Abstract
Chest drains incorporate the use of a one-way valve to drain fluid or air from the pleural cavity. The valve prevents back-flow of air and fluid into the pleural cavity. They are indicated for use when collections of fluid or air are present in the pleural space, and by draining the collection they restore efficient gaseous exchange. Little has been written on the nursing management of chest drains and the literature highlights a lack of national standardized guidelines for due to the range of thoracic conditions encountered by clinical staff. Themes such as pain management and mechanism of breathing occur frequently; however, there is a lack of up-to-date literature for the nurse to refer to. This article examines the nursing role in chest drain management from insertion to removal and includes aspects of pain management and features of a functioning chest drain.

Key words: Chest drain • Critical care • Pleural cavity • Thorax

Mechanism of breathing
When breathing, the diaphragm descends and contracts, while the lower ribs move upwards and outwards, and the upper ribs and sternum move upwards and forwards. This creates increased intrathoracic volume and negative intrapulmonary and intrapleural pressure, drawing outside air into the lungs (Figure 1). Expiration is a passive procedure whereby the muscles relax expelling air from the lungs (Marieb, 2004). This process allows oxygenation of haemoglobin in the red blood cells via diffusion across the alveolar membrane and expulsion of carbon dioxide. When trauma to the lung occurs and intrathoracic pressure is increased, lung expansion becomes compromised and gas exchange cannot take place efficiently. This results in under perfusion of tissues, leading to breathlessness, as the person tires with the increased effort of breathing (Adam and Osbourne, 2003).

Table 1. Indications for drain insertion

<table>
<thead>
<tr>
<th>Indication</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Pneumothorax</td>
<td>Air in the pleural space</td>
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<tr>
<td>Pleura effusion</td>
<td>Collection of fluid in the pleural space</td>
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<tr>
<td>Haemothorax</td>
<td>Collection of blood in the pleural space</td>
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<tr>
<td>Empyema</td>
<td>Infected fluid-pus in the pleural space</td>
</tr>
<tr>
<td>Chylothorax</td>
<td>Chyle-lymphatic fluid in the pleural space</td>
</tr>
<tr>
<td>Routinely post-cardio-thoracic surgery</td>
<td>Trauma caused during surgery causes collections of fluid and air in the pleural space which needs draining</td>
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Inhalation

Air flows into lungs due to increased lung volume following contraction of diaphragm and intercostal muscles

Exhalation

Air expelled from lungs due to relaxation of diaphragm and intercostal muscles

Compromised inhalation with lung trauma

When trauma to the lung occurs, and intrathoracic pressure is increased, lung expansion becomes compromised

Types of chest drain

Chest drains function by allowing drainage from the pleural cavity during expiration, when there is positive pressure within the pleura. The fluid or air within the cavity drains into the collection chamber (this can be water-sealed or incorporate the use of a one-way flutter valve). Some of the different types of drain available can be seen in Figures 2 and 3. Drains incorporating a 3-bottle system (compartmentalized) can be found across the NHS, as can the Heimlich device, which utilizes a rubber one-way flutter valve connected to a standard bottle. This allows the patient more freedom as it does not need to be kept upright like water-sealed drains. They are, however, bulky and management of fluid drainage is difficult as the efferent port must be kept open to air (Graham et al, 1992). Water-sealed drains and flutter valves prevent air being sucked back into the pleural cavity during inspiration (McMahon-Parkes, 1997; Allibone, 2005; Sheppard and Wright, 2006), while allowing air and fluid to bubble into the external environment. The drain tubing should be no more than 3 cm underwater; if greater than this, there is an increased resistance to air drainage, and as a consequence pneumothoracies will not resolve (Laws et al, 2003). Therefore, bottles should be changed if there is profuse drainage. It is, however, safe to leave bottles unchanged for 6 days if drainage is minimal (Hornick et al, 1992).

Although chest drains are inserted by doctors, it is the nurse who has responsibility for the day-to-day monitoring and management (Allibone, 2003). There is a varying standard of chest drain management throughout the NHS, which is largely the result of a lack of evidence-based
guidelines (Charnock and Evans, 2001; Parkin, 2002). The discrepancies include the use of suction to aid removal of air and fluid; the prescription and administration of prophylactic antibiotics to prevent infection; and the positioning of the patient. There is also no standard for the removal of drains when inserted to resolve a pneumothorax. Some will be removed on cessation of bubbling, while others, in specialties such as cardiothoracic surgery, will allow a longer indwelling after bubbling has ceased. Although none of these choices have been shown to have adverse effects, the lack of standardized guidelines seems to stem from the range of thoracic conditions encountered by clinical staff, rather than evidence-based practice (Tang et al, 1999).

