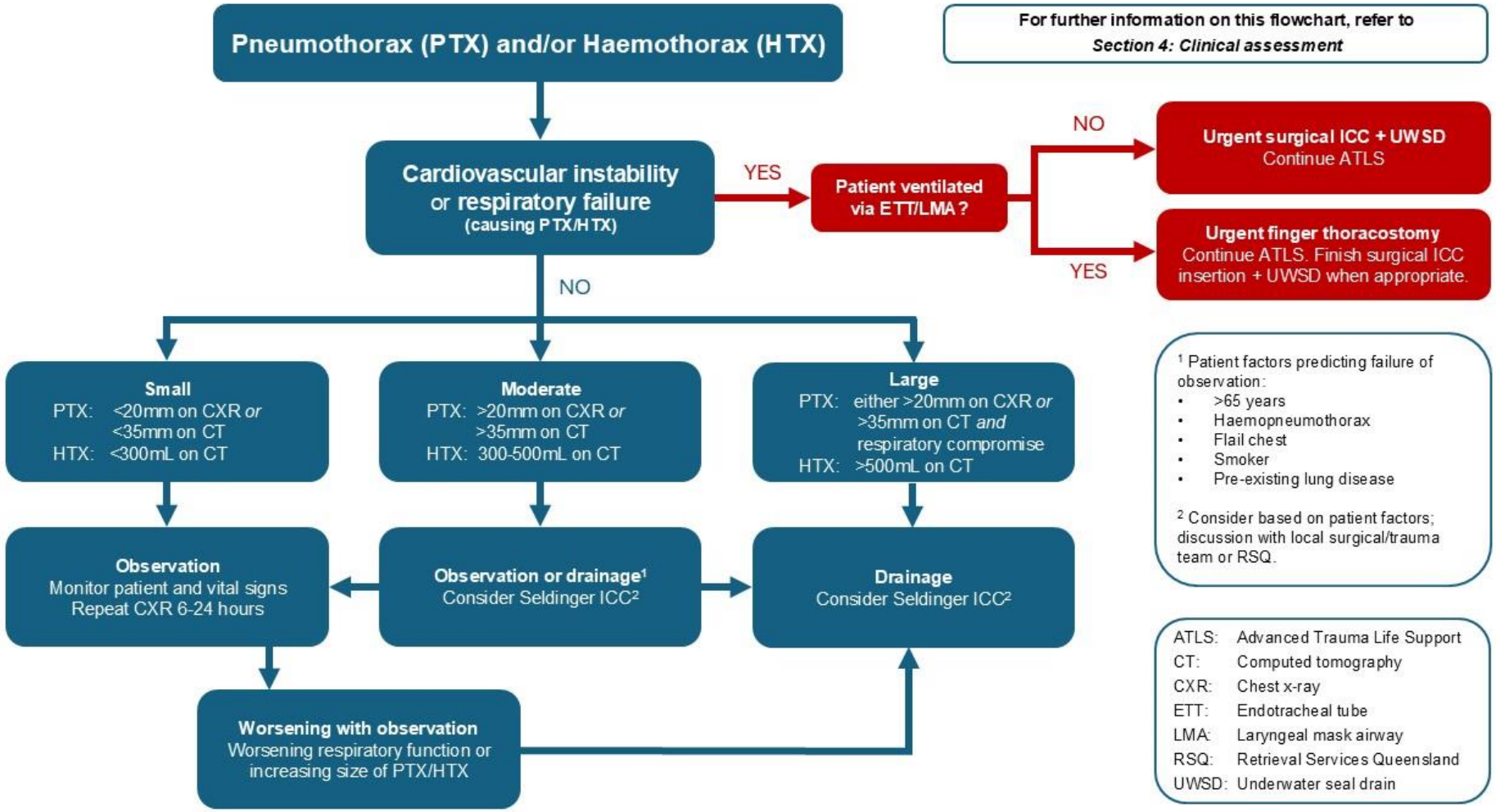
Flowchart 1: Management of pneumothorax and haemothorax



Contents

Summary

The insertion of an intercostal catheter (ICC) in patients suffering traumatic chest injuries may occur emergently, or as a planned procedure. ICC insertion comes with risks to the patient and clinician; and the need for standardised, appropriate and safe care is vital in minimising complications and facilitating optimal patient outcomes. This clinical practice guideline outlines the assessment and management of traumatic chest injuries with ICCs, including pre-insertion considerations, procedural information, and post-procedural care. Best practice recommendations are provided for adult trauma patients based on available evidence and expert clinical experience; however, this should never replace bedside clinical judgement. This guideline is intended for use by Queensland Health clinicians and is to be utilised in conjunction with local policies and procedures.

1. Scope

This document is relevant to clinicians that manage **adult** trauma patients presenting with thoracic injuries to Queensland Health facilities. **Paediatric** trauma patients aged under 16 years are not within the scope of this guideline; the Paediatric chest trauma guideline[1] should be consulted for this population. Medical officers must be appropriately skilled and have completed any requisite local hospital training prior to performing an ICC insertion, with consideration of local skills/experience, resourcing and available equipment for the ongoing management and removal of ICCs.

2. Related documents

Paediatric chest trauma guideline[1]
Blunt chest trauma clinical practice guideline[2]
Statewide intercostal catheter insertion consent form[3]
Queensland Trauma Education: Chest trauma resources[4]
Trauma in pregnancy clinical practice guideline[5]

3. Background

ICCs are used to drain blood (haemothorax), air (pneumothorax) or both (haemopneumothorax) that has accumulated in the pleural cavity. These conditions may compromise respiratory and cardiovascular function. Firstly, pneumo/haemothorax may reduce lung expansion and impair respiratory function. Importantly, if the air and/or blood are under pressure (tension pneumo/haemothorax), the intrapleural pressure increases and may reduce venous return, resulting in cardiovascular compromise and obstructive shock. Additionally, a massive haemothorax may result in haemorrhagic shock.

ICCs come in various sizes and may be placed using a surgical or Seldinger approach. Large bore ICCs are typically 24-32 French gauge (Fr) and are placed using a surgical technique. Small bore ICCs are typically 14-16Fr and are placed using a Seldinger technique.

If a large bore ICC is required, a size 24Fr ICC is suitable in most clinical situations, with 28Fr as a suitable alternative. While there is no definitive evidence regarding ideal ICC size currently, clinical experience using smaller large bore ICCs (e.g. 24Fr) has shown that these are usually appropriate for drainage and are tolerated more favourably by patients than the larger large bore ICCs.

A size 24Fr ICC is appropriate for most adult patients undergoing a surgical (large bore) ICC placement.

ICCs are attached to a drainage system with a valve to prevent the back flow of air and / or blood into the pleural space. Modern drainage systems have integrated drainage chambers, an underwater seal, and a suction attachment. Simpler systems have only a Heimlich valve and drainage bag.

