

Pleural procedures: intercostal chest drains and indwelling pleural catheters

Drainage of pleural effusions is often necessary to keep patients symptom free. This article describes two methods of removing pleural fluid and outlines the insertion procedure. Indications, potential complications and post-procedure management are also discussed.

Pleural effusions are a common medical problem, with over 3000 people per million population affected each year (Du Rand and Maskell, 2010). They are caused by a range of diseases, including malignancy, infection and organ failure. Patients with pleural effusions can present to a number of different medical specialties, so it is important that doctors are familiar with current best practice.

This article outlines two pleural interventions that can be used in the management of pleural effusions: intercostal chest drains and indwelling pleural catheters.

Intercostal chest drains

Indications for the insertion of an intercostal drain are listed in *Table 1*. Traditionally large bore chest drains were inserted via blunt dissection, particularly when dealing with pleural infection. However, it is now recognized that these cause more pain and are more uncomfortable for the patient than smaller guidewire-inserted chest drains, without conferring better clinical outcomes (Rahman et al, 2010). The British Thoracic Society recommends the use of wire-guided small bore catheters (i.e. 10–14 French Seldinger drains) as first-line management for pneumothoraces, free-flowing effusions and pleural infection (Havelock et al, 2010).

Complications

All interventions carry a risk of complications. A National Patient Safety Agency report released in 2008

highlighted 12 deaths and 15 cases of serious harm related to chest drain insertion (National Patient Safety Agency, 2008). Adverse events were commonly associated with:

1. Inexperienced or poorly supervised clinicians inserting drains
2. Inadequate imaging and poor choice of insertion site
3. Poor patient positioning
4. Lack of familiarity with equipment, including over-insertion of dilator
5. Lack of knowledge of clinical guidelines.

Methods of avoiding these situations and thus reducing complications are outlined in *Table 2*. Specifically, chest drains should be inserted as planned procedures, during daylight hours, by suitably trained operators. If necessary, it is advised that simple aspiration of 1–1.5 litres of fluid be performed as a holding measure until a suitable person is available to insert a drain (Maskell et al, 2010).

Despite these measures complications may still occur and written consent should be obtained from all patients. The commonest complications include infection at the drain site or within the thoracic cavity, drain blockage and dislodgement. The most serious complications are laceration of an intercostal artery or organ puncture. To reduce these risks, standard safety checks as described in *Table 3* should be carried out in all patients before performing a pleural procedure.

Table 1. Indications for insertion of an intercostal chest drain

Haemothorax
Empyema
Complicated parapneumonic effusions
Tension pneumothorax
Non-resolving primary pneumothorax
Symptomatic secondary pneumothorax
Pneumothorax in a ventilated patient
Malignant effusions requiring pleurodesis

Table 2. Reducing the incidence of iatrogenic chest drain complications

Chest drains are only inserted by staff with relevant competencies and/or under adequate supervision
Drains are inserted in a dedicated procedure room under full asepsis (<i>Figure 1</i>)
A single, consistent brand of chest drain kit is used throughout the hospital or trust
Bedside ultrasound is used to mark a suitable site for all chest drains inserted into fluid
A lead clinician is identified in each trust to train staff and review data on local incidents

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Insertion

All intercostal drains should be inserted within the triangle of safety, where the intercostal arteries run a more predictable course along the bottom edge of the rib. The safe triangle is outlined anteriorly by the lateral border of pectoralis major, posteriorly by the lateral border of latissimus dorsi and inferiorly by the fifth intercostal space. Patients should be positioned so that the operator has access to this area, in a way that is comfortable for the patient and can be maintained throughout the procedure. Suitable positions have been described in the British Thoracic Society guidelines for the insertion of intercostal chest drains (Havelock et al, 2010).

The use of bedside ultrasound reduces the risk of the most serious complication – organ perforation. It is preferable to insert the drain at the time of ultrasound rather than mark a site for later insertion, as any movement of the patient will change the relationship between the marked area and the underlying structures. Real-time imaging, using ultrasound or computed tomography, is essential when inserting drains into small or heavily loculated effusions.