Nursing role
The nursing role is initiated when the decision is made to insert a chest drain in the ward environment, as opposed to post-surgery. The nurse has a role in the positioning of the patient for the procedure – this is vital for the safety and comfort of the patient throughout (Lazzara, 2002). Although there is no 'one method' decided for positioning of the patient (McMahon-Parkes, 1997; Casson and Johnston, 1999; Lazzara, 2002; Laws et al, 2003), doctor preference seems to be the main factor determining patient position, thus the nurse must be adaptable (Lehwaldt and Timmins, 2005). The positions which are advocated, and which the nurse should be aware of, are the patient being in an upright position, as this aids lung expansion (Horsington, 1984; Lazzara, 2002). However, there is limited evidence to suggest that other positions are unsuitable. The guidelines produced by the British Thoracic Society (BTS), suggest drains should be inserted on the bed, with the patient’s arm on the side where the drain is to be inserted placed behind their head, so as to expose the axilla (Laws et al, 2003).

It is important for the nurse to reassure the patient during the procedure and monitor them for signs of discomfort and relay this to the medical staff, who can administer more analgesia if required.

Drain position
The position of the drain will be influenced by the reason for drain insertion. If air in the pleural space is indicated, then the drain tip will be positioned apical and anterior to the chest cavity, as air will rise within the pleural space (Avery, 2000). However, if it is indicated that fluid collection is the reason for drain insertion, then this will migrate to the base of the lungs, and thus the drain tip will be positioned posterior and basal to the chest cavity (Graham, 1996). (Figure 4 shows a chest drain in situ.)

Although the nurse is not inserting the chest drain, it is important to know why the drain has been inserted, what it is draining and where the drain tip is, as this will influence the care the patient receives with regard to positioning. Both fluid and air will migrate within the chest cavity, and thus if they are away from the tip of the drain, the drain will be ineffective and the problem will not resolve as promptly as desired. It is also an important consideration when positioning the patient that the drain tubing does not become occluded by kinking, as this will impede the drainage capacity. If this is left unresolved, it can cause raised intrathoracic pressure, compounding breathlessness and the original condition for which the drain was inserted, and may lead to a tension pneumothorax (Munnell, 1997).

Complications of chest drain insertion
Although chest drain insertion is carried out by the doctor, there are complications the nurse needs to be aware of. It is important that the reason for insertion is clear as an incorrectly placed drain will not resolve the problem (Tang et al, 1999). It is also possible for a tension pneumothorax to occur from incorrectly placed drains – where air enters the pleural cavity during inspiration but cannot escape during expiration. The increased pressure causes compression of the soft lung tissue (Thorn, 2006).

As the drain is inserted blindly it is also possible to cause damage to internal structures such as diaphragm, liver, aorta and the lung tissue itself (Allibone, 2003). As with all procedures which penetrate the skin there is a risk of infection. However, by following aseptic technique this risk is reduced and there is no evidence to suggest prophylactic antibiotics are beneficial, unless the patient has presented with a penetrating chest injury (Nichols et al, 1994). With the chest drain in situ there are potentially emergency situations which may occur. The drain may become detached from the bottle – if this occurs clamp the drain tube to the patient and re-establish the connection to a new drainage bottle. Inform the medical team. If the drain is pulled out of the pleural space accidentally, the purse string suture should be tied immediately to prevent air entering the pleural cavity. A full set of cardiovascular observations should be carried out and the medical team should be contacted (Allibone, 2003).

Infection control in chest drain management
Infection stemming from the chest drain poses a potential problem. The drain should be inserted using aseptic technique.
and this will minimize the risk of infection. However, it is important to monitor the drain site for signs of inflammation and redness which could indicate bacterial colonization (Allibone, 2005). If such signs are present a swab should be taken and sent for analysis and identification of infective cause, after which appropriate treatment can be commenced. It is also important to remember to adhere to aseptic technique when changing dressings or drain tubing (Thorn, 2003).

**Monitoring**

There are a number of factors to be addressed with regard to monitoring the chest drain. Post-insertion observations are taken at 15-minute intervals for 1 hour; then half hourly for 2 hours, then hourly until the drain is removed (Dougherty and Lister, 2004). In conjunction with monitoring blood pressure, pulse, respiratory rate and pattern and oxygen saturations, the drain will be observed for swing, bubbling and air leak. This should be documented on a specific observation sheet and the amount of fluid drained should be recorded on the patient's fluid balance sheet (Allibone, 2003). The drain should be labelled according to site and if multiple drains are inserted they should be numbered.