Patients presenting with a pneumo/haemothorax from chest trauma can present along a wide spectrum of physiological stability, from clinically stable to life threatening compromise, or even in traumatic cardiac arrest. Along with various ICC sizing, insertion techniques and drainage systems available, it is imperative that all factors are considered thoroughly prior to an ICC insertion, and care is provided by appropriately skilled clinicians who can perform the insertion, manage the ICC after insertion, and take appropriate action in the event of any complications. Flowchart 1 supports clinical decision-making for various traumatic chest injuries.

In some patients who are stable, a small bore Seldinger ICC (rather than a large bore surgical ICC) may be appropriate. Confirm with local Trauma Service/ Emergency Department/Intensive Care/Retrieval Services Queensland.

4. Clinical assessment

4.1 Signs and symptoms

Patients with a small pneumo/haemothorax may have pleuritic chest pain, cough, and dyspnoea. Severe cases may progress to shock, respiratory distress, altered mentation, agitation, or dizziness/presyncope. Clinical signs include tachypnoea, hypoxia, subcutaneous emphysema, reduced/unequal chest expansion, and reduced air entry on auscultation. Evidence of other chest injuries such as crepitus from rib fractures or flail segment may be seen. Similarly, with increasing severity, tachycardia and later hypotension may be seen. Oxygen saturations may be normal even with large pneumo/haemothorax due to appropriate physiological hypoxic pulmonary vasoconstriction. These signs and symptoms are non-specific and other chest injuries such as pulmonary contusions, pain or aspiration may cause similar findings. The absence of these findings does not exclude a small pneumo/haemothorax.

4.2 Clinical stability

It is important to assess the patient's clinical presentation. Patients with an actual or suspected pneumo/haemothorax who have haemodynamic or respiratory compromise ('unstable' with abnormal vital signs) attributable to their pneumo/haemothorax require time-critical intervention. This usually occurs with the placement of a large bore ICC via a surgical approach.

- In patients where positive pressure ventilation is delivered via an endotracheal tube (ETT) or laryngeal mask airway (LMA), a finger thoracostomy may be the immediate intervention with an ICC placed subsequently. Needle decompression continues to be utilised by some services as a temporising intervention prior to surgical thoracostomy and placement of a large bore ICC.
- Patients with a pneumo/haemothorax who do not have haemodynamic or respiratory compromise (considered 'stable' with no abnormal vital signs) may be managed with an ICC

placed using a surgical approach with larger bore ICC, a small bore catheter via a Seldinger approach, or with observation alone depending on patient/clinician/service variables, and the pathology identified.

Patients not undergoing positive pressure ventilation by an advanced airway (ETT or LMA) should have the finger thoracostomy converted to an ICC in rapid succession.

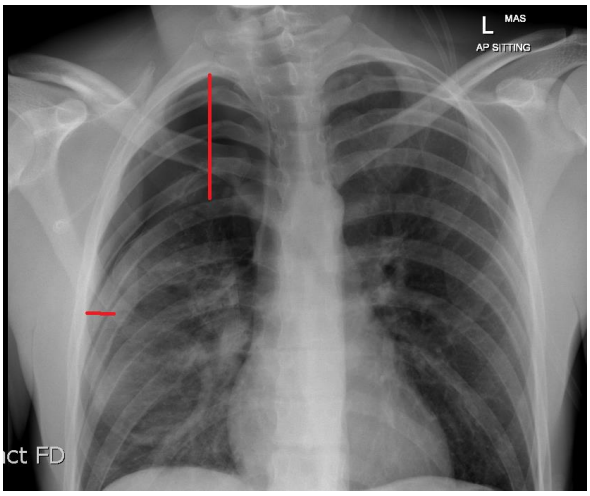
4.3 Medical imaging

Chest Xray (CXR) and Computed Tomography (CT) imaging may be utilised for measurement and sizing classification of pneumo/haemothorax, as listed below in Table 1. Point of care ultrasound may be used by appropriately trained clinicians for diagnosis of pneumo/haemothorax, as part of an extended focused assessment with sonography in trauma (eFAST) scan. In addition, ultrasound guidance may also be utilised for small bore ICC insertion by clinicians adequately credentialled in the procedure. However, CXR or CT is recommended for accurate quantification of size, because the size on CXR or CT is utilised in clinical decision making for stable patients. CXR is used for serial radiological assessment of size and resolution of pneumo/haemothorax.

Table 1: Key imaging features and sizing classifications

	Measurement	Sizing classification
Pneumothorax	CXR: Distance from the chest wall to the lung edge at the level of the hilum or apex. Variation occurs between erect and supine films (figure 1).	20 mm equates to a pneumothorax of approximately 20%
	CT: Radial distance between parietal and visceral pleura / mediastinum in line perpendicular to the chest wall of the largest air pocket on axial imaging (figure 2).	35 mm equates to a pneumothorax of approximately 20%
Haemothorax	CT: Radiology where available may provide an estimate of haemothorax volume, or the volume can be estimated using a validated calculation tool, e.g. formula utilised by previous published tools: [6, 7]	Small: <300mL on CT Moderate: 300-500mL on CT Large: >500mL on CT
	V = d2 x L (On axial CT: V - volume in cubic cm; d – greatest depth of HTX; a – line drawn perpendicular to chest wall in the largest fluid collection on axial CT; L – greatest craniocaudal length of HTX in cm)	

Figure 1 and 2: Assessment of PTX size on CXR



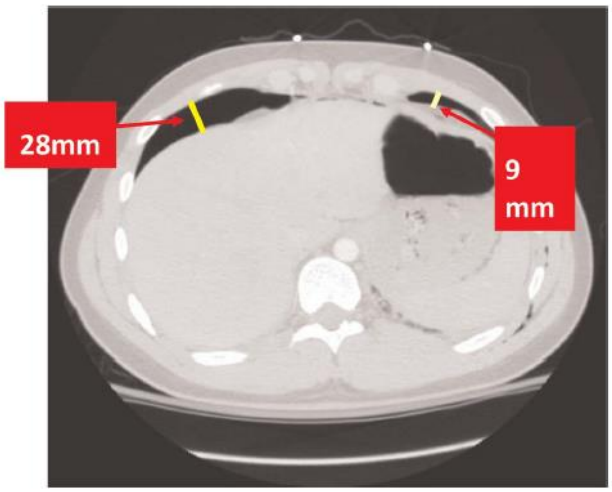


Photo credit: de Moya et al[8]

In the examples above:

- CXR: PTX size measurement using measurement between lung edge and chest wall, from the hilum and apex.
- CT: PTX size measurement using an axial line in the largest air pocket, drawn perpendicular to the chest wall.

4.4 Management considerations

The decision to drain a pneumo/haemothorax depends on the patient's vital signs indicating clinical stability, pneumo/haemothorax size, anticipated clinical course, and patient co-morbidities. Anticipated difficulties, e.g. reduced access during transport or prolonged procedure in a prone position, may influence the decision to place a drain. Consideration should also be given to the availability of experienced and trained staff, along with local facility considerations (e.g. level of ongoing monitoring available). Some pneumo/haemothoraces can be managed without a drain with a low failure rate. Failure is defined as a progression of the pneumo/haemothorax on imaging, or physiological deterioration - requiring intervention.

