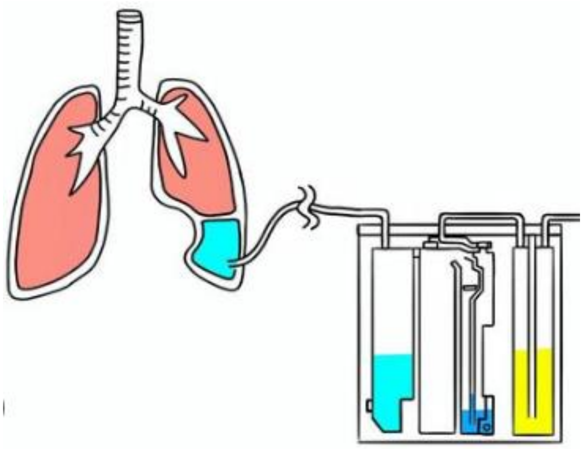
COMPETENCY ASSESSED

SELF DIRECTED LEARNING PACKAGES

UNDERWATER SEAL DRAINAGE



NAME____

HEALTH SERVICE / DEPARTMENT________________________

GRCE Points 3 for package + 1 point for competency

FEBRUARY 2009, Updated 2013, 2023

Approved by the Gippsland Region Nurse Educators Group 2009,2013, 2023
Acknowledgements to Gippsland Health Service Consortium Members for input

Under Water Seal Drainage

Table of Contents

INTRODUCTION

Congratulations on deciding to take on the challenge of a Self-Directed Learning Package.

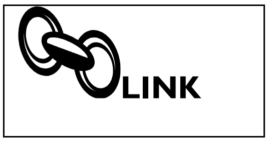
This package has been created to increase awareness and understanding of the concepts and related nursing care associated with the insertion of an Intercostal Catheter (ICC) and the management of an Underwater Seal Drainage (UWSD) system or other chest drainage devices.

The package addresses review of basic anatomy and physiology of the thoracic cavity in concurrence with physiological conditions that require intervention. ICC insertion and UWSD system management will be discussed in detail with both theoretical and practical information included.

Assessment within the package includes both short answer and multiple-choice questions at the end of the three chapters. At the end of each chapter, questions may be submitted for marking and feedback before progression onto the next chapter. The registered nurse is then required to achieve a merit of clinical competency which is discussed in detail at the end of part 3 of the learning package. On successful completion, a certificate will be awarded to you for the practical component.

Proceed through the package at your own pace reviewing the information provided and responding to the assessment questions. For further knowledge, go to the suggested reading or links to websites for in depth explanations regarding the information provided. It is expected that this package should take approximately 4 hours including suggested readings.

This symbol indicates further reading to consolidate information or to further your knowledge. It may be a book or a journal article



This symbol indicates a link with a website

This symbol indicates to refer to your workplace policy

OBJECTIVES

The nurse, upon completion of this package, should be able to:

1. Describe the thoracic anatomy, physiology and pathophysiology with particular reference to conditions that may require chest drainage.
2. Outline the procedure for insertion of an Intercostal Catheter
3. Discuss the functions of chest drainage
4. Outline the specific nursing care when managing a patient with an Under Water Seal Drainage system
5. Document assessments performed on both the patient and Under Water Seal Drainage system in an accurate and concise manner
6. Identify and discuss the potential hazards and emergencies that may occur during treatment with an Under Water Seal Drainage system
7. Demonstrate increased knowledge of the concepts associated with Under Water Seal Drainage by successfully completing the self-test at the end of each module.
8. Demonstrate clinical competency in the management of an Under Water Seal Drainage system

PART ONE

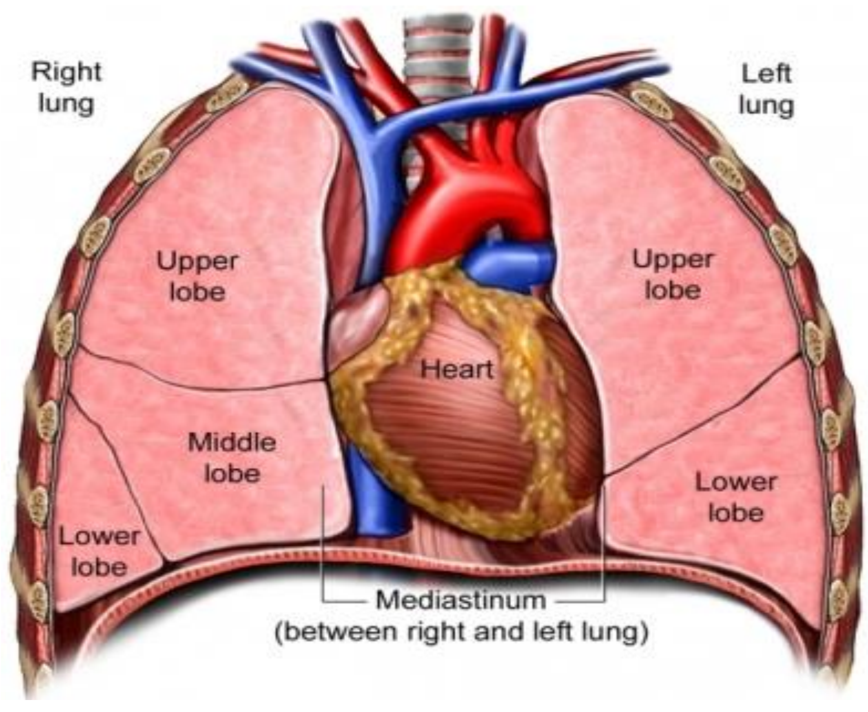
ANATOMY AND PHYSIOLOGY

One of the main difficulties in the understanding of the concept of UWSD lies in the knowledge base of the nurse regarding normal anatomy and physiology of the thorax with emphasis on the physiology of respiration. Once these concepts are grasped, it enables us to understand what can go wrong in the structure and function of the chest and how these problems are treated.

The chest wall (known as the thoracic cavity) is made up of bones and muscles. The bones, primarily ribs, sternum and vertebrae, form a protective cage for the internal structures of the thorax. The main muscles of the chest wall, the external and internal intercostals, extend from one rib to the next.

THORACIC CAVITY

Within the thoracic cavity are the lungs and mediastinum. The external intercostals enlarge the thoracic cavity by drawing the ribs together and elevating the rib cage, while the internal intercostals decrease the dimensions of the thoracic cavity.