The fluid within the collection bottle needs to be regularly assessed for signs of fresh blood, and if present, should be reported immediately to the medical staff (Sheppard and Wright, 2006). It is also important to monitor the fluid for signs of clouding as this could indicate infection; if this is noted, a specimen from the tube should be sent for microbiology, culture and sensitivity. This will allow for identification of bacteria and any infection to be treated with the correct antibiotics (Jevon and Ewens, 2002).

When managing chest drains it is important to monitor for fluid swing and bubbling. Fluid swing occurs when the fluid which is draining through the tube swings back and forth on inspiration and expiration. This swing shows that the tube is patent (Dougherty and Lister, 2004). If swing is not present the tube should be checked for kinks or loops; if none are present, medical advice should be sought, as a blocked tube can lead to a tension pneumothorax or surgical emphysema (Allibone, 2003).

**Bubbling**

Bubbling signifies that air is being removed from the pleural space, and will occur with a pneumothorax or following surgery where parts of the lung have been removed. Bubbling will be seen in the drain bottle, under the water seal on expiration or coughing. If continuous bubbling is seen the tube can be pinched near its insertion to the chest; if bubbling continues this signifies a break in the tubing connection; if bubbling stops then air is leaking from within the pleural space and medical advice should be sought (Allibone, 2003). If the bubbling ceases it is necessary to ask the patient to cough as this will show small air leaks only visible on forced expiration. The drain should not be removed until this bubbling has ceased and medical confirmation of removal has been sought.

**Milking and clamping**

There is a technique called milking, where the tube is massaged to try and draw fluid out of the thoracic cavity and may remove the source of any blockages, such as a clot, if the tube is occluded. However, this technique has been proved unsafe, as it can cause lung tissue to be drawn into the drain tubing causing bruising and trauma (Gordon et al., 1995; Dougherty and Lister, 2004). Milking can also cause an increased rise in intrapleural pressure; this can cause cardiac instability and can increase the chance of a tension pneumothorax (Sheppard and Wright, 2006).

Chest tube clamping is the subject of much debate within the medical texts, with an almost even split between those advocating clamping and those not (Baumann et al., 2001). However, drain clamping is not advocated in the nursing texts (Jevon and Ewens, 2002; Allibone, 2003; Dougherty and Lister, 2004; Sheppard and Wright, 2006). The reasons for not clamping in the nursing context are not rationalized; however, anecdotal evidence suggests that it could be due to incidences of clamps being left on. The only time a chest drain should be clamped is when the bottle is being changed (Dougherty and Lister, 2004). For this procedure, two clamps should be used, one above and one below the connection to the drain tubing. On changing the tubing, the clamps should be removed as soon as possible to prevent a rise in intrathoracic pressure from collection of air or fluid (Allibone, 2003). There is no need to clamp the drain when mobilizing the patient in bed, a simple kink of the tube will prevent backflow of fluid or air. It is also not necessary to clamp the drain when transferring the patient to other departments, as again, this may cause a rise in intrathoracic pressure if left for too long (Hyde et al., 1997).

**Suction**

The use of suction for evacuating air or fluid after chest drain insertion is also a factor the nurse needs to be aware of, even though it is usually at the discretion of the doctor. It works by increasing the negative pressure aiding lung re-expansion by sucking out fluid or air. Nursing staff need to ensure the suction pressure remains between 5 and 15 kPa or 10–20 cm H$_2$O — any
higher than this and lung trauma can be caused (Dougherty and Lister, 2004). Figure 3 shows a drain connected to suction, this is most commonly used post-thoracic surgery.

**Drain management**

There are some important considerations for managing a chest drain. The chest drain should always be kept below the level of the patient's chest to prevent back flow of fluid in to the pleural space (Avery, 2000). This could lead to infection and the worsening of the condition for which the drain was inserted. If the drain needs to be raised above the patient's chest, e.g. when moving the patient in bed, the tube can be kinked to prevent back flow. The chest drain will be held in place by an anchoring suture and will be dressed with gauze and a non-occlusive dressing. These dressings should be assessed every day for oozing and signs of inflammation and changed if oozing is present (Allibone, 2003). Inflammation should be monitored and if worsening a swab should be sent for analysis.

The drain tubing should never be secured to the patient's bedding or clothing, as sudden movements by the patient could cause the drain to become dislodged, allowing air to enter the pleural cavity. It is also important to encourage the patient to mobilize, this can be in the form of deep breathing for bed-bound patients, or short walks and raising arms in the more active patient. The movement will help with fluid and air drainage (Sheppard and Wright, 2006). Physiotherapy input can be sought to provide a more structured mobility programmes.

**Pain management**

Analgesic management of the patient with a chest drain is an integral part of holistic drain management. It can be divided into three areas:
- Insertion of the drain
- While the drain is in situ
- Removal of the drain.