4.4.1 Pneumothorax:

A pneumothorax can be further categorised as occult or uncomplicated.

An ***occult pneumothorax*** is diagnosed on CT but not evident on a preceding CXR. These are relatively safe to manage with observation alone. There is a low failure rate and reduced hospital length of stay for both blunt and penetrating trauma for patients with occult pneumothoraces who are not undergoing mechanical / positive pressure ventilation.

For patients with occult pneumothorax undergoing mechanical / positive pressure ventilation, the decision to observe is more complex. In this group, 1 in 4 patients will require later drainage, including for tension pneumothorax, and is more likely if they have prolonged mechanical ventilation, flail chest, or develop ventilator-associated pneumonia.[9] Factors that contribute to failure include a higher burden of chest injury (e.g. flail chest), presence of a haemothorax and prolonged positive pressure ventilation.

Patients with occult pneumothorax may safely undergo high flow nasal oxygen therapy as indicated for concurrent chest injuries. High flow nasal oxygen therapy should be instituted in conjunction with appropriate monitoring, and in accordance with local guidelines.

An ***uncomplicated pneumothorax*** causes no derangement in haemodynamic or respiratory physiology. There is conflicting evidence regarding the size of an uncomplicated pneumothorax that should be drained. While there is no definitive upper limit of uncomplicated pneumothorax that can be observed, in general the cut-off threshold for observation with low failure rates (10-11%) appears to be pneumothoraces ≤ 35 mm in size, for both blunt and penetrating trauma and including patients undergoing positive pressure ventilation. When a pneumothorax is ≥ 35 mm, it is more likely to require drainage.

Where a decision has been made to drain a traumatic pneumothorax in a physiologically well patient, it is safe to place a small bore (14Fr) Seldinger-guided catheter.[8, 10, 11] Seldinger-guided small-bore catheters are significantly less painful both on insertion and thereafter, without differences in success or failure rates.[10, 11] Local guidelines may describe a preference for formal ICC placement, which should be confirmed prior to insertion.

4.4.2 Haemothorax:

Small haemothoraces can be safely observed without intervention, avoiding the complications of drainage such as pain, risk of infection, and prolonged hospitalisation. All patients with 'unstable' physiology should undergo pleural decompression and have an ICC inserted for ongoing assessment and management. For stable patients, there is no well-defined volume of haemothorax which needs drainage, however in settings where more than 300-500mL is present it is commonly recommended. These moderate/large haemothoraces are typically drained via an ICC (e.g. 24-32Fr), especially in unstable patients. In stable patients with isolated haemothorax, drainage via a Seldinger-guided drain (e.g. 14Fr) may be appropriate and has been shown to have similar efficacy and safety, but with improved patient experience.[11-14]

Patients with a massive haemothorax, with ongoing large amounts of bleeding or over 1500mL within a 24-hour period must be referred to a Cardiothoracic or Trauma Surgical Team as soon as possible. A widely used definition of massive haemothorax is 1500mL upon ICC insertion, or output >150mL/hour for two to four hours.[15] Given distances involved in Queensland aeromedical retrievals, consideration of referral to a major centre should be considered at an earlier point on a case-by-case basis, with consideration given to other injuries, haemothorax drain output, local services available and distances involved.[15] In addition to the drain output from a massive haemothorax, the haemodynamic status and blood product requirements are important data points that will need to be communicated to the receiving Cardiothoracic or Trauma Team.

Refer early to a Cardiothoracic or Trauma Surgical Team where there is large ICC drain output, either upon ICC insertion or ongoing. Consideration of patient physiology, local surgical services / resources, and retrieval distances are more important than rigid definitions of massive haemothorax.

4.4.3 Haemopneumothorax:

Both the size and effect on physiology from tamponade or blood loss of the pneumothorax and haemothorax factor into decision making. Observation of small haemopneumothoraces should be considered in selected patients (<65 years, absence of ipsilateral flail chest and comorbidities that

may result in impaired pulmonary function) although the presence of a haemothorax increases the probability of failure of conservative management.

4.5 Contraindications

There are no absolute contraindications for pleural decompression and ICC insertion in a life-threatening situation involving a pneumo/haemothorax. Consideration may be given to management of coagulopathy prior to inserting an ICC, however coagulopathy is not an absolute contraindication in the emergent setting. Consideration to insertion site may occur with other penetrating injury or evidence of skin infection, ensuring the insertion point remains in the triangle of safety, as described below in section 5.2.

5. Preparation for insertion

5.1 Consent and documentation

Informed consent must be obtained in all patients prior to ICC insertion (using a surgical or Seldinger technique) except for scenarios in which the pleural decompression is time-critical and lifesaving. As a minimum, verbal consent is to be documented by the treating team in the clinical notes, and the Statewide ICC Insertion Consent form may be utilised.[3] An ICC underwater seal drain observation form should be used in monitoring the ICC, either within the ieMR or on a paper form (Appendix 1).

5.2 Site identification

Confirm the patient identification, site and side where the ICC is required, with at least one other clinician. Recline patient at 30 degrees head up, if possible, considering all other injuries. Ideally, the patient should have upper limb abducted to 90 degrees to allow identification of landmarks and unobstructed access to the chest wall, with breast tissue moved away from site of insertion. The preferred position for ICC insertion is the fourth or fifth intercostal space in the ‘triangle of safety’, on the affected side, in the space between the anterior and midaxillary line.

The triangle of safety (figure 3 and 4) is defined by:

- Anterior - lateral border of pectoralis major
- Posterior – anterior border of latissimus dorsi
- Inferior – 5th intercostal space*
- Superior/apical – base of axilla

* The inferior border may also be located using the mid arm point (midpoint between acromion and olecranon in adducted upper limb with 90-degree flexion of elbow. The chest is marked at this point then upper limb abducted to raise mark one rib space higher). The mid-arm point technique (figure 5-7) has been demonstrated as a reliable and accurate way to identify a safe site for ICC insertion.[16] Axillary hair line and nipple line should never be used in isolation due to the risk of misplacement with variable body habitus. An incision too low risks injury to the diaphragm and intra-abdominal organs (liver, spleen, stomach, colon). The skin incision and blunt dissection should be made just anterior to the mid-axillary line to avoid damage to the long thoracic nerve.

The mid-arm point method has been shown to be reliable for identification of a safe ICC insertion point.