The Thoracic Cavity is divided into two distinct regions:

1. **The Mediastinum** is the central part of the thoracic cavity which is a flexible partition that is bounded laterally by the left and right lungs, anteriorly by the sternum and posteriorly by the vertebral column. Within the mediastinum are the heart, pericardium, thymus gland, oesophagus, trachea, nerves and blood vessels. The diaphragm is a dome shaped muscle that separates the thoracic cavity from the abdominopelvic cavity.

2**. The lungs** consist of airways (trachea and bronchi) that divide into smaller and smaller branches until they reach the air sacs, alveoli where gaseous exchange takes place. The lungs are cone shaped elastic spongy organs that fill a large portion of the thoracic cavity. Due to the space occupied by the heart, the left lung is smaller, narrower and longer than the right lung and is divided into two lobes, upper and lower. The right lung is the larger and divided into three lobes, upper, middle and lower.

The boundaries of the lungs, being the chest wall, diaphragm and mediastinum are covered by a membrane called the **parietal pleura**. The parietal pleura also contains nerve receptors to detect pain. A similar membrane called the **visceral pleura** covers the external surface of each lung. There is a potential space between the two pleura known as the **pleural cavity.** The visceral pleura is mainly perfused by the pulmonary circulation and the parietal pleura is perfused by the systemic circulation. The pleural cavity is normally filled by a thin layer of lubricating fluid (approximately 4mls) that is secreted by the membranes. This fluid prevents friction between the visceral and parietal membranes and allows them to slide smoothly over one another during normal breathing. This close opposition of the two pleura creates interdependence between the movement of the thoracic cavity and the lungs.

During expansion of the thorax, the parietal and visceral membranes normally adhere to each other tightly due to the subatmospheric pressure between them and because of the surface tension created by their moist adjoining surfaces. Therefore, as the thoracic cavity expands, the parietal pleura, lining the cavity is pulled outward in all directions, and the visceral pleura and lungs are pulled along with it.

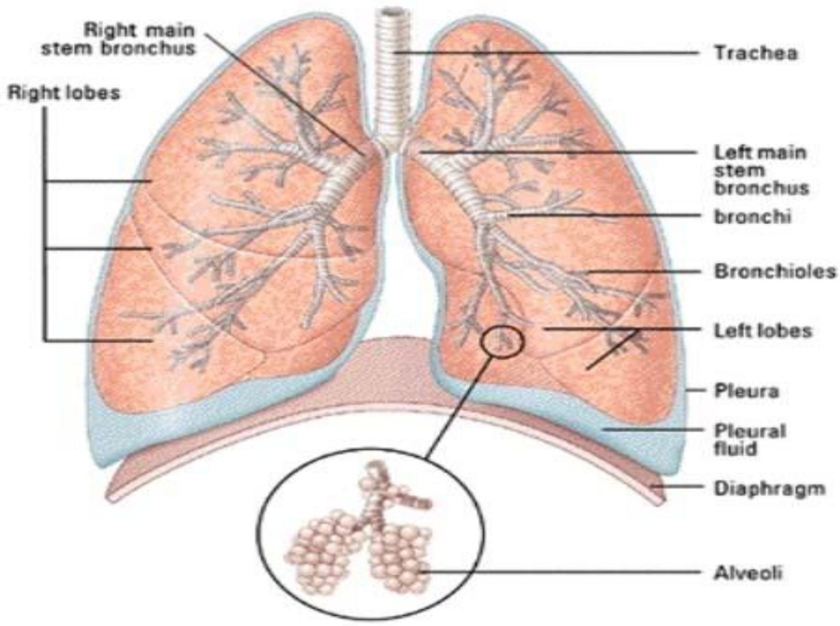


Figure 2. [2]

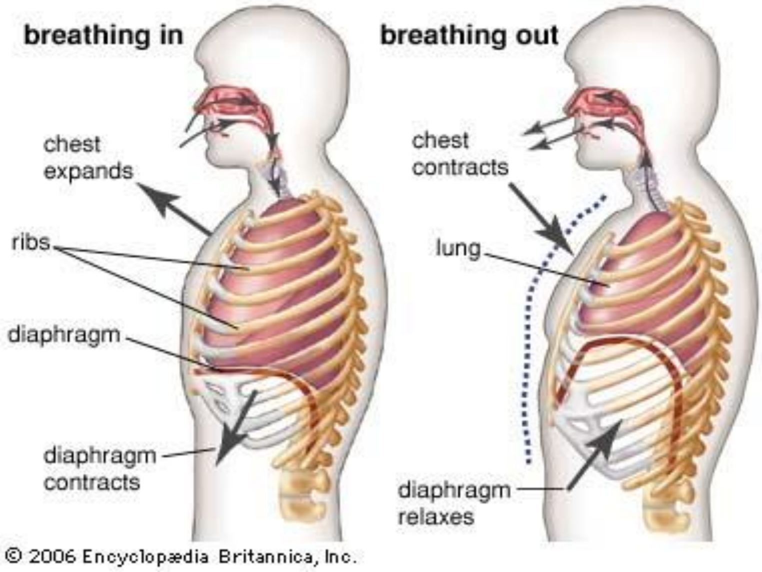
RESPIRATORY PHYSIOLOGY

Respiration is an involuntary activity. Air moves in and out of the thorax due to pressure changes. **Pulmonary Ventilation** (breathing) is the process of gaseous exchange between the atmosphere and lung alveoli. Air moves into the lungs when the pressure inside the lungs is less than the air pressure in the atmosphere. Air moves out of the lungs when the pressure inside the lungs is greater than the pressure in the atmosphere.

Inspiration occurs when intrapulmonic pressure falls below atmospheric pressure (760mmHg at sea level). When we inhale the diaphragm (which is mostly muscle) contracts, moving downward increasing the vertical dimension of the chest cavity. At the same time external intercostal muscles lift the ribs up and out increasing the transverse dimension of the chest cavity (see Figure 3).