The analgesic requirements for insertion will be managed by the doctors. However, pain management while the drain is in situ and on removal is the nurse's responsibility. There is limited literature to describe the nurse's role in pain management regarding chest drains. A literature review by Owen and Gould (1997) found that the need for analgesia has not been explored; however, they expressed that pain can be rated as moderate. On the wards, patients with chest drains are often on paracetamol and dihydrocodeine; these appear to manage their pain effectively. However, it is important to remember that pain is subjective and patients will have individual experiences. Therefore, regular pain assessments are required to maintain adequate analgesic relief from the discomfort and pain caused by chest drains.

It is important for the nurse to act as an advocate. There are a number of alternative pain relieving strategies, such as distraction and positioning of the patient, all of which may produce non-pharmacological relief. It is also important to make sure that there is suitable analgesia prescribed on the drug chart, and if not, then to liaise with the doctors to have analgesia prescribed (Gray, 2000).

**Drain removal**

Upon confirmation that the indication for the chest drain insertion has resolved, it is then important to remove the chest drain. This must be carried out in a way which minimizes the risk of allowing air to enter the thorax, thus causing a pneumothorax. It may be the responsibility of the nurse to remove the drain, thus it is important to be aware of the removal technique. Nurses should also be aware of the patient's blood results, as low platelets could result in excessive bleeding; it is also important to be aware of any thrombolytic drugs the patient may be on, which could affect their clotting and discuss with doctors before removal of the drain.

Chest drain removal is a two-person procedure. The nurses need to explain to the patient what will happen throughout the removal. Evidence advocates that the patient inhales deeply and holds their breath while the drain is pulled out (Welch, 1993). However, a study by Bell et al (2001) showed that removing the drain at end-inspiration or end-expiration are equally safe. From practice experience, it has been seen that end inspiration is the preferred method. It is good practice to have a run through with the patient so that they know what to expect — ask the patient to take two deep breaths and hold at peak inspiration of the third. The experience of removing a chest drain can be painful for patients. Thus, it is good practice to for the nurse to administer prescribed analgesia in accordance with Trust policy and allow this to take effect before commencing the procedure.

To start the removal, the securing sutures and the purse-string suture need identifying (Figure 6). The anchoring suture needs to be cut and removed while the purse-string suture needs to be cut approximately 5 cm from the chest wall — this will leave a suitable length to be tied off. It is then the responsibility of one nurse to ask the patient to take two deep breaths and then hold on the third. Upon the patient holding their breath, the nurse pulls the drain tubing out in one smooth motion. Once the drain has been removed the second nurse ties the purse-string suture and then tells the
patient they can breathe again normally. The drain and tubing should be discarded in a large yellow waste bin. The wound should be cleaned with normal saline and covered with a non-occlusive dressing and observed for signs of oozing. The suture can be removed after 7–12 days (Dougherty and Lister, 2004). The patient should be observed closely after removal for signs of a recurrent pulmonary event.

The patient can mobilize without restriction, the wound site should also be monitored for tissue necrosis from over tightened sutures (McMahon-Parkes, 1997). It is also important to ensure a chest X-ray has been ordered post removal to check that neither fluid or air has re collected in the pleural cavity (Avery; 2000).

**Conclusion**

The nursing role in the management of chest drains is diverse and important. Chest drains can be inserted for a variety of reasons and it is important for the nurse to understand where and why the drain has been inserted, due to the influence it has on patient positioning.

The different aspects of chest drain management have been analysed, showing the importance of regular observations and what is normal and abnormal for a chest drain. This article has shown that the nurse plays a vital role in chest drain management from insertion to removal; however, the remainder of the multidisciplinary team are there to offer advice and support with issues such as pain management and physiotherapy.

Although most chest drains are found in the critical care setting and specialist areas, some chest drains will be encountered on the wards. The nursing management skills shown in this article are transferrable to the ward environment. It has been highlighted that there is a need for nationally derived guidelines for chest drain management. Although the British Thoracic Society has derived guidelines for the insertion of chest drains, there are no national guidelines for the nursing management. Trusts derive their own standards, but there needs to be generic guidelines set in place to provide standardized care.

**Figure 6. Anchoring sutures and the purse-string sutures identified.**

**KEY POINTS**

- Drains are inserted to remove fluid and/or air from the pleural cavity.
- There is a lack of standardized national guidelines for nurses to use with regard to the management of chest drains.
- The nurse needs to be aware of drain position to comprehensively manage the patient’s condition.
- The nursing role extends from insertion to removal, to include the bio-psychosocial needs of the patient.
- There are a variety of drains in use that the nurse needs to be aware of.
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