Figure 3 and 4: Triangle of safety

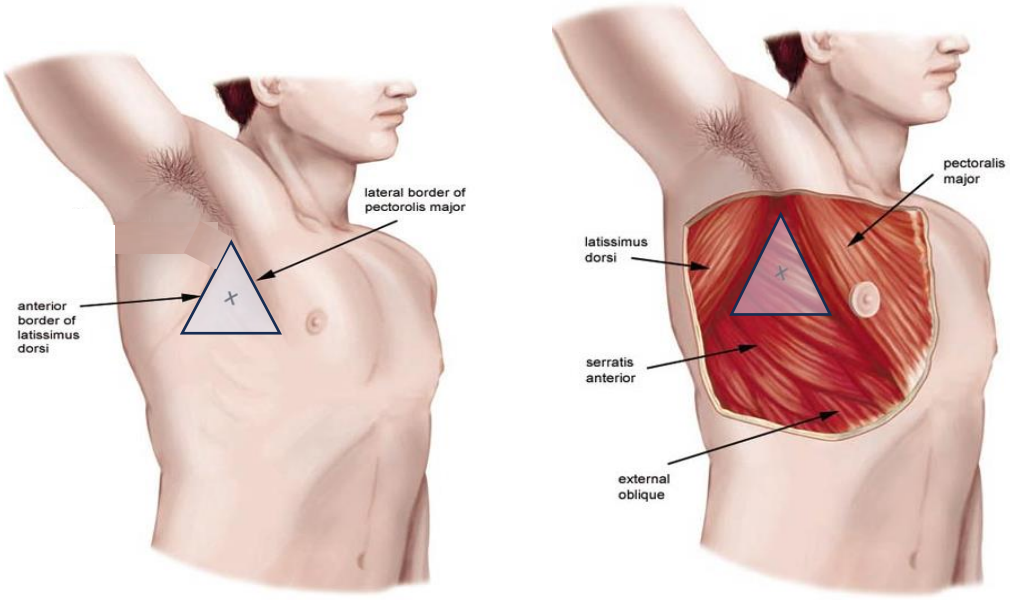


Figure 5, 6, 7: Mid-arm point method for ICC insertion*

Photo credit: Bing et al[16]

*Please refer to section 5.2 above and referenced literature[16] for a detailed description of the mid-arm point method.

For pregnant patients greater than 20 weeks gestation (or earlier in multiple pregnancy), consider ICC placement 1 or 2 intercostal spaces higher than usual (i.e. third or fourth intercostal space), to avoid potential abdominal injury due to a raised diaphragm.[5]

Seldinger-guided catheters should be placed in the fourth or fifth intercostal space anterior to the mid-axillary line only when the parietal pleura is clear of lung tissue to prevent iatrogenic pneumothorax. Occasionally Seldinger-guided catheters may be placed anteriorly in the second intercostal space, mid-clavicular line in select patients with anterior pneumothoraces or under ultrasound guidance in an alternative position for haemothoraces in line with local practice guidelines.

5.3 Pain management

Procedural pain may be managed with a combination of local anaesthetic (LA) infiltration to the pain sensitive structures (skin, intercostal muscles, rib periosteum and parietal pleura) as well as parenteral analgesia with or without sedation, in line with clinician preference and local guidelines. If LA is being used, ensure appropriate time provision for full anaesthetic effect. The better anaesthesia coverage of the site, the less chance of the patient moving, and the greater chance of a successful ICC insertion.

Post-procedurally, patients may have pain from the ICC insertion site or from the sensitive pleura, in addition to their thoracic injuries. Ensure effective analgesia is provided to allow comfortable deep breathing and coughing. Patient controlled analgesia or regional anaesthesia are not usually required for ICCs alone, however, may be needed for associated rib fractures and other injuries. For more advice on pain management in blunt chest trauma, refer to the statewide Blunt Chest Trauma Guideline.[2]

5.4 Equipment

A sterile technique should be always used in ICC insertion to avoid wound site infection or secondary empyema. An assistant should be present throughout the procedure. Table 2 below outlines the minimum standard equipment required for this procedure:

Table 2: Equipment

	Standard equipment required	
Clinician	Personal protective equipment - sterile gown and gloves, mask, hat, eyewear Assistant must be present	
Environment	Procedure trolley Sharps container Antiseptic solution (2% Chlorhexidine in Alcohol 70%) or iodine	Sterile drapes Oximeter Telemetry Non-invasive BP monitoring.
Local anaesthetic	20mL syringe 21G needle and drawing up needle Anaesthetic agent (e.g. 1% lignocaine with 1:100,000 adrenaline)	
Procedural	Scalpel, blunt dissection tissue forceps (e.g. Spencer-Wells forceps) ICC setup pack (ICC tray or similar) Appropriately sized ICC, **remove and dispose of trocar prior to use** 4 x packs of sterile gauze swabs For Seldinger technique – pre-packaged Seldinger chest drain set Suture - Size 1.0 – 2.0 silk Underwater Seal Drain (UWSD) system – primed according to manufacturer's instructions Dressing - 2 x Split drain dressing, occlusive dressing, Hypafix, non-stretch tape – Leukofix / Leukosilk	

6. Insertion

6.1 Procedure

Always follow local guidelines and ensure any clinician performing an ICC insertion is appropriately credentialed. Appendix 2 provides a detailed example of both ICC placement via blunt dissection and Seldinger-guided small bore ICC insertion.

Inserting an ICC through a pre-hospital thoracostomy

If a finger thoracostomy has been performed by pre-hospital clinicians, it is appropriate to use this site for subsequent ICC insertion if ALL the following criteria are met:

- The site is not grossly contaminated.
- The incision site position is appropriate.
- The tract is confirmed as patent by a finger sweep.
- Prior to drain insertion, the site must be thoroughly cleaned with chlorhexidine/iodine solution.
- The incision was made <6 hours prior.

6.2 Antibiotics

Antibiotic prophylaxis may be given to patients undergoing ICC insertion for trauma in the following settings:

- Penetrating chest trauma – administer antibiotics.
- Blunt chest trauma – consider a single dose of antibiotics (as per local protocol).
- Prehospital thoracostomy – consider antibiotics (based on the degree of contamination or duration of exposure prior to formalisation).

6.3 Complications

Potential complications of ICC insertion are outlined in Table 3 below.

Table 3: Complications

Common (>5%)	Uncommon (1-5%)	Rare (<1%)
• Pain during and after insertion. • Malposition, tube blockage or kinking, requiring reposition or reinsertion. • In obese patients: increased risk of wound infection, chest infection, heart and lung complications.	• Infection: may be superficial/ incisional, or deep, resulting in empyema or pneumonia. • Bleeding: may be incisional (relatively minor), or secondary to damage to intercostal vessels, which is more serious. • Irritation or damage to intercostal nerves. • Post-expansion pulmonary oedema.	• Damage to internal organs, diaphragm or long thoracic nerve. • Need for surgery/interventional radiology. • Injury to proceduralist from fractured ribs.

7. Management and troubleshooting

7.1 Post procedure care

Immediate: Once the ICC is inserted, connect to the underwater seal drain and assess function (e.g. swinging, bubbling). Secure the ICC and dress the wound site appropriately. If multiple drains are connected, clearly label / number each drain (e.g. apical or basal).

