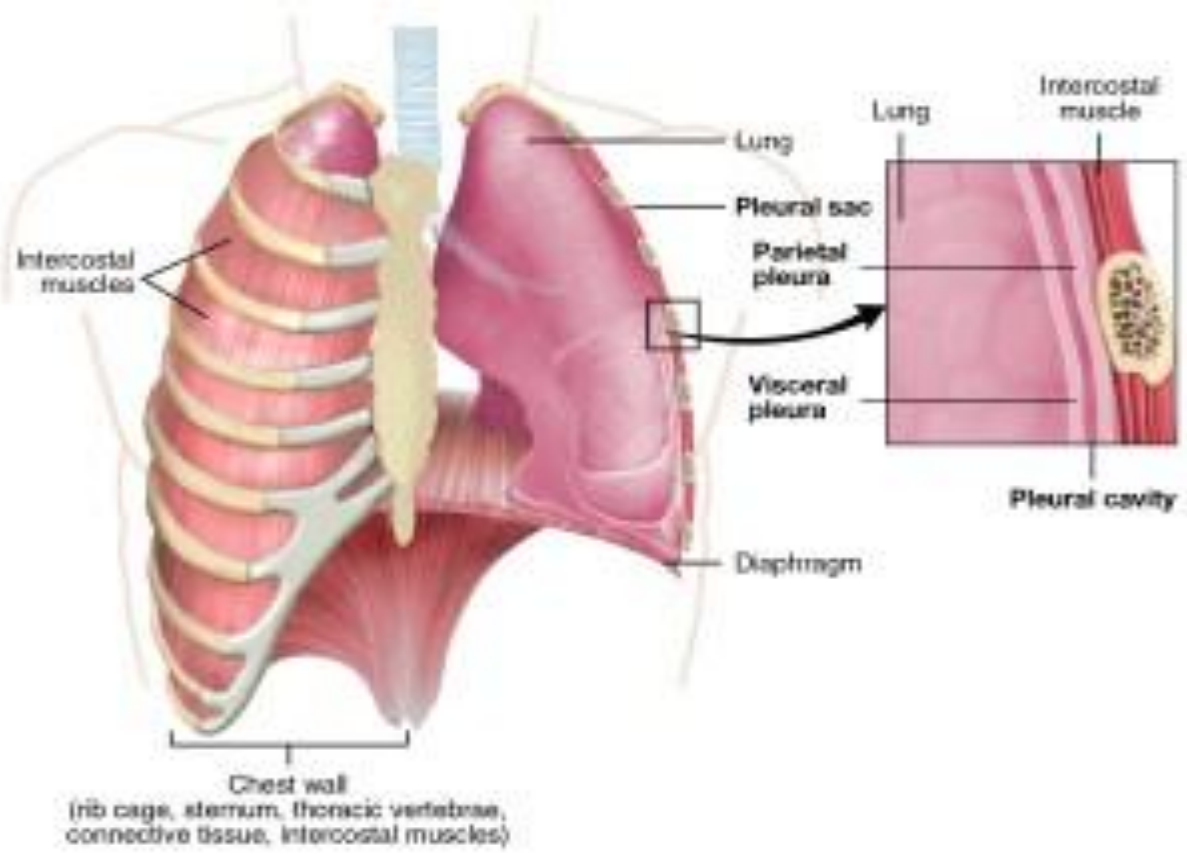
NURSING MANAGEMENT OF CHEST DRAINS

A LEARNING RESOURCE FOR INTENSIVE CARE NURSING STAFF



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Introduction:

Chest drain insertion is a common procedure, which may be carried out in clinical areas. Most are planned, but some may need to be done as emergencies. When they are not inserted properly, they may puncture major organs such as heart, lungs, liver and spleen.

Whenever possible, written evidence of consent should be obtained from the patient before the procedure, the only exception being in unconscious patients and in an emergency. The British Thoracic Society recommend that the following complications should be listed and discussed with the patient:

- Pain
- Intra-pleural infection
- Wound infection
- Drain dislodgement
- Drain blockage
- Pneumothorax
- Bleeding
- Drain-related visceral injury
- Mortality of 1%

Evidence of harm:

The National Patient Safety Agency (NPSA) has received reports of **12 deaths relating to chest drain insertion and 15 cases of serious harm between Jan 2005 and March 2008**. A substantial number of less severe incidents have been reported highlighting poor management of inserted chest drains. Many more are likely to be unreported.

The Medicines and Healthcare Products Regulatory Agency (MHRA) have received reports of nine incidents since 2003, all but one relating to the seldinger type drain which is now the most commonly used technique.

Common themes from a review of incidents reported to the NPSA, MHRA, local investigations and literature include:

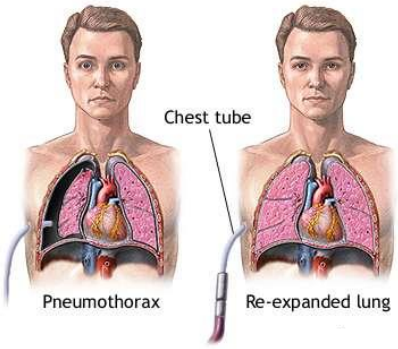
- Supervision of junior doctors and levels of experience of clinicians inserting chest drains.
- Failure to follow manufacturer's instructions.
- The site of insertion and poor positioning.
- Excessive insertion of dilator.
- Anatomical anomalies and the patient's clinical condition.
- Inadequate imaging.
- Lack of knowledge of existing guidelines.

The NPSA also provides guidance relating to patient assessment for insertion of a chest drain. The following need to be answered:

- Do I need to do this? Does the amount of air/pleural fluid require drainage?
- Does it need to be done as an emergency – can it wait?
- Is any doctor recognised as being competent of chest drain insertion available? Are senior staff to hand?
- Am I familiar with this equipment?
- Is ultrasound available, with trained staff, to position it safely? Or is the latest x-ray/CT scan available and up to date?

Chest drains are inserted through an intercostal space into the pleural cavity and are designed to:

- Remove air, blood, pus or fluid safely
- Prevent re-introduction of air or fluid
- Facilitate lung re-expansion
- Induce pleurodesis.



Common conditions requiring chest drain insertion are:

- Pneumothorax
- Haemothorax
- Pleural effusion
- Empyema
- Pleurodesis
- Broncho-pleural fistula, post-op or due to mechanical ventilation.
- Following cardiothoracic surgery.