As the thoracic cavity enlarges, the lungs greatly increase their size and capacity, as they are intimately associated with the thoracic cavity. As the lungs expand the lung pressure changes, creating a negative pressure (sub-atmospheric pressure approximately 758mmHg). The difference in pressure causes air to move into the lungs via the trachea along the pressure gradient, therefore the pressure in the lungs is decreased or becomes **negative** during inspiration. This concept is referred to as **Boyles Law** where the pressure of gas in a closed container is inversely proportional to the volume of the container. If the size of a closed container is increased, the pressure of the air inside the container decreases. The pressure in the pleural cavity (intrapleural pressure) inspiration is approximately 754mmHg. This intrapleural pressure is considered negative as it is less than atmospheric pressure. This sub atmospheric pressure is created by the 'pull' of the two membranes in opposite directions. The parietal pleura is pulled outward by forces within the chest wall while the visceral pleura is pulled inward by the forces of the elastic fibers within the lungs.

Expiration occurs when intrapulmonic pressure rises higher than atmospheric pressure (reversal of inspiration approximately 763mmHg in intrapulmonic pressure and 756mmHg of intrapleural pressure). Relaxation of the diaphragm and external intercostals muscles compress the thoracic cavity and the lungs recoil. Lung volume decreases, increasing intrapleural pressure and intrapulmonic pressures greater than atmospheric, therefore, air moves out of the lungs to the atmosphere along the pressure gradient. (see figure 3)
Note**:** During normal respiration no air enters the intrapleural space as there is no communication between the alveoli and the pleural cavity.



PATHOPHYSIOLOGY

All gases travel from high pressure to low pressure in an attempt to equalize pressure. It is the negative pressure present during normal respiration which prevents the visceral and parietal pleurae from separating and therefore must be maintained at all times.

Conditions or circumstances occur that allow fluid, air or blood to enter the pleural space. When this transpires, the visceral and parietal pleura separate resulting in disruption of the negative pleural pressure that keeps the lungs from collapsing at the end of exhalation. The lung will therefore collapse or recoil. The parietal pleura remains fixed against the chest wall, while the affected portion of the visceral pleura and lung are displaced away from the chest wall. If only a small amount of air or fluid is present, it may be reabsorbed without intervention. However, if large enough, the fluid and/or air will compromise normal respiration and must be evacuated from the pleural space.

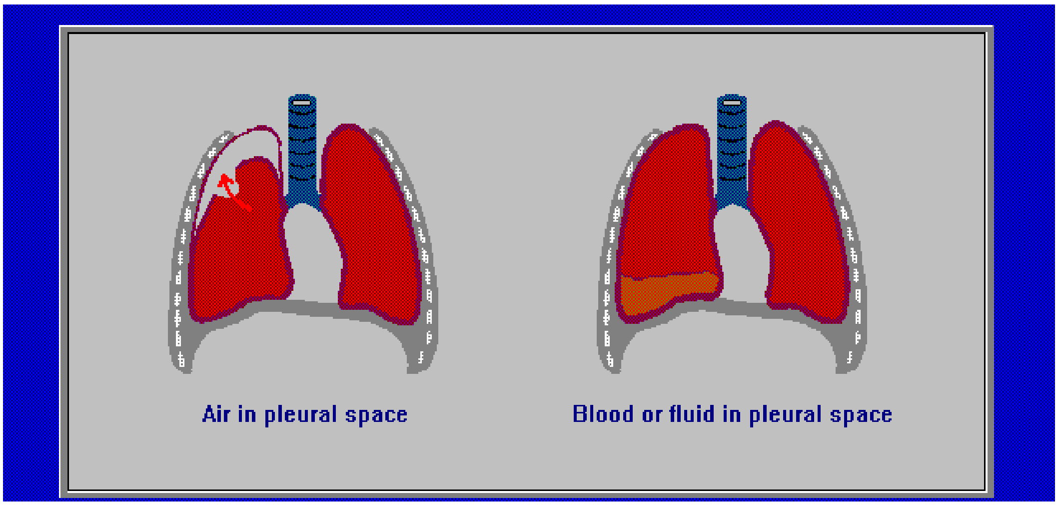


Figure 4. [5]

PNEUMOTHORAX

Air in the pleural cavity is identified as a **Pneumothorax,** which can be classified as either **Spontaneous** or **Traumatic.** On the X-Ray below, absent vascular markings in the right lung (and a black appearance) indicate air in the pleural space. The right lung has 'shrunk' to where the arrow is pointing.

R L

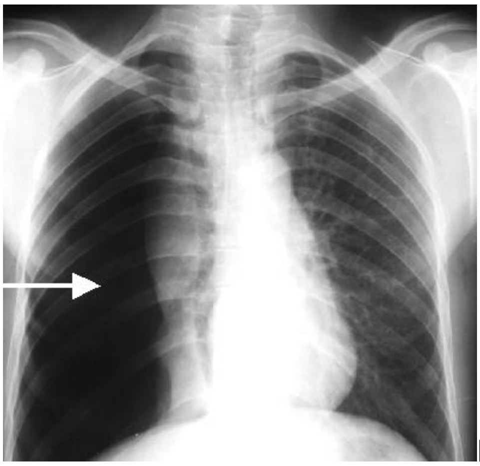


Figure 5.

SPONTANEOUS PNEUMOTHORAX

Spontaneous pneumothorax occurs from an internal rupture of a small subpleural bleb (enlarged air sac) on the surface of a lung allowing entry of air and fluid into the intrapleural space, whilst the chest wall remains intact. Spontaneous pneumothorax is further classified as **primary (idiopathic)** or **secondary (related to disease).** The etiology of these blebs is uncertain but it is known that smoking increases the risk and commonly these smokers are tall thin men where mechanical stresses at the apex (top) of the lung weaken the lung tissue. Spontaneous pneumothorax may also occur as a result of a complication of pre-existing lung disease that weakens the lung, making it more prone to rupture. Common causes include chronic obstructive pulmonary disease, cystic fibrosis, necrotizing pneumonia, cancer of the lung and AIDS patients with pnemocytis carinii infection.

TRAUMATIC PNEUMOTHORAX

Traumatic pneumothorax occurs when either *accidental* or *surgical* trauma (known as **iatrogenic**) causes external rupture of the chest wall and/or lung surface, allowing air and fluid to enter the intrapleural space. May be further classified as either **open** or **closed**:

- **Closed Pneumothorax** – an opening between the visceral and parietal pleura with no opening to the outside of the chest wall. Air enters the pleural space from a tear in the lung but is prevented from moving back into the lung by the edges of the torn lung acting like a valve and closing on expiration. *Therefore, the visceral pleura is perforated but the parietal covering remains intact.*

  An example of an accidental closed pneumothorax includes:
    - blunt trauma which causes lung tissue to rupture resulting in air leakage from lung into pleural space (i.e.; air bag).