Ongoing: Obtain a CXR to assess position, closely monitor the patient condition, and continue to assess drain function. Ensure the patient has ongoing adequate analgesia.

Further details on post-procedure care are outlined in Appendix 2.

7.2 Suction

Suction assists drainage of fluid from the pleural cavity, used routinely for haemothorax and pneumothorax with ongoing large air leaks. It should always be considered in the early stages of management, particularly when there are concerns for an ongoing air leak. Suction isn't needed for simple pneumothoraces, and not using suction does allow patients more mobility with a drain. Suction can be temporarily stopped with haemothoraces but should not be stopped in pneumothoraces with ongoing persistent bubbling, or where suction is required to maintain lung expansion.

Wall suction is attached to the drain system and usually set at -15-20cmH_2O on the drain system. It must not be attached to an ICC without an ICC drainage system. After wall suction is ceased, ensure the suction tubing is removed, to prevent tension physiology from 'closed circuit'.

7.3 Assessment of drain function

The effectiveness of an ICC may be assessed by the observed draining, bubbling and swinging. ***Draining*** refers to the fluid draining from the pleural cavity into the ICC and drainage system. It is expected with a haemothorax. Small amounts of drainage of physiological pleural fluid may or may not be seen with pneumothorax. Absence of ongoing drainage may represent complete drainage of fluid without ongoing bleeding, or blockage.

Bubbling is the visible movement of air through fluid in the tubing or the underwater seal. It usually represents drainage of pneumothorax via the ICC. This may stop after the pneumothorax is fully drained or continue if there is ongoing air leak from the lung. It may also stop if the drain becomes blocked. Bubbling may also be seen when the drain is on suction and there is a loose connection (see section 7.4). Note that some drainage systems have bubbling separately as part of the suction regulation mechanism.

Swinging is the back and forward movement of fluid in the drainage system (tubing or underwater seal) timed with a patient's breathing pattern. It occurs due to cyclic changes in pleural pressure with breathing and confirms tube patency. Swinging is usually obvious in spontaneously breathing patients and exaggerated with deep breathing or coughing. It may not be obvious in patients who are intubated and ventilated or when a drain is on suction.

7.4 Clamping an ICC

Clamping of an ICC or the drainage system is rarely required in trauma and will prevent ongoing drainage of pneumo/haemothorax. Do not clamp drains for active bleeding. If clamping is required for the reasons outlined below, this is a temporary measure and should be released as soon as possible.

ICCs which are consistently bubbling should not be clamped, as this may result in recurrence of pneumothorax. Clamping may either be through a sliding clamp on a drainage system, closure of a 3-way-tap on a Seldinger drain, or clamping of the drain/tubing with metal clamps (e.g. Howard Kelly clamp) and should always be under medical direction.

Clamping may be used:

- To assess if an ICC can be removed, by clamping the ICC/drain and later repeating a CXR, to assess for recurrence of pneumothorax.
- When changing drainage systems.
- In the diagnosis and troubleshooting of persistent air leak.
- When the drainage system has to be briefly lifted higher than the patient, to prevent backflow into the chest.

7.5 Troubleshooting

Kinking or blockage: This is common around the insertion site underneath the patient's arm. The chance of this can be reduced by securing the drain on a 'mesentery' (as described below) to prevent it kinking at the skin level. Kinking can also occur internally, which is usually evident on CXR. The ICC or drainage tubing can also be caught in the bed rails or other patient equipment. Internal tube blockage can occur from clotted blood or pleural exudate. Completely kinked or blocked drains won't have swinging, drainage or bubbling. The patient may develop reaccumulation of pneumo/haemothorax, with or without symptoms.

Insertion site bleeding: Minor bleeding from the skin and subcutaneous tissue usually resolves spontaneously after suturing and dressing. If persistent, consider and assess for coagulopathy in the setting of trauma. Further suturing, dressing (including topical haemostatic dressings), or infiltrating lignocaine and adrenaline may be needed. Significant bleeding from the insertion site usually represents bleeding from an intercostal vessel and may require interventional and/or surgical management.

Insertion site infection: This should be taken seriously and is usually treated with IV antibiotics. If suitable, the ICC should be removed. Communication with the pleural space and resultant empyema should be considered.

Dislodgement of the ICC: If the ICC suture fails and the ICC migrates partially out of the thorax, it should not be reinserted as it is considered 'dirty' and high risk of subsequent infection. If the catheter side holes remain in the pleural space, it can be resecured at the new depth. If the side holes have come out, the catheter should be removed and consideration given to whether a replacement ICC is required.

Inadequate drainage of pneumo/haemothorax: After chest drain insertion and time, the pneumothoraces should resolve with complete expansion of the lung. Persistent bubbling *with* complete lung expansion after a period of time suggests an ongoing lung air leak that is being drained effectively. It may also be due to a loose connection in a drain system on suction. Persistent bubbling *without* complete lung expansion after a period of time suggests inadequate drainage, and a second ICC may be required. Check for ICC blockages as the first step.

Similarly, worsening subcutaneous emphysema (clinically or radiologically) after drain insertion suggests inadequate drainage and the ICC should be checked for blockages. Haemothoraces typically take longer to drain and a persistent haemothorax >72 hours after drain insertion represents a 'retained haemothorax' and often requires further surgical management.

Persistent bubbling: Persistent bubbling may represent either ongoing air leak from the lung, or a loose connection in a drain on suction. Check for loose connections or incomplete dressings. If bubbling persists when the ICC is clamped close to the patient, there is a leak somewhere between the clamp and the suction. Bubbling which stops when the suction is turned off does not confirm the air leak is in the drain – it may just be a pneumothorax that is now not draining.

8. Removal of an ICC

All ICCs should be removed as soon as they are no longer required to reduce infection risk, pain and assist with patient mobilisation. For a pneumothorax, this is typically when the lung is fully re-expanded on CXR (i.e. the pneumothorax is 'drained'), and there is no ongoing bubbling for >24-48 hours. For a haemothorax, the ICC is removed when the haemothorax has resolved, as assessed by CXR and reduction of drainage amounts into the canister (typically <200mL/day). Premature removal of an ICC for haemothorax may increase infection risk due to the retained haemothorax. ICCs do not need to be clamped prior to removal, however in very specific circumstances, clamping and performing a CXR to check for re-accumulation of pneumothorax may be used if there is uncertainty about ongoing bubbling. This should only occur under direct consultant advice.

ICCs may be left in longer as a precaution if the patient has further planned procedures, interhospital transfers, or to prevent re-accumulation that may be difficult to identify or manage in these settings.