Contra-indications/cautions:

- Anticoagulation, coagulopathy, or a bleeding diathesis are relative contra-indications in a patient undergoing elective chest tube placement.
- Transudative pleural effusions due to liver failure are not generally managed with thoracostomy drainage.
- Blind insertion of a chest tube is dangerous in a patient with pleural adhesions from infection, previous pleurodesis, or prior pulmonary surgery; guidance by ultrasound or CT scan without contrast is preferred

Antibiotic prophylaxis:

The need for prophylactic antibiotics prior to the placement of thoracostomy tubes depends upon the clinical circumstances:

- Spontaneous pneumothorax: prophylactic antibiotics are not warranted for chest tube placed in the setting of spontaneous pneumothorax or other nontraumatic conditions.
- Penetrating trauma: prophylactic antibiotics are warranted for chest tubes placed in the setting of trauma, particularly in patients with penetrating injury.
- Elective thoracic operations: prophylactic antibiotic therapy is administered as a pre-op dose only. There is no evidence of benefit for continuation of antibiotics for longer than 24 hours.

Anatomy and physiology:

Pleural space:

This is the cavity between the membrane lining of the lungs (visceral or pulmonary pleura) and the lining of the chest cavity (parietal pleura).

The pleural space function is to:

- Prevent friction between the outer lining of the lung and the inner lining of the thoracic cavity during respiration.
- Hold the 2 pleural surfaces together, creating negative pressure (a vacuum) that keeps the lungs expanded.

The lungs are elastic and naturally tend to collapse or recoil, but in normal conditions, the pleural space causes the outer lining of the lung to adhere to the lining of the chest cavity, keeping the lungs expanded to proper position during inspiration and expiration.

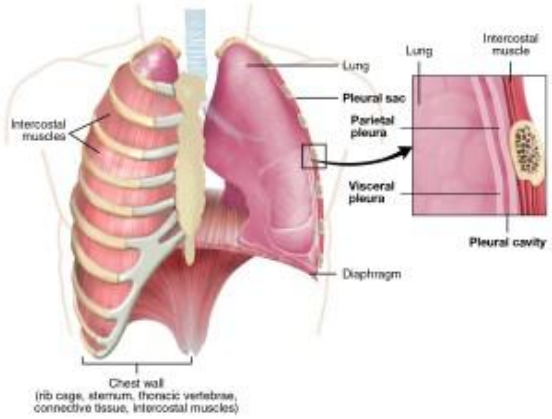
The pleural space is normally filled with around 50ml of fluid, only enough to provide a thin coating of fluid for lubrication of the opposing surfaces. Small increases in volumes of air and/or fluid can be absorbed by the body, whereas larger volumes prevent the lung from expanding to its full potential.

Breathing is completely compromised when this excess air and/or fluid enters the pleural space. The lungs may partially or completely collapse if a certain negative pressure threshold is not maintained i the pleural space. Obviously then, shortness of breath and increased respiratory rate and effort will be among the symptoms in such an event.

There is a potential space between the parietal and visceral pleura which surround the lungs. In a normal healthy adult this space contains nothing other than some secretions to help the two membranes slide against each other. However there can be instances when the space between these two membranes can fill with air or a gas. As the space fills with this air or gas so the patient's breathing may start to become compromised.

Damage to the chest wall can be caused by physical trauma or as a complication of medical or surgical interventions or underlying disease. This can then allow the passage of a gas or air into the pleural space creating a pneumothorax.

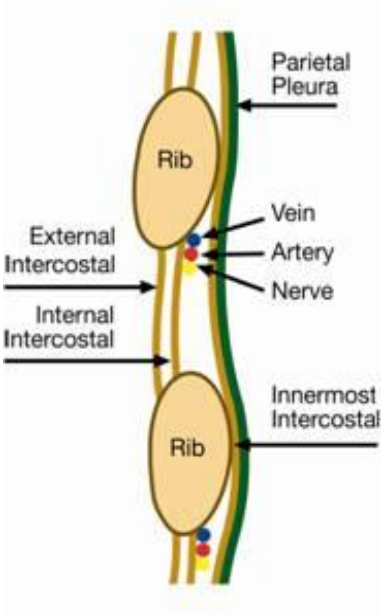
A pneumothorax which occurs in the absence of any other significant lung disease and without an apparent cause is known as a **primary pneumothorax**, whilst that which occurs in the presence of existing lung disease is known as a **secondary pneumothorax**.

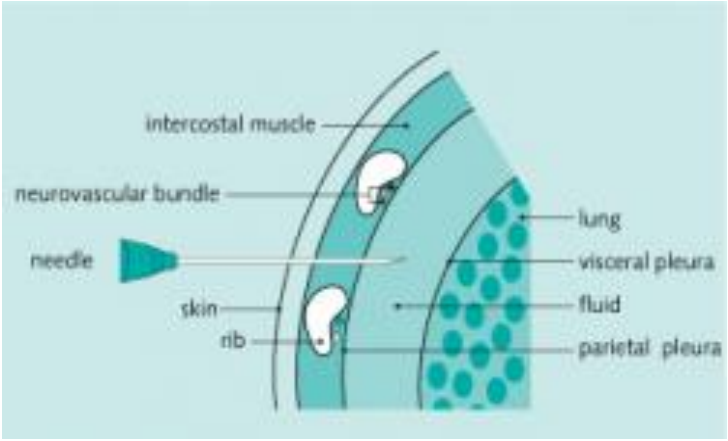


Anatomy of the chest wall:

The anatomy of the chest wall is important to consider when preparing for chest drain insertion.

Between each of the ribs lie the intercostal spaces which are breached over by the intercostal muscles. Each intercostal space has a nerve, artery and vein running through it. These vessels lie and run just under the rib. This means that a chest drain should be inserted just above the upper border of the rib to avoid damage to the neuro-vascular bundle. The long thoracic nerve runs down the lateral border of the thorax and so chest drains should be inserted anterior to the mid-axillary line to avoid damage to this structure.