An example of a closed iatrogenic pneumothorax includes:

- Barotrauma on the ventilated patient who is either receiving positive end expiratory pressure (PEEP), positive pressure ventilation or volume cycled ventilation where the volumes are set too high. These high pressures facilitate leakage of air into the pleural space.

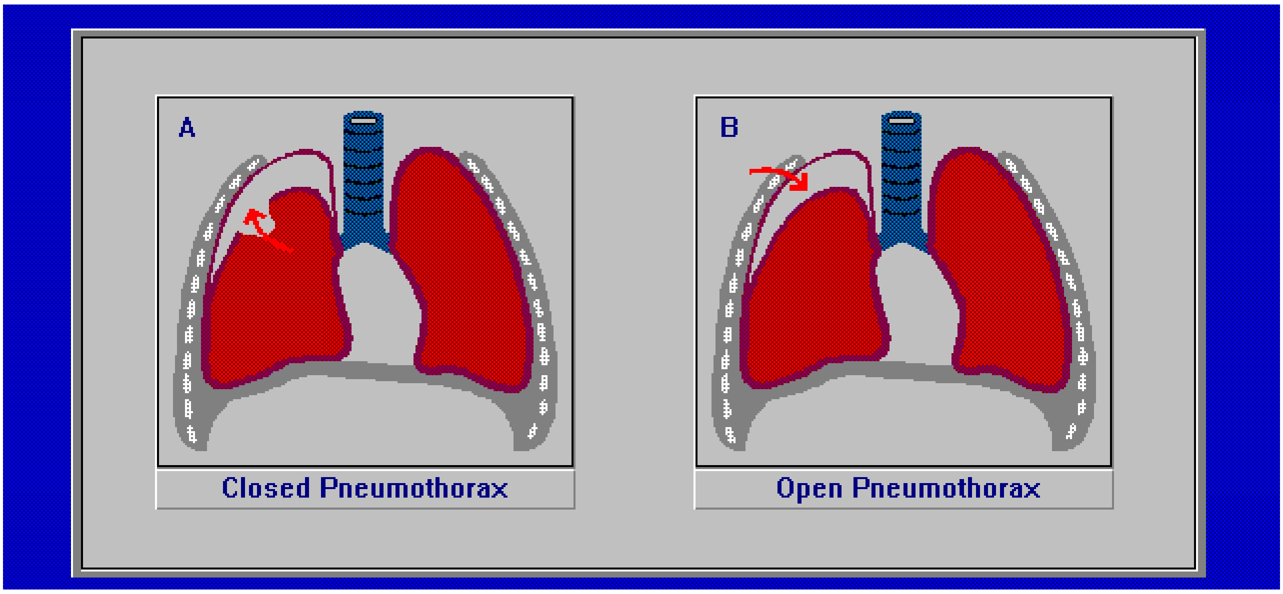
- **Open Pneumothorax** – is defined as a penetration of the chest wall either surgically (iatrogenic) or accidentally which allows air into the pleural cavity via the visceral pleura (often referred to as a 'sucking chest wound'). Air enters the pleural space from the atmosphere. When air is trapped inside the pleural space, the lungs cannot fully expand and the patient will experience dyspnoea and tachypnoea. The lung may partially or completely collapse. *Therefore, the visceral pleura remains intact but the parietal pleura is perforated.*

Examples of an accidental open pneumothorax include:

- penetrating stab wound
- impaled object

Examples of an Iatrogenic open pneumothorax include;

- invasive or therapeutic procedures such as subclavian needle stick (during insertion of a Central Venous Catheter)
- surgery to adjacent organs
- needle biopsy of the lung
- Video-assisted thoracoscopic surgery



TENSION PNEUMOTHORAX

Tension Pneumothorax occurs when air continuously enters the intrapleural space with no means of escape causing the pressure to build within the space more rapidly than it can be evacuated. This condition is very serious and potentially life threatening. Tension pneumothorax may develop from spontaneous or traumatic pneumothorax but is more likely to be seen with a traumatic. For example, a knife wound tends to seal itself in the chest wall thus trapping air leaked from the lung injury in the chest cavity. Tension pneumothorax may also develop from a closed iatrogenic pneumothorax as seen in barotrauma in the ventilated patient. [14]

As pressure builds up, the lung not only collapses, but the continual increase in intrapleural pressure causes the mediastinal cavity to be pushed toward the opposite lung as it takes up more thoracic space (see Figure 7). The other lung can collapse as a result causing respiratory distress. The great veins leading to and from the heart can be compressed, reducing venous return and further reducing cardiac output, a significant drop in blood pressure resulting. This is known as a mediastinal shift. It is critical at this point to intervene to relieve the intrapleural pressure build up by means of an emergency thoracotomy, usually with a size 14-gauge intravenous cannula that is inserted into the second intercostal space of the thorax (discussed in more detail in 'treatment of pneumothorax).

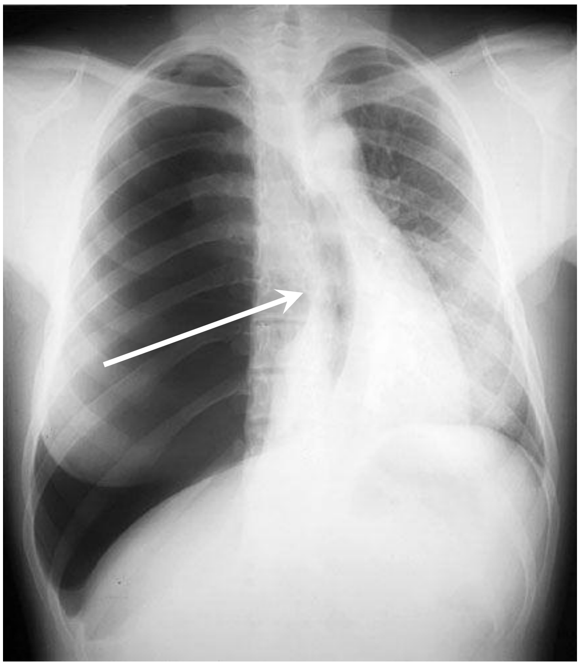


Figure 7. Tension Pneumothorax. Notice the shift of the mediastinum demonstrated as tracheal deviation (where the trachea has skewed away from the side of the tension pneumothorax).