The following steps should be utilised when removing an ICC:

1. Confirm the medical order to remove, and if multiple ICCs, which drain is to be removed.
2. Explain procedure to patient and ensure adequate analgesia beforehand.
3. Prepare equipment required:
    - PPE (gown, goggles, gloves)
    - Suture cutter
    - Dressing pack
    - Sodium Chloride (0.9%) or antiseptic per local guideline
    - Steristrips
    - Gauze
    - Occlusive transparent dressing (e.g. IV3000, Primapore, Opsite)
    - Absorbent pad
4. Ensure the suction is off at the wall and remove tubing (if applicable).
5. Adhere to the five moments of hand hygiene and don PPE.
6. Prepare absorbent pad under the patient / ICC site, loosen existing dressing around the ICC.
7. Perform hand hygiene and prepare dressing pack, pre-prepare steristrips, gauze and occlusive dressing.
8. Perform hand hygiene and don sterile gloves.
9. Cleanse the site from the insertion site outwards (with normal saline solution or as per local guidelines).
10. Use a stitch cutter to cut the securing suture.

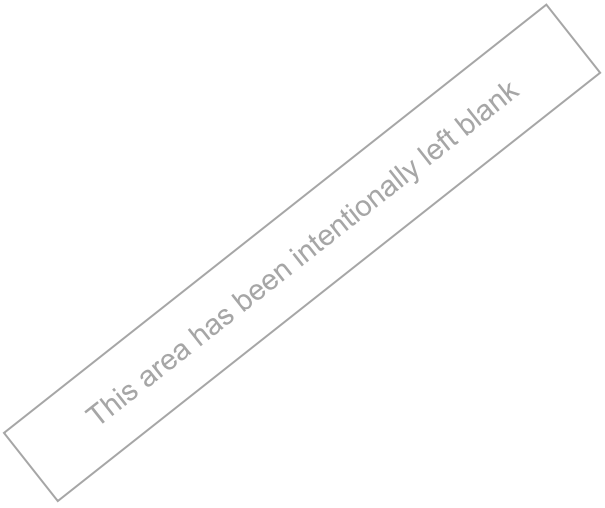
11. Ask the patient to take a full breath in and hold. For intubated patients the drain should be removed on inspiration.
12. Remove the ICC in one fast continuous motion during the breath hold (or inspiration in intubated) (this will help prevent air entering the tract) and squeeze sides of the wound together.

There should be no excessive force required to remove the drain. If any resistance is met, stop the procedure and request senior Medical Officer review.

13. Instruct the patient to breathe normally.
14. Cleanse the wound with saline and apply an occlusive dressing. Steristrips may be used to appose the wound edges if required. Large incisions require suturing.
15. Discard the chest drain into the appropriate clinical waste receptacle.
16. Document the procedure in the medical record.

8.1 Post procedure care

Assess patient's condition, including chest auscultation, respiratory rate, work of breathing, oxygen saturation, blood pressure, heart rate and pain and escalate any acute changes or concerns post-procedure. A post-removal CXR is recommended, the timing of which depends on local practice and resources. The CXR must be reviewed by an appropriately trained clinician.



Appendix 1: ICC underwater seal drain observations

(paper and electronic versions)

Queensland Government

Central Queensland Hospital and Health Service

Chest Drain Observations (Atrium)

Facility / Unit: .....

Insertion Date: ..... / ..... / ..... Insertion Site: .....

Post -Insertion X-ray Date:...../...../..... Time: .....

Frequency Observations: (vital signs, swinging, bubbling, drainage and amount of suction applied)

- In first hour after insertion and removal check every 15 mins.
- Then hourly for 4 hours.
- After 4 hours they should be checked every 4 hours (or more frequency if necessary).
- Note hourly blood loss and inform responsible medical officer

Refer: *Pleural Drain Insertion and Management procedure*

(Affix identification label here)

URN:

Family name:

Given name(s):

Address:

Phone:

Date of birth: Sex: ☐ M ☐ F ☐ I

Note: TURN SUCTION OFF from wall suction source prior to conducting observations for swinging and bubbling.

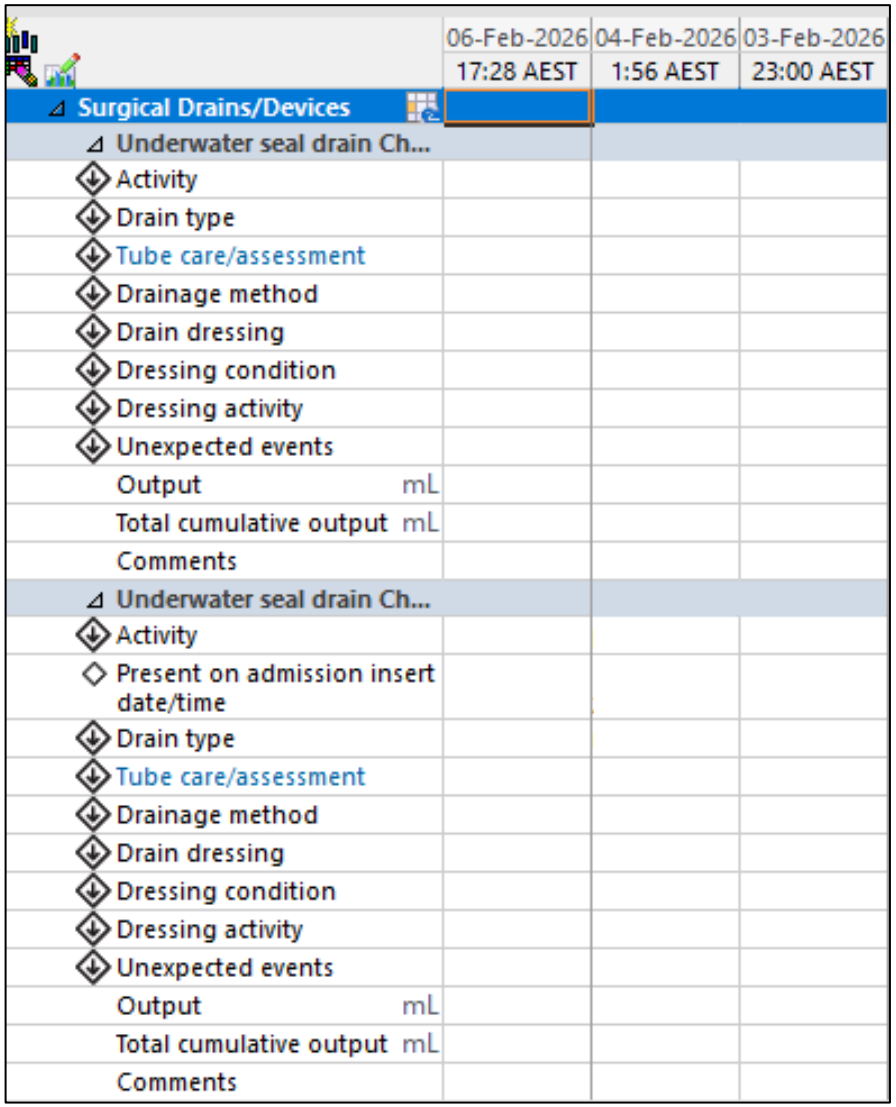
Drainage Type: N - Nil, **P** - Purulent, **H.S.** - Haemoserous, **H.P.** - Haemopurulent, **S** - Serous, **B** - Blood, **C –** Chyle (milky fluid > notify MO immediately).