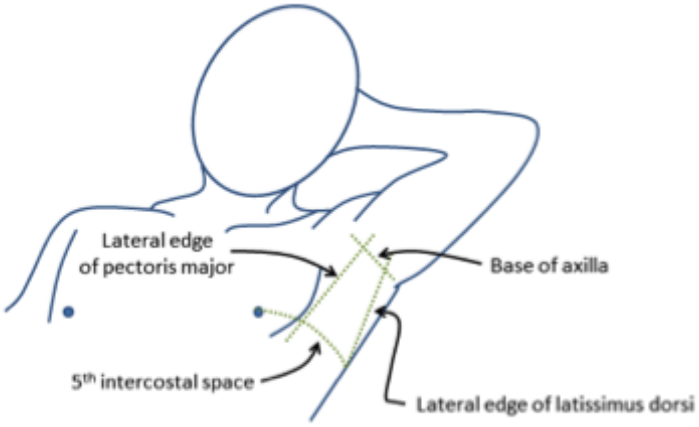


Insertion site:

- The chest tube insertion site depends upon the indication for tube placement. Fluid collects in the dependent portion of the chest cavity, whereas air collects in the non-dependent portion.
- For evacuating pneumothorax, most clinicians insert the tube via an incision at the 4th or 5th intercostal space in the anterior axillary or midaxillary line.
- A potentially better site for patients with only a pneumothorax is the 2nd intercostal space in the midclavicular line.
- For draining a haemo-pneumothorax, the chest tube is directed posteriorly because the priority is to drain the blood and monitor the blood loss. For draining pleural effusions, the tube can be placed lower in the chest.
- Chest tube insertion at any site is uncomfortable or even painful for most patients, but in emergency clinical settings the chest tube can readily be inserted under local anaesthesia e.g 1% lignocaine with or without an intercostal nerve bloc. In the elective setting, oral or iv sedation and analgesia can be administered prior to the insertion.

Figure above: The 'triangle of safety'

- The site of chest drain insertion should generally in the 'safe triangle' in the mid-axillary line.
- The triangle is bordered anteriorly by the lateral edge of the pectoralis major, laterally by the lateral edge of the latissiumus dorsi, and inferiorly by the line of the 5th intercostal space and superiorly by the base of the axilla.
- Thorough clinical examination and imaging should be used to select the appropriate site for chest drain insertion and radiology/ultrasonography must be used to confirm safe and adequate placement.



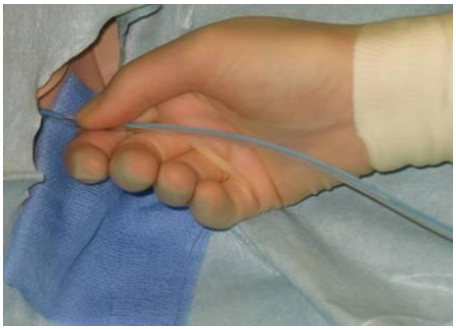
- For all small bore drains (seldinger drains) insertion under image guidance with a guidewire is recommended.
- The marking of a site using thoracic ultrasound for subsequent remote aspiration or chest drain insertion is not recommended except for large pleural effusions.
- Anatomy can be more challenging to identify in larger/obese patients.

Chest tube selection:

- Chest tubes are silicone or PVC that have a radiopaque strip with a gap that serves to mark the post proximal drainage hole.
- Chest tubes are in a range of French (Fr) sizes from 14 to 40.
- Since these tubes can become plugged easily with blood or purulent drainage, a large tube is needed. For example, a 28 Fr or larger tube may be preferred to manage haemothorax since it will allow evacuation of gelatinous clot.
- Tubes can be angled or straight. Angled chest tubes are used often in the surgical setting to assure placement in the posterior costophrenic sulcus.
- Chest tubes come in 2 standard lengths, and either length may be appropriate for an adult. The length of a thoracostomy tube is determined by the ability to place all lateral perforations inside the pleural cavity without kinking of the tube.
- For patients with a large pneumothorax, a small bore chest tube can be placed with a Seldinger technique without imaging and causes less pain compared with a large bore chest tube. For patients with a loculated collection, imaging (CT) should be performed during placement.

Large bore chest tube:

Small bore chest tube Seldinger:



Conditions requiring the insertion of a chest drain:

Pneumothorax**:**

Initial management is dictated by the severity of the patient's symptoms and the size of the pneumothorax. Once the decision is made to proceed with drainage of the pneumothorax, the size of the chest tube selected depends upon whether high-volume air leakage (e.g. large pneumothorax, mechanical ventilation) and/or concomitant blood drainage(e.g. traumatic pneumothorax, large pleural air-fluid level) are anticipated.

- For the majority of patients with spontaneous or iatrogenic pneumothorax, a small bore catheter (8 to 14 Fr) is sufficient because these air leaks are due to alveolar-pleural fistulae.
- For patients at risk for a large air leak due to broncho-pleural fistulae (e.g. on mechanical ventilation, bronchial dehiscence) a larger bore tube is preferred i.e. 24 Fr.
- For traumatic pneumothorax, the size of the chest tube will depend on what is seen on CXR. If there is an effusion, a 28 Fr chest tube may be used because of the potential need to drain blood as well as air. However if no effusion is seen, then a small bore (≤14 Fr) tube is placed. Occasionally, more than one ipsilateral chest tube is needed, especially in the mechanically ventilated patient.
- Suction is not initially routinely employed: instead the tube is attached to the drainage system that contains a valve mechanism to allow air and fluid to exit but prevents air or fluid from entering the pleural cavity from the outside.
- Valved drainage systems may use underwater seal drainage or a uni-directional flutter valve i.e. Heimlich valve. The underwater seal can be easily converted to suction, while the uni-directional flutter valve allows the patient to be mobile. If the pneumothorax does not resolve with these methods, suction may be applied.
- Air leaks can be identified by the presence of bubbling, along with the timing of the air leak in the respiratory cycle.The size of the potential air leak cannot be known before putting in the chest tube, and the tube that is chosen may be too small. If the pneumothorax does not resolve, the first step is to increase the level of suction, and only if maximal suction fails to resolve the pneumothorax should a second chest tube be considered.

Heimlich flutter valve: a one-way valve that allows air to leave the pleural space but not re-enter.

Tension pneumothorax:

- Tension pneumothorax is a life-threatening emergency that requires immediate decompression. In the absence of haemodynamic compromise, the suspicion for tension pneumothorax should ideally be confirmed on CXR prior to thoracostomy.

- However, the patient with worsening dyspnoea, hypotension, diminished breath sounds on the affected side, distended neck veins, and tracheal deviation away from the affected side should be treated without a CXR.

- If immediately available, a standard thoracostomy tube (24 to 28 Fr) should be placed; otherwise needle thoracostomy should be performed, followed by chest tube placement as soon as possible. If a chest tube is not immediately available, needle decompression can be a life-saving (albeit temporising) measure that should be performed in an arresting patient for whom tension pneumothorax is a possibility.

Haemothorax:

- Haemothorax is most commonly a result of closed-chest trauma, but haemothorax can also result from nontraumatic conditions e.g. malignancy, pulmonary infarct, anticoagulation, aneurysm rupture.

- The goals of tube thoracostomy in acute haemothorax are drainage of fresh blood, measurement of the rate of bleeding, evacuation of co-existing pneumothorax, and tamponade of the bleeding site by apposition of the pleural surfaces.