HAEMOTHORAX

A condition caused by blood ('haem') collecting in the intrapleural space following trauma or surgery which also causes lung collapse.

HAEMOPNEUMOTHORAX

The collection of blood and air in the intrapleural space.

EMPYEMA

The accumulation of pus in the pleural space caused by infection (pneumonia), lung abscess, injury or iatrogenic contamination. If extensive, a thoracotomy and drainage of the pleural cavity may be required.

CYLOTHORAX

The presence of lymph fluid within the intrapleural space. Rupture of a thoracic duct (part of the lymphatic system) can occur during thoracic surgery (particularly during oesphagogastrectomy) or as a result of erosion from the presence of an ICC. As a result, lymphatic fluid drains into the thoracic cavity causing pressure on the lungs. This leads to basal collapse or chylothorax.

The collection of fluid in the intrapleural space causes the same disruption to the intrapleural pressure that leads to decreased lung expansion as a pneumothorax, although tension pneumothorax is extremely rare.

PLEURAL EFFUSION

Pleural Effusion is defined as a collection of fluid that has entered the pleural space. Anything that affects the balance between the fluid filtration by the parietal pleura and fluid absorption by the visceral pleura can cause a pleural effusion. Pleural effusions can develop from;

- increased capillary pressure e.g.; left ventricular failure
- reduced plasma oncotic pressure e.g.; cirrhosis of the liver
- increased capillary permeability e.g.; pleural metastases
- obstruction of lymphatic drainage by tumors or obstruction of the superior vena cava

Etiology of Pleural Effusions

When the presence of a pleural effusion is suspected by physical examination, confirmation with a Chest X-Ray is necessary. To establish the aetiology of a pleural effusion, a thoracentesis usually needs to be performed. Thoracentesis involves inserting a catheter into the pleural space through the thoracic cavity to extract fluid. It may also be referred to as a pleural biopsy or a pleural tap. Thoracentesis may be performed while simultaneously using ultrasound guidance to extract 50-100ml of fluid for analysis.

Not every pleural effusion needs to be tapped, but when there is no obvious clinical cause for the effusion, the patient is febrile, or has respiratory compromise, fluid should be removed. Extraction of fluid may also be performed for the relief of symptoms caused by the pleural effusion. It is recommended that a pleural effusion be drained slowly to avoid the risk of re-expansion pulmonary oedema. Laws et al (2003) suggests that no more than 1500mls should be drained at one time and subsequent drainage should be limited to 500mls per hour. Chest CT is performed to distinguish between parenchymal and pleural disease and may demonstrate pleural thickening, pleural calcification, a pleural based mass, or collections of fluid.

The purpose of the pleural fluid analysis is to determine if the fluid is a transudate or an exudate (i.e. where the fluid is coming from). Transudative (watery) effusions are associated with problems outside the lungs, which disrupt protein production and decrease oncotic pressure. These effusions are usually bilateral and are often caused by abnormal lung pressure. Congestive heart failure is usually the cause. Exudative pleural effusions are protein rich effusions, which usually signal infection or inflammation of the pleura as a result of inflammatory disease, cardiac surgery, drugs or pleural malignancy. Blood-stained fluid is suggestive of severe inflammation, infarction or malignancy and is unilateral.
Once an effusion is categorized as transudative or exudative, identifying the cause narrows. Additional pleural fluid studies that help to establish a diagnosis include glucose, amylase, white blood cell counts with differential and cytologic and microbiologic examination.

Treatment of a Pleural Effusion

As previously mentioned, therapeutic drainage of a pleural effusion may be done if the fluid collection is large and causing pressure with associated shortness of breath. Pleural effusions caused by congestive heart failure are treated with diuretics and other medications that treat heart failure. Pleural effusions caused by infection are treated with antibiotics specific to the causative organism. In patients with cancer or infections, the effusion is often treated by inserting an ICC to drain the fluid or a smaller catheter known as a pigtail catheter, pleurax or pleurocath catheter. The choice of catheter to be inserted is dependant on the type of fluid to be drained, for example empyema may require a thicker catheter and dependant on the amount of drainage will decide how long the catheter remains insitu. Chemotherapy or radiotherapy, or instilling medication within the chest (referred to as a pleurodesis) that prevents re-accumulation of fluid after drainage may also be used in some cases.

Treatment for Chronic Pleural Effusions

The development of the PleurX Catheter system has now been introduced for patients whose pleural effusion is chronic and at times irreversible. This entails a catheter being inserted into the patient which remains in place and clamped off. When required, the patient or home nurse (or as an inpatient) can attach the drainage system to the patient when they become symptomatic (i.e.: in the case of pleural effusion = shortness of breath) and drain fluid off. On completion of drainage, the catheter is re-clamped and the disposable system is simply discarded. This means that the patient does not have to endure repeated insertions of a pig tail catheter for treatment of a chronic condition (Carefusion, 2010).

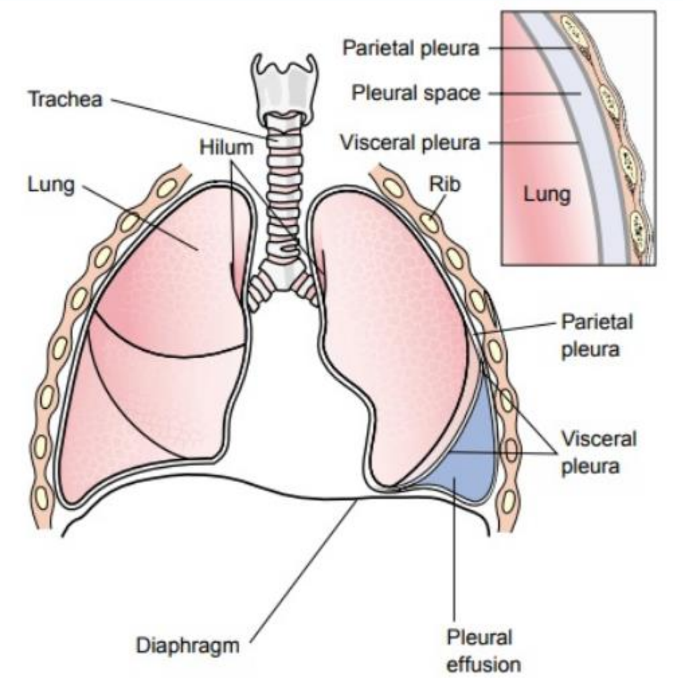
PLEURODESIS

Pleurodesis is a surgical procedure used to stop fluid or air from building up between the pleural space. This procedure is usually performed to prevent recurring pleural effusions or pneumothorax.