Bubbling: N -nil, **INT –** intermittent, **CONT –** continuous

Date	Time	Suction On (Y/N)	Swinging (Y/N)	Bubbling when patient coughs?	Bubbling	Migration	Drainage	Total Cumulative	Drainage Type	Connection Secure	Wound Dressing intact	Pain Score	Comments	Nurse
		Pressure in cm H2O on Atrium *e.g. Y -20*	observe swing of pressure float ball	Y/ N/A / sleep /NA **NA for pleural effusion*	**Score 1- 5** blue water seal chamber *e.g. INT - 2*	External drain measurement	Amount in mls since last check	amount in mls from the time of insertion	see above	no kinks, loops, blockages √	(Y/N)	1-10	MO notified, dressing changed, leak detected, tubing unlooped, clamped for X-Ray)	Initials

Chest drain clamped Date: Time: Requested by: Chest drain clamp released Date: Time Requested by:

Chest drain clamped Date: Time: Requested by: Chest drain clamp released Date: Time Requested by:



	06-Feb-2026 17:28 AEST	04-Feb-2026 1:56 AEST	03-Feb-2026 23:00 AEST
Surgical Drains/Devices			
Underwater seal drain Ch...			
Activity			
Drain type			
Tube care/assessment			
Drainage method			
Drain dressing			
Dressing condition			
Dressing activity			
Unexpected events			
Output mL			
Total cumulative output mL			
Comments			
Underwater seal drain Ch...			
Activity			
Present on admission insert date/time			
Drain type			
Tube care/assessment			
Drainage method			
Drain dressing			
Dressing condition			
Dressing activity			
Unexpected events			
Output mL			
Total cumulative output mL			
Comments			

Appendix 2: Procedure for insertion of an ICC

Adapted from the intercostal catheter and Seldinger-guided small bore catheter insertion guideline, Emergency Department, Princess Alexandra Hospital.[17]

ICC placement via blunt dissection

1. Use strict aseptic technique to prepare the patient's skin; thoroughly clean with alcoholic chlorhexidine or povidone iodine 10% w/v solution. Drape the site with sterile drapes.
2. Use a scalpel to incise the skin only.
3. Use blunt dissection utilising the Spencer-Wells forceps, to spread the subcutaneous fat, and muscle. Remember the external and internal intercostal muscles are in a criss-cross pattern and must be physically spread apart in two planes.
4. At the superior aspect of the lower rib, puncture the parietal pleura with the tip of the forceps, while using your non-dominant hand to prevent insertion of the forceps too deeply into the pleural space. You will know when you enter the pleural cavity as the tissue resistance will abruptly disappear.
5. Ensure the tract through the intercostal muscles, and the hole in the pleura, are wide enough to allow easy passage of the ICC. This can be done with the forceps or a gloved finger. Creating an adequate tract for the ICC will ensure excessive force is not needed during ICC insertion. Digital examination into the thoracic cavity ensures there are no underlying organs or adhesions that might be damaged when the ICC is inserted, and that the tract is not sub-pleural. Be careful of fractured ribs and risk of lacerating the finger on a spicule of bone.
6. Insert the ICC using artery forceps or finger guidance, aiming apically to drain air or basally to drain fluid. Insert cautiously until resistance is met, then withdraw slightly. Ensure that all side holes of the catheter are inside the pleural cavity.

Note: The cm markings on the side of the catheter indicate the distance from the tip of the ICC, marked 5cm apart. These can be used as a guide to the distance between the skin and the nearest side hole. As a general guide, a digit can be used to determine the thickness of the chest wall. Add 8cm to the chest wall thickness to determine the total distance from skin to which the ICC should be inserted.

Seldinger-guided small bore chest catheter insertion

There are a number of brands/types of Seldinger ICCs. The below instructions are representative. Ensure you are familiar with your own device before use.

1. Use strict aseptic technique to prepare the patient's skin; thoroughly clean with alcoholic chlorhexidine or povidone iodine 10% w/v solution. Drape the site with sterile drapes.
2. Consider filling the 10mL syringe with saline / water and attach an introducer needle to the syringe. There is a choice of 2 introducer needles for aspiration, use the one that will allow best access to the pleural space depending on the thickness of the chest wall.
3. Prepare the catheter and insert the obturator through the 3-way stopcock into the catheter to straight out the catheter. Fasten the Luer lock connection securing the obturator to the catheter.
4. Once the anaesthetic has taken effect, use a scalpel blade to make a 0.5cm incision through the skin to subcutaneous tissue in the $4^{th}/5^{th}$ intercostal space, anterior to the mid-axillary line.
5. Insert the introducer needle through the skin incision into the pleural cavity, aiming just superior to the lower rib. When the needle tip enters the pleural cavity, you should aspirate air or fluid.

6. Once the introducer needle is in the pleural cavity, disconnect the syringe and introduce the flexible tip of the guidewire, feeding it 10-15cm into the pleural cavity. Patients may feel discomfort if the guidewire irritates the lung / mediastinum.
7. Remove the needle, leaving the guidewire in place. Advance the dilator over the guidewire until the dilator has entered the pleural cavity, controlling the dilator as it enters the pleural space.
8. Remove the dilator, being careful to maintain the guidewire in situ.
9. Advance the catheter over the guidewire to the depth required. The three black lines are 2.5cm apart, and the distal black line is 5cm from the proximal side-hole.
10. One satisfied with the depth, remove the guidewire and obturator.
11. Attach the catheter to the connecting tube via the 3-way stop cock.

Note: once the obturator is removed, the tip of the catheter will coil. The catheter must be far enough into the pleural space that the proximal side hole is inside the pleural cavity. Use the introducer needle insertion to gauge the thickness of the chest wall prior to entering the pleural cavity.

Confirm correct placement

Correct placement can be confirmed with CXR (where the drain has been placed non-emergently), fogging of the chest tube with expiration, swinging +/- bubbling +/- drainage. Warning signs of complications with the insertion procedure include: the patient experiences sudden pain or distress, or becomes hypotensive, hypoxaemic or observations deteriorate. This necessitates immediate senior medical review.