- Large-bore tubes (greater than 28 Fr) are required to achieve these goals. However, as the chest tube size increases above 32 Fr, there is diminished benefit with increasing patient discomfort.

Malignant effusion:

- The management of malignant pleural effusions depends on the patient's symptoms and rate of reaccumulation. A small-bore catheter (8 to 18 Fr) placed under ultrasound or CT guidance is usually adequate to drain a malignant pleural effusion or perform pleurodesis (depending upon the viscosity of the sclerosant).

- The optimal chest tube for malignant effusion drainage or pleurodesis is not known. Smaller-diameter tubes are assumed to be more comfortable, but larger-diameter tubes may provide better drainage. Many studies have suggested that smaller chest tubes have similar effectiveness compared with larger tubes for malignant effusion.

- Chronic indwelling catheters are available for outpatient treatment of recurrent malignant effusion. These catheters come in a kit that includes disposable suction bottles and the appropriate tubing and connectors to access the catheters

- Refer to British Thoracic Society Guidelines pages 19-22 for pleurodesis procedure.

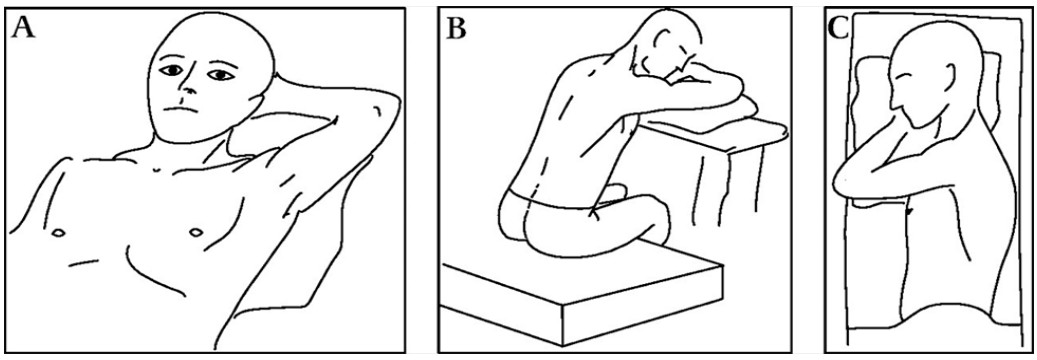
Empyema:

- For empyema, the first decision is whether to treat with chest tube drainage or perform surgical decortications. If tube drainage is selected, the clinical stage of the empyema needs to be considered.
- Stage 1 empyema, a 28r or larger tube will be needed to manage the thick pus, particularly if there is also debris, but will likely result in a successful outcome.
- Stage 2 empyema: a chest drain is still warranted but may fail. Failure to achieve drainage with a single tube should prompt thoracic surgery consultation for drainage using video-assisted thoracoscopic surgery.
- Stage 3 empyema: chest tube drainage almost assuredly fails in treatment failure.

Parapneumonic effusion:

- For parapneumonic effusion that is amenable to drainage with a single catheter, initial image-guided placement of a small catheter is preferred (10 to 14 Fr) with or without intrapleural fibrinolytic agents.
- A smaller tube is generally more comfortable for patients, particularly if more than one tube is needed.
- However if the fluid appears viscous or loculated on chest CT, a larger drainage tube (16 to 24 Fr) should be used to minimise the risk of occlusion with fibrinous debris. Unsuccessful drainage of an effusion using a small catheter indicates the presence of multiple loculations or very viscous material.

Patient positioning:



(A) The most commonly used position is with the patient lying at 30-45 degrees with the arm raised behind the head to expose the axillary area.

(B) An alternative is for the patient to sit upright leaning over an adjacent table with a pillow under the arms.

(C) The patient is in the lateral posture with the affected side uppermost.

Preparing the patient for chest drain insertion:

- Explain the procedure to the patient and provide reassurance.
- Position the patient – check with medical staff how the patient should be positioned.
- Consent should be obtained unless the patient is unconscious or the drain needs to be inserted as an emergency.
- The patient will require O2 to be administered during the procedure.
- A large bore cannula should be inserted.
- Premedication will be required as the procedure is often painful.
- Additional opioid analgesia may be required during the procedure.
- Cardiac monitoring is required: obtain baseline observations prior to chest drain insertion.
- Monitoring of vital signs is necessary during the procedure: report deviations from baseline observations to medical staff.
- A chest X-ray will be required once the chest drain is inserted.

Equipment required for chest drain insertion:

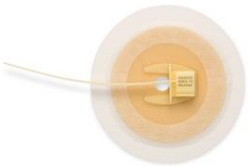
- Sterile chest drain insertion pack.
- Sterile gown, gloves, facemask, full-face visor.
- Sterile fenestrated drape.
- Chlorhexidine gluconate 2% (Chloraprep).
- Local anaesthetic: lignocaine 1%
- Light sedation may be required for the non-intubated patient. Opioid analgesia and sedation is required for the mechanically ventilated patient.
- Seldinger chest drainage kit containing: scalpel, syringe & tuohy needle, 50cm guidewire, dilator set and chest drainage catheter (size 12 FG) along with connector & 3-way tap. Or pleural catheter with flexible introducer for large bore chest drains 24-32FG,
- Sterile 2/0 suture.
- Chest drain bottle & tubing set.
- Bottle of sterile water.
- Chest drain adhesive attachment.
- Ultrasound imaging may be required for some procedures.

Inserting the chest drain:

- The procedure is carried out using full aseptic conditions.
- Sterile drapes are applied and the skin site is cleaned with an antiseptic solution.
- Adequate infiltration of local anaesthetic and allowing sufficient time for it to work needs to be ensured.
- The patient may require further analgesia/sedation during the procedure.
- The position of the drain is determined by the location and the nature of the collection to be drained.
- The 5th intercostal space in the mid-axillary line is generally used for most situations (adhering to the 'safe triangle). A specific position may be required for a loculated effusion.
- Aspiration of fluid confirms that the operator is in the pleural space and that it is safe to proceed. If fluid or air is not aspirated the procedure should not continue and further radiological help sought.
- The chest tube should be placed in the pleural cavity: significant force should not be used as this risks sudden chest penetration and damage to essential intra-thoracic structures. The operator needs to avoid injury to the intercostal vessels and nerves that run below the inferior border of the ribs.
- All drain holes need to be in the pleural cavity for the drainage system to work safely and effectively.
- A CXR is needed once the procedure is completed.