The procedure involves the injection of a chemical that seals the space to prevent leakage. There are a variety of agents which can be used, including talc, tetracycline, povidine iodine and bleomycin. They work by causing irritation between the two layers covering the lung, eliminating the space between the pleura and preventing the re-accumulation of fluid.

Chemical pleurodesis is a painful procedure, so patients require strong analgesics prior to the procedure. A local anaeasthetic may be instilled into the pleural space, or an epidural catheter may be placed for anesthesia.

Pleurodesis is reported as being 40-80% effective in the recurrence of pleural effusions and pneumothorax.



LINK For more interesting reading on pleural effusions, go to:
http://www.medicinenet.com/pleural_effusion/article.htm

All the conditions described above may require ICC insertion and an UWSD system to drain the excess air and/or fluid from the intrapleural space allowing the lung to fully expand once again and normal breathing to resume.

Signs and Symptoms of a Pneumothorax

Whether traumatic or spontaneous and dependant on the health status of the individual, pneumothorax may cause these cardinal signs and symptoms:

- Sudden, sharp, pleuritic pain exacerbated by chest movement, breathing and coughing
- Asymmetrical chest wall movement
- Cyanosis
- Shortness of breath
- Hyper resonance or tympany heard on percussion
- Respiratory distress
- tachycardia
- Absent or muffled breath sounds on affected side
- Hypertension
- Hypoxia with associated restlessness/confusion
- Crackling beneath the skin on palpation indicating subcutaneous emphysema (air in the subcutaneous tissue)
- Referred pain to one or both shoulder tips

Advanced signs and symptoms indicating a Tension Pneumothorax has developed may include:

- Chest rigidity on affected side
- Cyanosis
- hypoxemia
- Tracheal deviation and hypotension signifying a mediastinal shift has occurred
- Cardiac Arrest

CARDIAC TAMPONADE

All patients following cardiac surgery (such as valve replacement or coronary artery bypass graft (CABG) surgery) will require chest drainage. Chest tubes must be placed in the pericardium postoperatively to remove residual blood from the mediastinum.

Open thoracic surgery or trauma causes blood to pool in the mediastinal cavity therefore the insertion of a chest tube post operatively is common. The most serious complication of mediastinal drainage is known as cardiac tamponade. This occurs when blood or other fluids collect in the pericardial sac, compressing the heart and preventing it from expanding to accept venous return. This blood collection clots and compresses the heart, reducing cardiac contractility, cardiac output and may produce a life-threatening cardiopulmonary crisis.

COMPLETE SHORT ANSWER AND MULTIPLE-CHOICE QUESTIONS FOR PART ONE AND SUBMIT TO YOUR NURSE EDUCATOR

NAME: ________________________________DEPARTMENT: _________________

QUESTIONS: PART ONE

1. What 2 distinct regions is the thoracic cavity divided into?

____

____

____

____

____

____

2. Describe the two types of pleural membranes involved in respiration and the organs/structures that they encase.

____

____

____

____

3. What causes destruction of the pleural space and what happens to both the parietal and visceral pleura?

____

____

____

____

4. Describe the difference between the two types of traumatic pneumothorax?

____

____

____

____

5. What is the difference between a tension pneumothorax and cardiac tamponade? What can they both potentiate?

____

____

____

____

____

MULTIPLE CHOICE QUESTIONS

1. The organs encased in the mediastinum are:

   a. heart, pericardium, thymus gland, oesophagus, trachea, nerves and blood vessels
   b. heart, pericardium, thymus gland, oesophagus, trachea, lungs and blood vessels
   c. heart, pericardium, intercostal muscles, thoracic vertebrae
   d. heart, pericardium, lungs, thymus gland, pleural cavity

2. Pulmonary Ventilation works on the theory of Boyles Law where the volume of gas in a closed container is inversely proportional to the volume of the container.

   a. True
   b. False

3. The visceral and parietal pleura normally rub smoothly against each other because of:

   a. The vacuum that separates them
   b. Changes in thoracic cage size
   c. Phrenic nerve stimulation
   d. A thin layer of lubricating fluid

4. Mr Smith has been dropped off at your emergency department by a friend with a stab wound to the right side of the chest. Clinical assessment indicates that he has incurred a traumatic pneumothorax. Traumatic Pneumothorax is further divided into classifications. What type of pneumothorax does he have?

   a. Open pneumothorax
   b. Closed pneumothorax
   c. Iatrogenic pneumothorax

5. Signs and symptoms of a tension pneumothorax occurring include:

   a. Hypotension, tracheal deviation, hypothermia
   b. Hypotension, tracheal deviation, hypoxemia, hyperglycemia
   c. Mediastinal shift, hypoglycemia, tachycardia, decreased respiratory rate
   d. Hypotension, tracheal deviation, hypoxemia, dyspnoea

6. A haemopneumothorax includes the collection of any type of fluid

   a. True
   b. False

7. A Pleural Effusion may be caused by:

   a. Increased capillary pressure
   b. Reduced plasma oncotic pressure
   c. Increased capillary permeability
   d. Obstruction of lymphatic drainage by tumors
   e. All of the above

8. Transudative exudate aspirated from a pleural effusion is usually indicative of:

   a. malignancy
   b. Left ventricular failure
   c. Infection
   d. Trauma

9. Under normal conditions, pleural pressure is:

   a. Zero
   b. Positive
   c. Negative
   d. Equal to atmospheric pressure

10. Signs and symptoms of a pneumothorax include:

   a. Shortness of breath, dyspnoea, tachycardia, abdominal pain
   b. Shortness of breath, tracheal deviation, hypotension
   c. Shortness of breath, tachycardia, dyspnoea, +/- shoulder tip pain
   d. Shortness of breath, visual disturbance, absent breath sounds on affected side

PART TWO

TREATMENT OF A PNEUMOTHORAX

Treatment for pneumothorax depends on its type and the amount of lung collapse. If less than 20% of the lung has collapsed, the patient may only need bed rest or limited physical activity. If the pneumothorax is greater than 20%, air may be evacuated by needle aspiration (thoracentesis) or in more serious cases, through the insertion of an ICC. The goal of therapy is to remove the air in the pleural space in order to reestablish subatmospheric intrapleural pressure which will reexpand the affected lung. (see Figure 9)

- Spontaneous pneumothorax is usually treated conservatively. This however is dependant on the size of the pneumothorax.
- A traumatic or an iatrogenic pneumothorax usually requires chest tube insertion for lung reexpansion and also may require surgical repair.