The equipment necessary for inserting a Seldinger chest drain is pictured in *Figure 2*. Sterile gloves, gowns and drapes should be used to ensure full aseptic conditions. The chest drain can then be inserted via the following steps:

1. Clean the skin twice and arrange the drapes to create a sterile field

2. Inject 1% lidocaine into the subcutaneous tissue, aspirating before injection to prevent accidental intravenous administration
3. Insert and advance the Seldinger needle, perpendicular to the skin, until pleural fluid is aspirated. Remove the syringe from the needle, leaving the needle in place, and cover the end of the needle
4. Advance the guidewire through the centre of the introducer needle into the pleural cavity. The guidewire should pass smoothly and easily, without requiring undue force
5. Remove the needle, taking care not to dislodge the guidewire. Take note of the depth of the effusion from the skin using the centimetre marks on the introducer needle (*Figure 3*)

Figure 1. A dedicated procedures room in which to perform pleural procedures.



Table 3. Safety checks to be carried out before inserting an intercostal chest drain

Are platelet count and clotting studies normal?
Has a recent chest X-ray been reviewed?
Do clinical findings correlate with X-ray appearance?
Has the patient given written consent?
Has a safe site been chosen using bedside ultrasound?

Figure 2. Equipment necessary for insertion of Seldinger intercostal drain.



Figure 3. The markings on a Seldinger introducer needle, and the safety marker on the dilator.



6. Set the safety marker on the dilator to the depth of the effusion plus 1 cm (*Figure 3*) and slide over the guidewire up to the skin
7. Make a small incision in the skin and push the dilator through. Warn the patient that he/she may feel some pressure, and insert the dilator into the soft tissue, gently pushing to create a tract down to the pleura
8. If a large bore drain is being inserted, dilators of expanding width are provided to serially dilate the tract to a size sufficient to pass the drain through
9. The dilator is then removed, leaving the guidewire in place. The drain is passed over the guidewire and quickly and smoothly inserted into the pleural cavity. N.B. the end of the guidewire must always remain in view
10. Remove the guidewire, attach the drain to the tubing and drainage bottle via an underwater seal. A three-way tap should be incorporated into the system to allow regular flushing and sample removal, and to facilitate pleurodesis
11. Suture the drain to the skin, and apply a clear dressing. Secure all connections with tape and attach tubing to skin with an 'omental tag' to prevent accidental chest drain dislodgement.

Aftercare

Once the chest drain has been inserted the patient should be repositioned comfortably and a set of observations performed. Rapid drainage of fluid should be avoided as patients can experience vaso-vagal symptoms, and occasionally re-expansion pulmonary oedema. The drain should be clamped after the initial 1.5 litres of fluid, and then drained at a rate of 500 ml/hr thereafter. A chest X-ray must be performed to check drain position and exclude pneumothorax.

The patient should be given an information leaflet on caring for the chest drain, including basic instructions such as keeping the drain below chest height at all times. The patient should be nursed on a ward familiar with the management of intercostal chest drains, and daily checks should take place of the wound site, the amount drained and whether the drain is still swinging or bubbling. The drain should be flushed with 20 ml of saline three or four times a day to reduce the risk of chest tube blockage.

Indwelling pleural catheters

Some patients, particularly those with malignant effusions, experience re-accumulation of pleural fluid following successful initial drainage. This can be managed either by inserting an indwelling pleural catheter or by draining to dryness with an intercostal drain before undertaking chemical pleurodesis. Indwelling pleural catheters provide symptomatic relief and improved quality of life as well as shorter initial inpatient stay and fewer subsequent hospital visits (Putnam et al, 1999, 2000;

Pien et al, 2001). These are obvious benefits for patients suffering from malignancy, in whom the presence of a malignant effusion implies a poor prognosis. There is also evidence that if the pleural space is drained regularly and the underlying lung not trapped, spontaneous pleurodesis can be obtained in up to 58% of patients (Putnam et al, 1999; Warren et al, 2008).

Indications and contraindications

The patients who are most likely to benefit from an indwelling pleural catheter are those whose lungs are unlikely to re-expand once pleural fluid has been removed. This may be secondary to a thick malignant rind encasing the visceral pleura (known as trapped lung) or to a proximal obstructing endobronchial lesion that prevents distal lung re-inflation. If the visceral and parietal pleura can not be opposed, pleurodesis is unlikely to succeed. Similarly, if the effusion is producing high volumes of fluid, then a chest drain and chemical pleurodesis is unlikely to be successful and an indwelling pleural catheter is a better option.

Before performing the procedure it is important to ascertain that drainage of the pleural fluid provides some symptomatic relief, and that the patient's breathlessness is not secondary to other causes such as intrapulmonary disease. The procedure itself can cause some chest wall discomfort for a week, so simple aspiration may be a better option for those with a very limited life expectancy. As with all end-of-life decisions, the situation must be tailored to the patient's wishes. For example, an indwelling pleural catheter may allow a patient with terminal disease to spend the final week at home with family, rather than in hospital with an intercostal drain in situ.