The drainage system:

- The chest drain collection bottle is filled with 500ml sterile water to the appropriate prime level.
- Once the drain is adequately inserted it is then connected to the chest drain collection bottle.
- The green cap is a venting cap which allows the free flow of air from the bottle.



Drain security and dressings:

- The chest drain tubing is held secure to the patient's chest wall using an appropriate Hollister tube attachment device: this is a sterile product and is not made with natural rubber latex.
- Large amounts of tape and padding to dress the site are unnecessary and may restrict chest wall movement or may increase moisture collection/wound infection: the use of sleek should be avoided.
- The tubing connections to the drainage bottle should be kept secure using the appropriate chest drain connectors: sleek or other adhesive tape should be avoided.
- The insertion site should be checked daily for signs of infection or subcutaneous emphysema. The insertion site should be kept clean and dry. If leaking from the site is observed obtain surface swab and send to microbiology.

Maintaining safety of the underwater seal drainage system:

Once the chest tube is inserted, it is then attached to a drainage system which only allows one direction of flow. This is usually the closed underwater seal bottle in which a tube is placed under water at a depth of approximately 3cm with a side vent which allows escape of air, or it may be connected to a vacuum control.

- The chest drain bottle must be positioned below the insertion site/level of the chest at all times to prevent fluid re-entering into the pleural space.
- It must be kept upright. Care should be taken to avoid knocking the chest drain bottle over – ensure that it is securely stabilised. Caution visitors against handling equipment or displacing the drainage bottle. Where appropriate, educate the patient.
- All drains should have clear labelling e.g. apical, basal or mediastinal.
- Chest drains must not be clamped. Never clamp a bubbling chest drain as this may result in a tension pneumothorax or possibly worsening subcutaneous emphysema.
- Avoid kinking or obstructing the chest drain tubing. Fluid within the tube should swing with respiration. If the swing is absent, check for kinks or blockage. Report same to medical staff.
- Daily reassessment of the amount of drainage should be recorded on the patient's fluid balance. Bubbling and the presence of respiratory swing should be documented on the patient's observation chart.
- Inform medical staff if drainage suddenly increases or there is more than 100ml/hr of blood drainage. Bloody drainage in the chamber indicates a potential for clot formation in the tubing and collection bottles may need to be changed more regularly. Little or no drainage may indicate that clots have obstructed the connecting tubing.

The following site, tubing and bottle connections must be checked:

1. Ensure that the chest drain is held secure at the insertion site and use the appropriate adhesive flange.
2. Check that the drain has not moved: all the holes of the drain need to be in the pleural space. If drain holes are situated within the subcutaneous tissues, air or fluid may escape into the tissues and cause subcutaneous emphysema or collections of potentially infected fluid. Report signs of subcutaneous emphysema to medical staff. Worsening subcutaneous emphysema may at its worst, track up to the face and neck, potentially causing acute/emergency airway problems.
3. If the chest drain is observed to have slipped out: inform medical staff immediately. Under no circumstances should attempts at re-inserting the tube be made.
4. Ensure a secure connection is maintained between the drainage tube connection and the bottle. Maintain secure connection using zinc oxide tape.
5. The chest drain is filled with water to the appropriate prime level (500ml). The level must be checked regularly to ensure that the drainage tube is submerged.
6. Venting the short plastic tube lets air escape from the bottle – ensure the vent hole is clear of any obstruction.

The chest drain collection bottle require to be changed when:

1. Too much fluid collects in the bottle as resistance to drainage increases.
2. Large deposits of fibrin/clots appear as this may increase the risk of tube obstruction.

Bubbling and swinging:

Bubbling and swinging should be assessed with the patient deep breathing and if possible coughing. This also has the benefit of assessing adequacy of analgesia. Bubbling and swinging indicates that the drain is working effectively.

Bubbling:

- Bubbling indicates that air is being removed from the pleural space and is visible in the water seal bottle without suction when the patient exhales or coughs.
- Never clamp a bubbling chest drain as this may result in a tension pneumothorax or possibly worsening subcutaneous emphysema.
- Observe for leaks of air in the drainage system as indicated by constant bubbling in the water-seal bottle
- Report excessive bubbling in the water-seal chamber immediately. A more serious cause of bubbling may arise if there's a leak in the chest drain tubing itself or if the chest tube has slipped outside of the chest wall. The uppermost part of the chest tube has openings along the lumen of the tube that draw in air and fluid for drainage. If this part dislodges outside the chest wall, then air will be sucked in – instead of being pulled out of the chest.

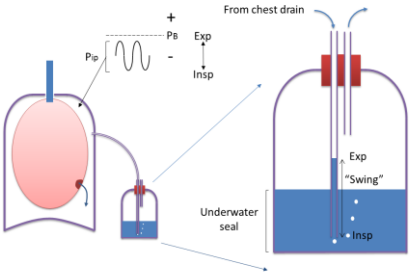
Excessive bubbling observed in the drain:

- Could either be from chest drain connections or persistent leak within the lung.
- Check patient for signs of distress. Check haemodynamic and respiratory parameters.
- Check drain connections and tubing.
- Get immediate help from senior medical staff.

- Inform medical staff immediately if it is noticed that the chest tube has slipped as leaking and trapping of air in the pleural space can result in tension pneumothorax.
- Persistent bubbling throughout the respiratory cycle may indicate a continuing broncho-pleural leak. This may sometimes be observed in ventilated patients requiring high inflation pressures: the volume of air pushed into stiff noncompliant lungs and the air pushed into the pleural space, prevents the broncho-pleural fistula from being healed.
- Inform medical staff if an **unexpected absence of bubbling** occurs as this may indicate tube blockage.
- Bubbling will slowly disappear as air stops leaking and the lung expands to fill the pleural space.