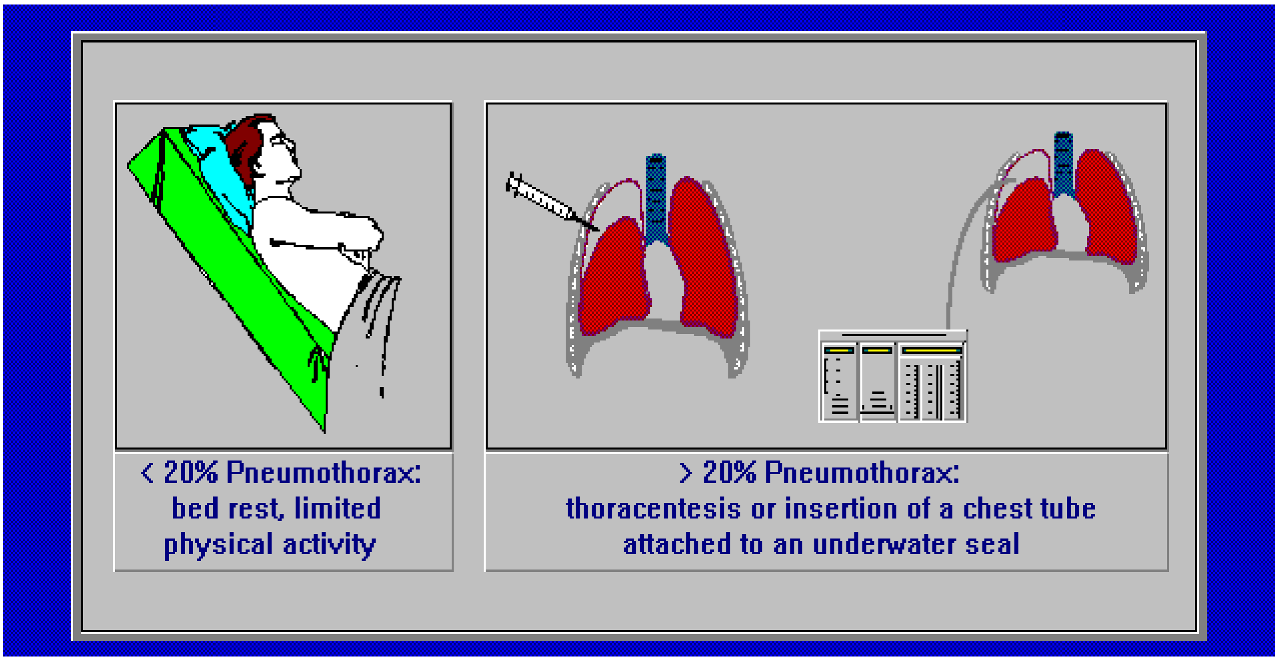


Figure 9. [5]

Treatment of a Tension Pneumothorax

Tension pneumothorax is a medical emergency. Diagnosis is made on clinical assessment as there is no time for chest X-Ray comfirmation. If tension in the pleural space isn't relieved quickly, the patient will die from inadequate cardiac output and hypoxemia. To prevent this, a clinician will insert a large bore needle (14-gauge intravenous cannula) into the pleural space at the second intercostal space, mid clavicular line, also known as needle decompression or needle thoracotomy. If successful, the pressure will be relieved, and the patient's lung will reexpand. A hissing sound will be audible as the tension pneumothorax converts to a simple pneumothrax. The physician may apply a three way tap and 20ml syringe to the canula and further aspirate air if required whilst inserting the ICC for the resulting pneumothorax, connecting the ICC to an UWSD system or valve (known as a Heimlich Valve).

INSERTION OF AN INTER COSTAL CATHETER

Also referred to as a thoracostomy tube, thoracic catheter, pleural drain tube, or a chest tube

Size and Structure
The intercostal catheter (ICC) is generally 16 to 20 inches in length and made of medical grade clear polyvinyl chloride (PVC) with 3 to 6 drainage holes at its proximal end. There is a radiopaque line along its length to allow the catheter to be visualized on x-ray, ensuring proper placement.

There are two types of ICCs:

1. Flexible, straight or right-angle catheters designed for insertion through an open chest during surgery.

2. Trocar type catheters which are flexible straight transparent PVC which are packaged with a rigid, pointed stylet through its centre,

Catheter Insertion
A patient may have one or more ICCs inserted depending on the kind of drainage. If fluid (blood, pleural effusions) is to be drained, the ICC is placed lower in the chest. Maintaining an upright position will increase drainage by gravity as fluid sinks to the lowest point.

- Placement:
  - Pneumothorax
    - If the pneumothorax is large and the patient **unstable,** placement is directed to the 4th to 5th inter costal space mid axillary line using a size 24-28 French ICC
    - If the pneumothorax is large but the patient is **stable,** placement is the same but a smaller french catheter may be used: 16-22 French
    - NB; 2nd intercostal space, mid clavicular line may be used for apical pneumthoraces, but is not routinely recommended due to discomfort and cosmesis
  - Haemothorax
    - 5th to 6th inter costal space mid axillary line using an ICC >28 French

(See figure 11)

Patients who present with pleural effusions may have a smaller thoracic catheter inserted (usually an 8 to 14 French) and connected to a sealed drainage bag on free flow instead of an UWSD system to evacuate the fluid. (e.g.: Pigtail Catheter or Pleurocath) This usually follows pleural aspiration and is left in place for 24-48 hours until drainage ceases. These catheters are usually placed in the posterior axillary line and may be inserted under fluoroscopy or ultrasound guidance. Or as mentioned earlier, the insertion of a long-term catheter known as the Pleurex catheter.