Tables 4 and 5 show the indications and contraindications for inserting an indwelling pleural catheter.

Table 4. Indications for indwelling pleural catheter insertion

- Recurrent malignant effusion with symptomatic relief on aspiration of fluid
- Symptomatic 'trapped lung'
- Malignant pleural effusion producing high pleural fluid volumes
- Recurrent malignant effusion with previous failed chemical pleurodesis

Table 5. Contraindications for indwelling pleural catheter insertion

- Coagulopathy
- Inability to identify safe site for indwelling pleural catheter insertion with ultrasound
- Patient unwilling or unlikely to be able to manage indwelling pleural catheter in community
- Lack of community support for home drainage of indwelling pleural catheter
- Life expectancy <2 weeks (relative contraindication)

Complications

As described above, patient selection is of great importance before placing an indwelling pleural catheter. Once the decision has been made, preparatory blood tests should be taken, including a clotting screen and full blood count. Written consent should be obtained highlighting the small risks of pleural infection (1–2%) and haemorrhage (<1%) (Putnam et al, 1999, 2000; Warren et al, 2008).

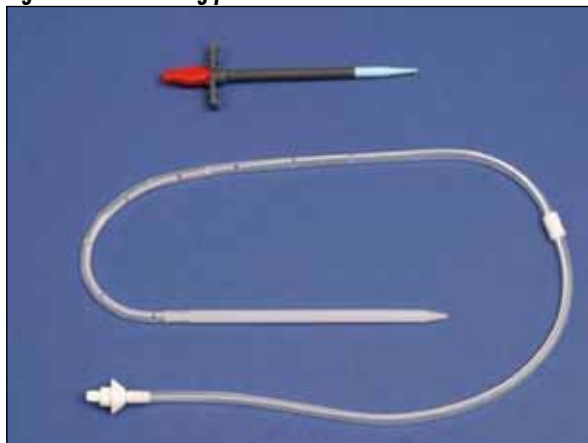
Insertion

The pleural catheter is a 15.5Fr, 66 cm silicone rubber tube with multiple fenestrations along the proximal 24 cm (*Figure 4*). It is tunnelled beneath the skin to prevent infection or dislodgment, and has a polyester cuff half way along the tunnelled part to reduce bacterial invasion. At the free end of the tube there is a one-way valve which allows removal of fluid while reducing the risk of creating a pneumothorax. The catheter is accessed by inserting the tip of the access line through the one-way valve and attaching it to a vacuum bottle.

Given the importance of preventing infection indwelling pleural catheters should be inserted in clean or sterile environments such as day theatre or procedure room. The patient should lie in the lateral decubitus position and a site for catheter insertion chosen using ultrasound guidance. This is usually in the safe triangle, with an exit site marked 5–8 cm anteriorly. Once the patient has been lightly sedated, and the operator is scrubbed, the catheter can be inserted via the following steps:

1. The skin is cleaned twice, and sterile drapes used to create a surgical field
2. Local anaesthetic is injected to both the area where the drain is to be inserted and along the tract where the tubing is tunnelled
3. Two separate incisions are made at the drain entry and exit sites, as marked by ultrasound
4. An introducer needle is inserted at the entry site, until pleural fluid is aspirated. The guidewire is threaded through and the needle is removed, leaving the guidewire in situ

Figure 4. An indwelling pleural catheter.