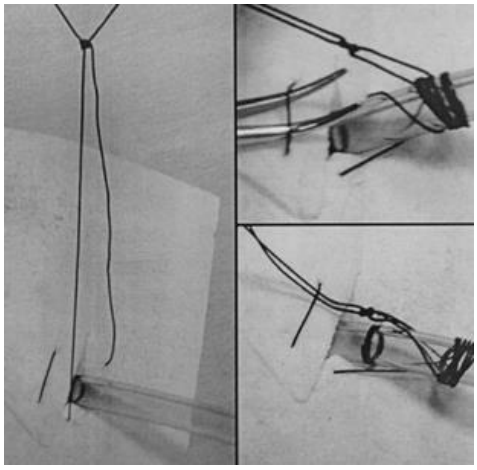
Securing and connecting the ICC

Suturing

Once the ICC is inserted in a satisfactory position, it should be secured with a stay or anchoring suture. The skin suture should include adequate skin and subcutaneous tissue to ensure it is secure. This suture should be tied to form a ‘locked’ knot, to which the chest catheter will be firmly attached. Start with a standard wound closure suture above the ICC. Then make a hitch by pulling the long length of suture across to one side of the ICC (use the caudal side), then wrap the end of the suture over the ICC, then under the ICC then back up and between the suture strand and the ICC. Pull it tight and close to the patient. Repeat this step 5 times and then tie it off. This will make a very strong anchor suture that will prevent the ICC from moving.

If the wound is too long for the chosen ICC, simple sutures should be placed at one or both ends of the wound, to ensure the skin fits snug around the tube. The anchoring suture can be used to do this. If a suture for wound closure post drain removal has not been inserted already, then consider doing this. The loose ends of the wound closure suture should be tied together at the distal end and wound around the ICC near the skin. This suture is to close the wound after drain removal. An example of a drain suturing technique is pictured in figure 8 and 9 below:

Figure 8 and 9: Example suturing technique



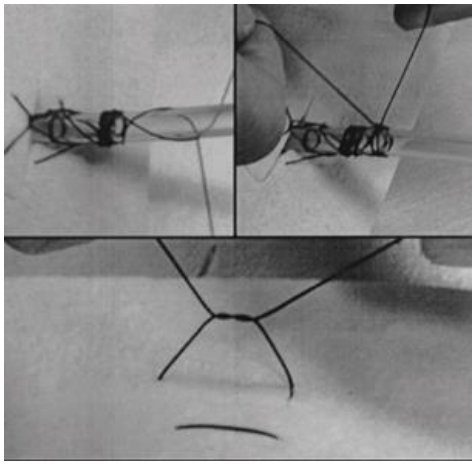
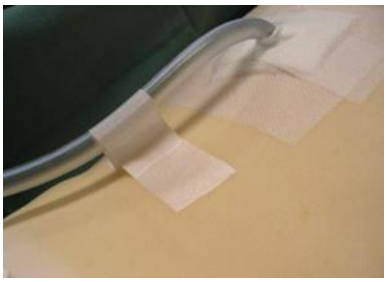


Photo credit: Martiz and McLauchlan [18]

For both the stay suture and the wound closure suture, choose a stout, non-absorbable suture material such as Mersilene 0 or Silk 1 on a cutting needle.

Further procedural videos are available on the Queensland Trauma Education[19] website.

Secure the tubing to the skin to facilitate drainage and reduce the risk of tube dislodgment. This should be done in a manner that maintains patient comfort. Use a mesenteric tag of tape applied to the chest tube about 15-20cm distal to the insertion site (allowing a gap between the skin and the tube where the tape is adhered to itself providing a stable anchor). This reduces tension at the insertion site and helps prevent kinking. Some sites may utilise commercial securement devices in specific clinical areas for this purpose.



Note: It is difficult to tie suture material finer than Silk 1 tightly enough to hold the ICC in. When tying off the suture ensure you 'lock' the knot to prevent it loosening. Increased morbidity and length of stay has been associated with ICCs that need reinserting because they are not properly secured and fall out.

Connecting

Ensure water is added to the water seal drainage system prior to connecting the drainage system to the ICC (very important). Once the ICC is in position and secured, remove the protective cap from the end of the drainage tube of the underwater seal drain and immediately connect it to the ICC.

If the ICC has been clamped, remove clamps immediately after connection to the system. Tape the junction of the tubes to prevent separation, ensuring that the connection remains visible. Use two thin strips of woven non-stretch tape lengthwise over connection, to allow for the observation of the junction and clots in the connection.

Ensure the drain system is below the patient's chest level by at least 80cm at all times.

For a large pneumothorax / haemothorax, once the ICC position is confirmed, it is seen to be swinging and bubbling and is secured and connected to the underwater seal drainage system then consider placing the ICC on wall suction.

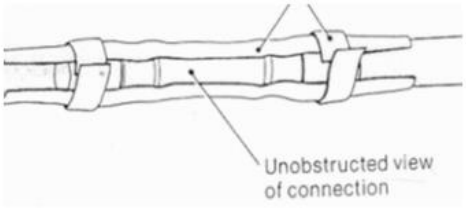


Photo credit: NSW Agency for Clinical Innovation[20]

Dressing

There are many options to dress the site, including split dressings and transparent dressings (figure 10 and 11 below). Avoid large amounts of tape and padded dressings as they may restrict chest movement and increase moisture collection. Use split dressings or a transparent dressings for minimal wound ooze to allow inspection of the site for leakage/infection. Use two absorptive dressings with adhesive dressing on top for moderate wound ooze. For a heavy exudating wound, use a highly absorbent dressing to prevent wound leakage and cover with adhesive dressing.

Figure 10 and 11: Dressing options for ICCs

Glossary of terms

Intercostal catheter	Any chest drains regardless of size or insertion technique
Haemopneumothorax	Blood and air between the parietal and visceral pleura on CXR or CT.
Haemothorax	Blood between the parietal and visceral pleura as suspected on CXR and / or CT.
Pneumothorax	Air (lucency) between the parietal and visceral pleura on CXR or CT.
Seldinger intercostal catheter	Any drain inserted using a Seldinger technique, typically with a smaller diameter (e.g. 10-14 French gauge)
Surgical intercostal catheter	Any drain inserted using a surgical technique, typically with a larger diameter (e.g. 18-40 French gauge, but more commonly 24-28 French gauge).

Abbreviations

ATLS	Advanced Trauma Life Support
BP	Blood pressure
CT	Computed tomography
CXR	Chest xray
eFAST	Extended focused assessment with sonography in trauma
ETT	Endotracheal tube
Fr	French gauge
HR	Heart rate
ICC	Intercostal catheter
INR	International normalised ratio
IV	Intravenous
LA	Local anaesthetic
LMA	Laryngeal mask airway
PPE	Personal protective equipment
RR	Respiratory rate
RSQ	Retrieval Services Queensland
UWSD	Underwater seal drain
VATS	Video assisted thorascopic surgery

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Consultation

Queensland Emergency Department Strategic Advisory Panel
Queensland Surgical Services Clinical Network
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Queensland Intensive Care Clinical Network
Queensland General Medicine Clinical Network
Queensland Infection Clinical Network
Queensland Maternity and Neonatal Clinical Network
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Queensland Rural and Remote Collective
Queensland Dementia, Ageing and Frailty Clinical Network
Queensland Persistent Pain Clinical Network
Queensland Trauma Clinical Network
Queensland Ambulance Service
Retrieval Services Queensland

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