Swinging (also referred to as fluctuation or oscillation):

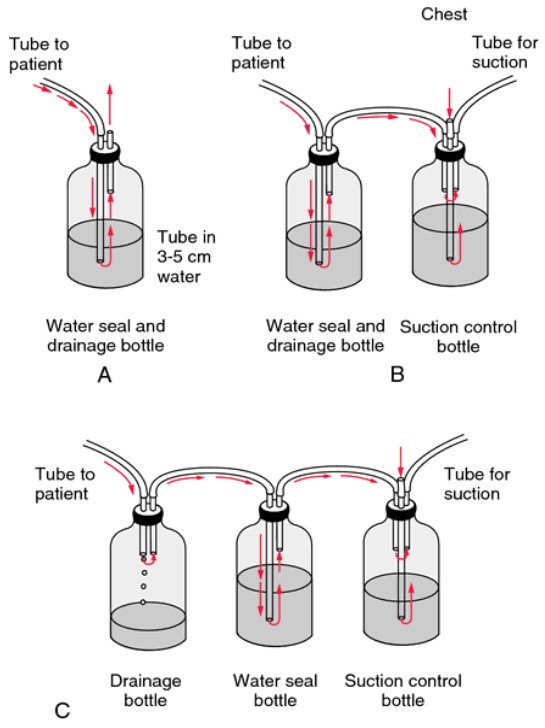
- Fluctuation of the water level in the tube demonstrates that there is effective communication between the pleural space and the drainage bottle, provides a valuable indication of the patency of the drainage system and is a gauge of intrapleural pressure.
- In non-ventilated patients, the water in the water-seal chamber will fluctuate approximately 5-10cm as the patient breathes in and out. During inspiration, the water level in the column increases and decreases with expiration.
- In ventilated patients, the water column actions will be reversed – it decreases with inspiration and increases with expiration. If not visible, check the draina tubing for kinks and notify medical staff.



Swinging of fluid in the tubing will stop when:

- The tubing is obstructed by blood clots or fibrin.
- The drainage tubing is kinked.
- The wall suction is not operating properly.
- The lung has fully re-expanded.

Occasionally, medical staff may also request chest drains to be set-up using either the two-bottle system or three-bottle system as illustrated below:



Two-bottle system:

In the two bottle system the fluid empties into a collection bottle before it reaches the water-seal. (The collection chamber and the water seal have been separated).

The air from the pleural space continues through the tubing that connects two bottles, bubbles through the water and exits to atmosphere.

Three-bottle system:

In the three-bottle system, the third bottle regulates the amount of suction being applied to the patient increasing the depth of fluid above the control straw will increase the maximum level of suction that can be applied before atmospheric air enters through the vent preventing a further increase.

If there is a persistent air leak or a large fluid collection, continuous suction may be applied to enhance drainage and to extract air from the pleural space to restore a negative pressure. High levels of suction must be avoided as this can lead to damage of the lung tissue.

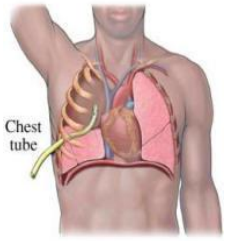
Setting up the chest drain when low suction is required:

Equipment needed:

1. Low pressure suction regulator (colour coded orange)

2 Suction collection unit

3. Chest drain



4. Patient

Procedure:

- Wash hands and put on gloves and apron.
- Throughout the procedure care must be taken to avoid contaminating any drain openings by contact with the environment such as bedclothes or patient clothing.
- Ensure chest drain bottle already attached to the patient is adequately filled with water to the appropriate prime level.
- Attach the low pressure suction unit colour coded orange to the wall suction port.
- Connect low suction unit to the **suction collection unit** using bubble suction tubing – connect to vacuum port.
- Cut another length of suction tubing and attach to the remaining port on the suction collection unit (**marked patient).** Now attach the free end of this length of tubing to the vent port (remove green cap) on chest drain bottle.
- Turn wall suction on to the level of suction required. A common initial setting will be -5 to -10cm H20 and may be titrated to -20 cm H2O as tolerated.
- Confirm chest drain bubbles initially. Gentle, moderate bubbling indicates that the wall suction is adjusted correctly. Rapid, loud bubbling indicates that the wall suction pressure is set too high. If absent or minimal bubbling is noted – the wall suction pressure may be set too low. Bubbling may be sustained, if not there should be evidence of negative pressure being exerted on the column of water within the chest drain.

When suction is no longer required:

- First remove the suction tubing from the chest drain bottle and replace green vent cap.
- Always disconnect the suction system **first** before switching off.
- If the suction unit is turned off – there is no valve in the system to allow air/fluids to travel down the drain – **this has the same effect as clamping**.

Drain problems and troubleshooting:

Drain has stopped swinging:

- Check patient including observations.
- Look for any obvious problem with chest drain, tubing and drain bottle: patient lying on tubing, tubing twisted, drain bottle full, drain fallen out.
- If the problem is not easily remedied inform medical staff.
- Medical staff should perform similar investigations for drain problems including taking the dressing down and if none are evident , consider whether an updated CXR and/or flushing of the drain is necessary. Flushing, if required, should be carried out by medical staff.

Drain appears to have slipped partially out:

- Check patient including observations.
- Inform medical staff immediately.
- Medical staff will need to determine whether the drain is still functioning and make a plan for further action if it is not i.e. drain removal or replacement.

Drain has fallen out completely:

- Check patient including observations.
- Inform medical staff immediately.
- Place an occlusive dressing over the drain site.
- Obtain a CXR.
- Medical staff will need to determine whether further intervention is required e.g. is a new chest drain needed, and if so whether it is required urgently.

Drain tubing disconnected:

- Reattach drain tubing.
- Check patient including observations.
- Inform medical staff immediately.
- If patient is well and drain functioning further action may not be necessary.
- CXR may be indicated.

Chest drain bottle knocked over:

- Return bottle to upright position;.
- Ensure the fluid level is not below the prime level, if there is insufficient water replace the chest drain bottle.
- Check patient including observations.
- Inform medical staff.
- If patient is well and drain functioning, further action may not be necessary.

Dressing no longer securely attached:

- Replace dressing.

Sutures no longer in place:

- Medical staff should ensure the drain remains in a satisfactory position. Re-suturing may be needed.

Complications of chest tube placement include:

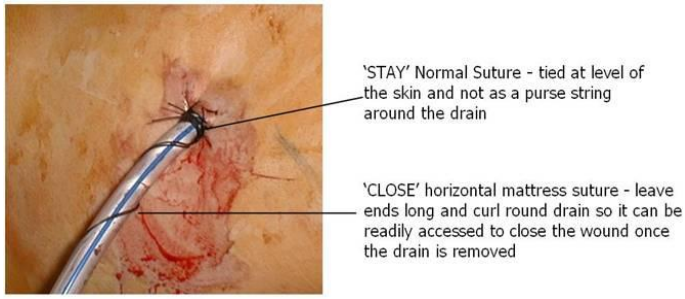
- Pain/discomfort in the chest wall: breathing with a chest tube in place can be painful and adequate analgesia should be prescribed on a regular basis.
- Reduced mobility: if low suction is connected, the patient will be restricted to the bedside. Otherwise, the patient should be encouraged to mobilise. Exercises to prevent complications such as a frozen shoulder or deep venous thrombosis is essential, as are deep breathing exercises to aid re-expansion of the lung.
- Injury to the intercostal muscles.
- Infection may occur e.g. empyema, pneumonia or infection at drain insertion site.
- Subcutaneous emphysema.
- Organ injury e.g. perforation of the lung, diaphragm, heart, liver or spleen.
- Blocked or kinked tubes.
- Malposition is the most commonest complication of tube thoracostomy. Malpositioned chest tubes may represent a form of penetrating trauma and should be managed accordingly. Consultation with a pulmonary or thoracic surgery service should be strongly considered before making any changes to a stable patient with a tube that is malpositioned. As an example, an intraparenchymal chest tube should not be removed until a second functioning chest tube has been placed into the pleural space. The clinician should be prepared to manage bleeding, as well as a potentially immediate massive air leak, when the malpositioned tube is removed. Without a second functioning tube in place, tension pneumothorax could arise very quickly.
- Recurrent pneumothorax on removal of chest tube.
- Pulmonary oedema related to re-expansion pulmonary oedema. Re-expansion pulmonary oedema is a potentially, life-threatening complication of tube thoracostomy that is usually due to the rapid expansion of a large pneumothorax, but it can also follow rapid drainage of large volumes of pleural fluid.

Removing the chest drain:

- Drains can be removed on instructions from medical staff.
- The timing of removal is dependent on the original reason for insertion and progress.
- Explain the procedure to the patient and provide reassurance.
- Adequate pain relief (opioid analgesia may be needed) should be ensured before removal of the chest drain. Allow sufficient time (15 minutes) for analgesia to take effect.
- Wash hands and put on gloves and apron.
- Remove the dressing securing the tube.
- Identify any ‘stay’ sutures: use stitch cutter to remove them.

Stay sutures and purse-string sutures (the latter is often referred to as mattress or 'close' sutures):

- A 'stay' suture is normally inserted close to the skin insertion site and helps anchor the chest tube in its intended position.
- Purse-string sutures (mattress or close sutures) may (or may not) be added so that it can be pulled and tied down after tube removal to ensure closure of the wound. They are not absolutely necessary. They can cause potential drawbacks. Pain is often triggered during tightening of closure purse-string suture and this increased pain can remain problematic for the patient. It leaves more of an unsightly scar and also requires a return visit for suture removal.



- Clean insertion site with antiseptic skin preparation.
- While some advocate for pulling the tube at end-inspiration, others advocate for end-expiration. A small study comparing these two techniques did not show a difference in post-pull pneumothorax. Either way, prior to removing the tube, the technique that will be used should be explained to the patient. The patient should rehearse this a few times prior to the actual tube removal.
- To remove the tube, hold a sterile gauze swab near the chest tube insertion site with the non-dominant hand, ask the patient to perform the planned technique, and verbally reinforce it.
- At the appointed time, remove the chest tube quickly with the dominant hand while placing a dry sterile dressing.
- If the chest drain site is gaping open, inform medical staff as closure of the site may need suturing. Smaller wounds may require the use of steri-strips. Discuss this with medical staff.
- A small gauze dressing is immediately applied to the insertion site and held secure with an occlusive dressing.
- Ensure the chest drain is sealed and dispose of equipment as per Hospital policy.
- Document the procedure, monitor after-effects and report any abnormal findings immediately. Check the patient's observations: temperature, pulse, blood pressure, respiratory rate, oxygen saturations and report any problems to medical staff.
- Check with medical staff if a CXR is required following removal of the drain.
- Prior to removing the chest tube, the likelihood of developing respiratory distress due to recurrent pneumothorax should be considered, and the patient should be monitored accordingly after removal.

Management Of A Malignant Pleural Effusion: British Thoracic Society Pleural Disease Guideline 2010:

Introduction:

- The majority of patients who present with a malignant pleural effusion are symptomatic, although up to 25% are asymptomatic with an incidental finding of effusion on physical examination or by CXR.
- Dyspnoea is the most common presenting symptom, reflecting reduced compliance of the chest wall, depression of the ipsilateral diaphragm, mediastinal shift and reduction in lung volume.
- Chest pain is less common and is usually related to malignant involvement of the parietal pleura, ribs and other intercostal structures.

Management options:

- Treatment options are determined by several factors: symptoms and performance status of the patient, the primary tumour type and its response to systemic therapy, and degree of lung re-expansion following pleural fluid evacuation.
- Malignant pleural effusions are often most effectively managed by complete drainage of the effusion and instillation of a sclerosant to promote pleurodesis and prevent recurrence of the effusion.
- Options for management include observation, therapeutic pleural aspiration, intercostal tube drainage and instillation of sclerosant, thoracoscopy and pleurodesis or placement of an indwelling pleural catheter.

Observation:

- Observation is recommended if the patient is asymptomatic and the tumour type is known.
- Advice should be sought from the respiratory team and/or respiratory multidisciplinary team for symptomatic malignant pleural effusions.

Therapeutic pleural effusion:

- Pleural effusions treated by aspiration alone are associated with a high rate of recurrence of effusion at 1 month so aspiration is not recommended if life expectancy is > 1 month.
- Caution should be taken if removing > 1.5 litres on a single occasion.

Intercostal tube drainage and intrapleural instillation of sclerosant:

- Other than in patients with a very short life expectancy small-bore chest tubes followed by pleurodesis are preferable to recurrent aspiration.
- Intercostal drainage should be followed by pleurodesis to prevent recurrence unless lung is significantly trapped.

Size of intercostal tube:

- Small bore 10 to 14 Fr intercostal catheters should be the initial choice for effusion drainage and pleurodesis.

Fluid drainage, pleurodesis and trapped lung:

- Large pleural effusion should be drained in a controlled fashion to reduce the risk of re-expansion pulmonary oedema.
- In patients where only partial pleural apposition can be achieved, chemical pleurodesis may still be attempted and provide asymptomatic relief.
- In symptomatic cases where pleural apposition cannot be achieved ('trapped lung') indwelling pleural catheters offer a more attractive therapeutic approach than recurrent aspiration.
- Once effusion drainage and lung re-expansion have been radiologically confirmed, pleurodesis should not be delayed.
- Suction to aid pleural drainage before and after pleurodesis is usually unnecessary but, if applied, a high-volume low-pressure system is recommended.

Analgesia and premedication:

- Lignocaine should be administered intrapleurally just prior to sclerosant administration.
- Premedication should be considered to alleviate anxiety and pain associated with pleurodesis.