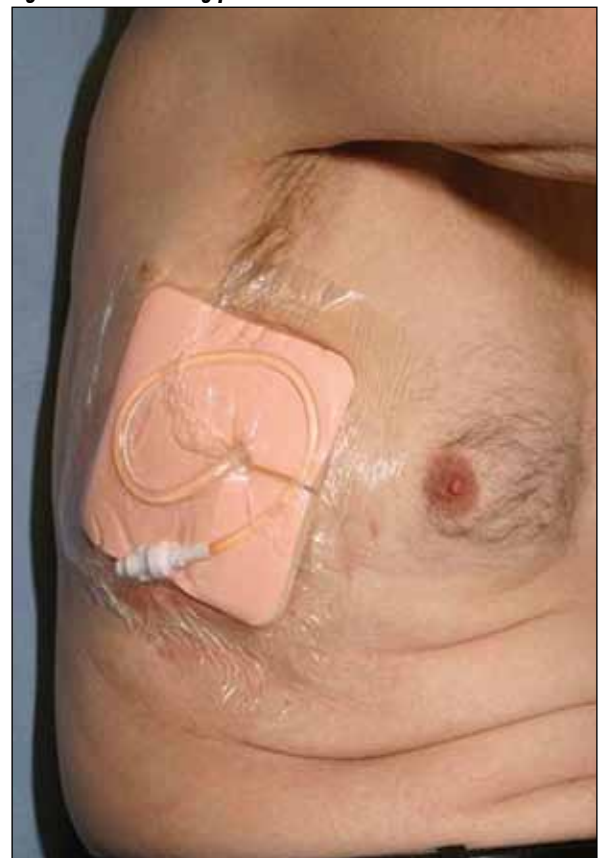


5. A tunnel is made under the skin by blunt dissection between the two incisions. The catheter is pushed through this tunnel until it emerges beside the guidewire
6. The tract into the pleural cavity is then dilated using a Teflon 'peel-away' dilator passed over the top of the guidewire. Caution must be exercised not to over-penetrate and cause visceral damage
7. The catheter is fed through the dilator until it is completely inserted, with no twists or kinks along its path. As the catheter is passed down the dilator, the dilator is removed by splitting into two halves and gently withdrawing, while simultaneously advancing the catheter
8. Once in position the catheter can be checked by inserting the drainage tip into the exit valve, and aspirating up to 1.5 litres of fluid. It is generally best to leave a reasonable residual pool of fluid so that the first domiciliary drainage session goes smoothly, and patient feels confident with home management
9. The incisions are then sutured and gauze and transparent dressings are applied to both sites (*Figure 5*)
10. A chest X-ray is performed to review the drain position.

Aftercare

The patient can go home on the same day as the catheter is inserted. It is advisable to give the patient an initial dose of analgesia before discharge to ensure there are no

Figure 5. An indwelling pleural catheter in situ.



adverse reactions, and the patient should be given a minimum of 2 weeks worth of adequate analgesia (such as co-codamol 30/500) to take home.

Drainage of the indwelling pleural catheter is performed in the patient's home by district nurses, lung cancer specialist nurses or, in some cases, family members. Good organization and communication are essential for establishing and maintaining a domiciliary service. Some tips for ensuring a good community indwelling pleural catheter service are outlined in Table 6.

The decision on how often to drain an indwelling pleural catheter should be made before its insertion. If the aim is to keep the pleural space as dry as possible and maximize the chances of spontaneous pleurodesis, regular drainage three times a week should be arranged. If the indwelling pleural catheter is to provide symptomatic relief of an effusion in a patient with a trapped lung, then drainage should be tailored to the rate of fluid reaccumulation and the patient's symptoms. Some patients require drainage every day to remain asymptomatic, while others can comfortably be drained only once a fortnight.

Conclusions

Patients with pleural effusions often need more than simple aspiration to achieve ongoing symptom relief. Different options are available for the removal of fluid from the pleural cavity, and this article describes two methods – intercostal chest drainage and indwelling pleural catheters. Clinicians should decide on the method most likely to provide ongoing symptom relief based on clinical situation, radiology and patient preference.

Indwelling pleural catheters have been shown to alleviate symptoms, improve quality of life and reduce hospital stays in a group of patients likely to experience maximal benefit from this. Careful patient selection remains key to its success. **BJHM**

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Table 6. Top tips for running a community indwelling pleural catheter service

Good communication between the clinicians inserting the indwelling pleural catheter and the coordinator of the community service is essential
Patient should receive information sheet well in advance of procedure to allow time to assimilate and make informed decision
GP or district nurses should order bottles before first drainage. Coordinator should provide company's telephone number, order code and fax number
Exceptional funding is required by some primary care trusts to provide drainage bottles. Clinicians and coordinator must arrange this before inserting an indwelling pleural catheter
Ensure patient has adequate analgesia at home, and takes a prophylactic dose before first domiciliary drainage
First domiciliary drainage session can double up as training session for all district nurses, lead by the coordinator
Ensure district nurses have a contact number for out of hours support

KEY POINTS

- Chest drains can remove pus, blood, air or pleural fluid from the pleural cavity.
- Indwelling pleural catheters can relieve symptoms in patients with recurrent malignant effusions.
- Never insert an intercostal drain or pleural catheter unless adequately trained.
- Ensure optimal safety conditions before performing any procedure.
- Seldinger technique and modified Seldinger technique are used to insert pleural drains and catheters.
- Indwelling pleural catheters can be drained in the patient's home once a domiciliary service has been established.