Sclerosant and complications:

- Talc is the most effective sclerosant available for pleurodesis.
- Graded talc (particle size > 15 μm) should always be used in preference to ungraded talc (particle size < 15μm) as it reduces the risk of arterial hypoxaemia complicating talc pleurodesis.
- Talc pleurodesis is equally effective when administered as a slurry or insufflations.
- Pleuritic chest pain and fever are the most common side effects of sclerorsant administration.

Clamping and removal of intercostal tube:

- The intercostal tube should be clamped for 1 hour after sclerosant administration.
- In the absence of excessive fluid drainage (>250ml/day) the intercostal tube should be removed within 24 – 48 hours of sclerosant administration.

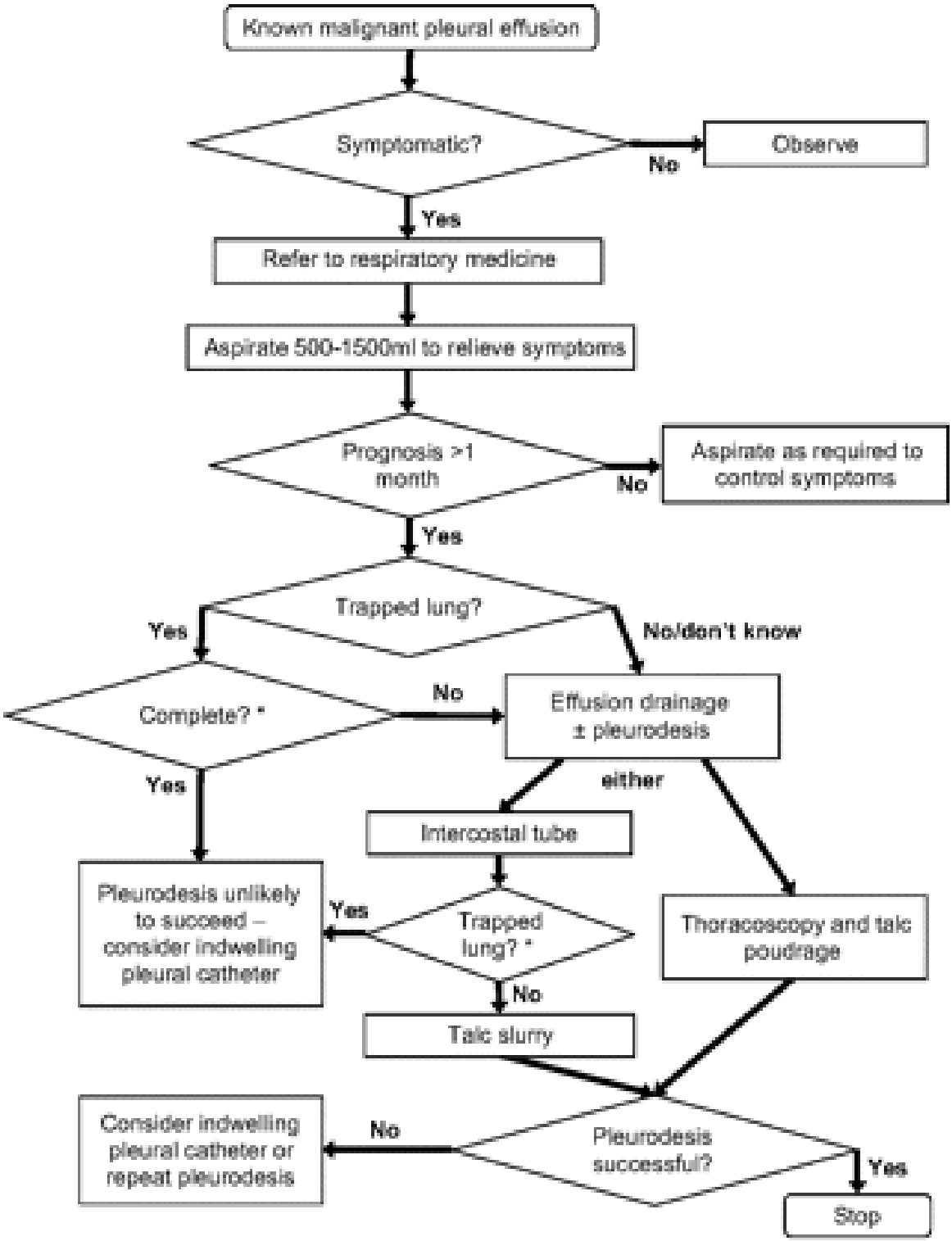
Intrapleural fibrinolytics:

- Intrapleural instillation of fibrinolytic drugs is recommended for the relief of distressing dyspnoea due to multiloculated malignant effusion resistant to simple drainage.

Thoracoscopy:

- In patients with good performance status, thoracoscopy is recommended for diagnosis of suspected pleural effusion and for drainage and pleurodesis of a known malignant effusion.
- Thoracoscopic talc poudrage should be considered for the control of malignant pleural effusion. Thoracoscopy is a safe procedure with low complication rates.

Management Algorithm For Malignant Pleural Effusion



* There is no evidence as to what proportion of unapposed pleura prevents pleurodesis. We suggest that <50% pleural apposition is unlikely to lead to successful pleurodesis

Talc Pleurodesis For Malignant Pleural Effusion:

Rationale for talc pleurodesis procedure:

- Medical pleurodesis with talc is a treatment designed to stop fluid collecting.
- The idea is to stick the two pleura together so that there is no space for the fluid to collect.
- May help prevent recurrence in benign or undiagnosed pleural effusion.
- May help reduce the rate of recurrence of spontaneous pneumothorax compared with chest drainage alone.

Procedure:

- Pleurodesis is an uncomfortable procedure and is associated with anxiety for the patient. Ensure that adequate pain relief is administered and allow time for analgesia to reach effect. Sedation may also be needed.
- Explain the procedure to the patient.
- Inject 10mls of 2% lignocaine via the chest drain and leave for 10 minutes to reach effect.
- Using a 50ml syringe, mix 4g of sterile graded talc with a small volume of normal saline, taken from a 50ml bag, to make a slurry paste.
- Draw up the remaining saline from the 50ml bag and mix well in syringe: inject into chest drain.
- Flush the drain with 20ml of normal saline, clamp the drain for 1 to 2 hourS and then return to suction.
- Repeat the procedure if fluid drainage is greater than 200ml in 24 hours.
- Remove intercostal drain once drainage is less than 150ml in 24 hours.

References:

UpToDate: keywords 'placement and management of thoracostomy tubes' [accessed 30.05.17]

Roberts et al., (2010) Management of a malignant pleural effusion: British Thoracic Society pleural disease guideline 2010. Thorax: 65(Suppl 2): ii32-ii40.