Insertion technique of an ICC

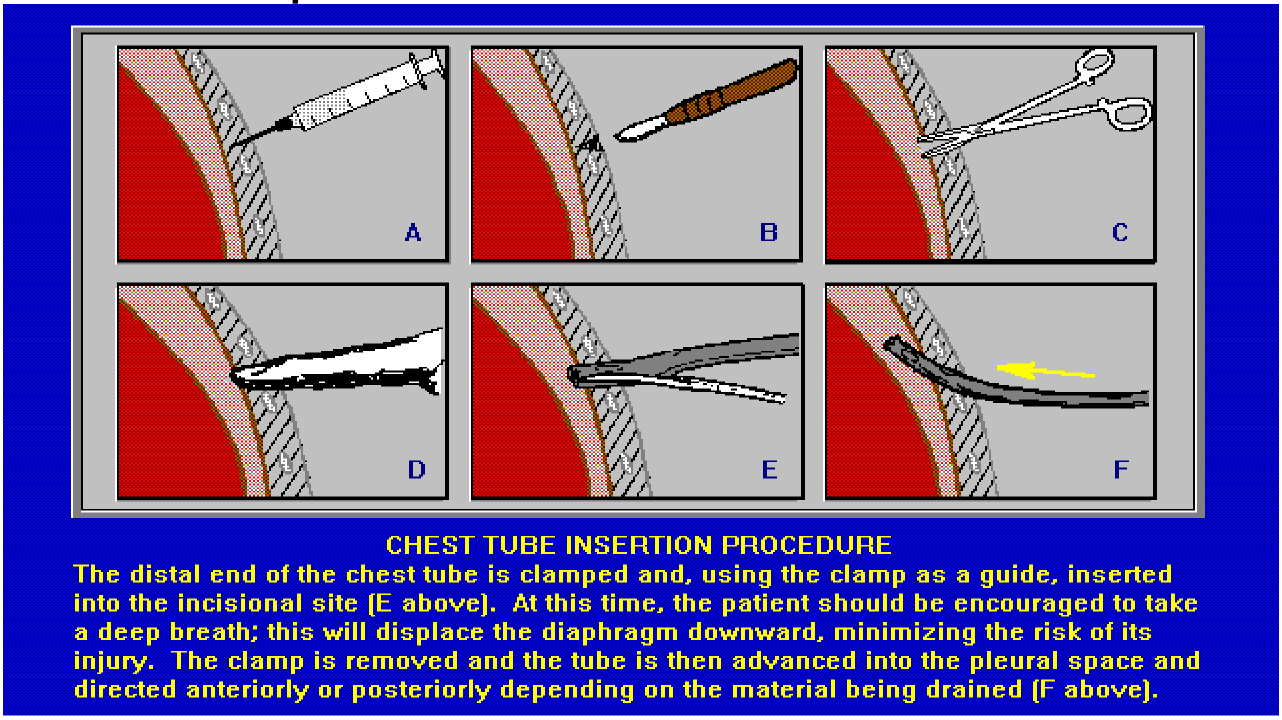


Figure 10. [5]

The ICC is securely anchored with a strong polypropylene suture to prevent displacement. A purse string suture may be placed around the incision to close the track and aid in ICC removal. A mattress suture may also be used as an alternative to the purse string suture to assist with closure.

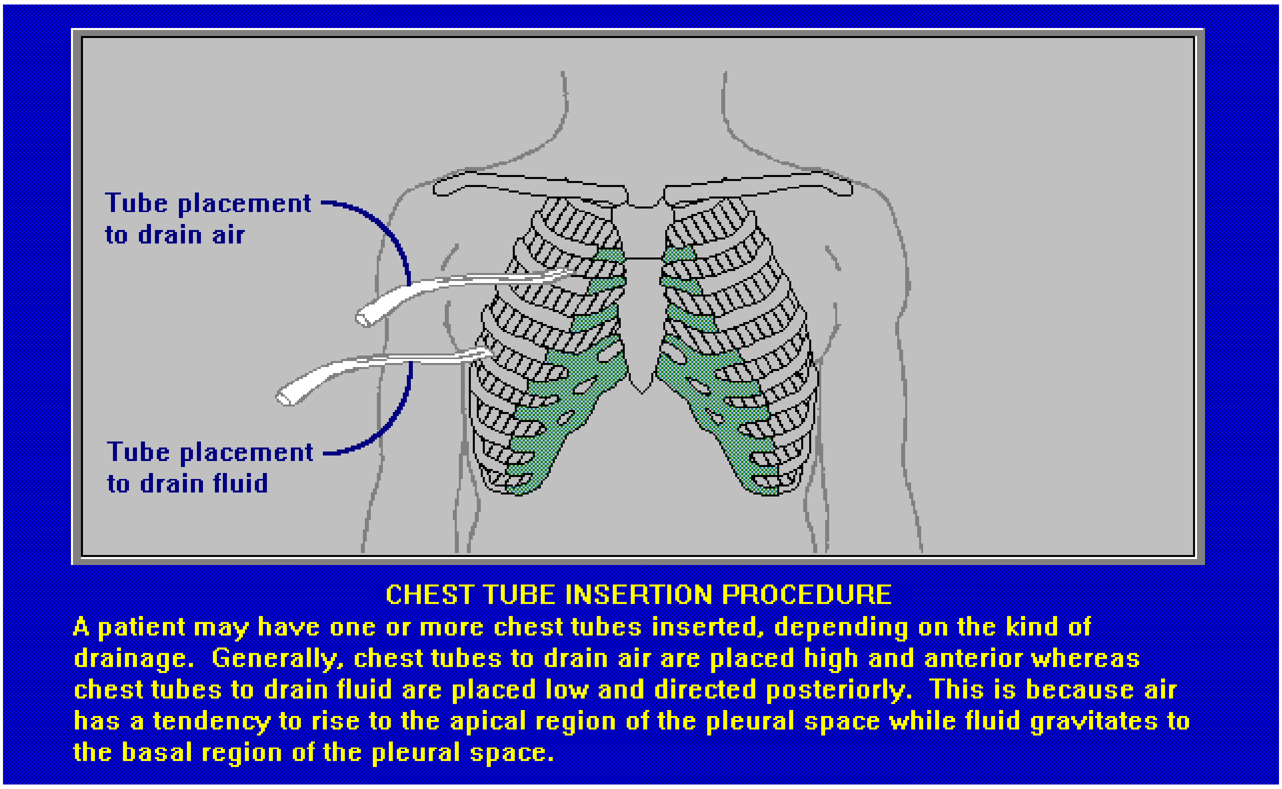


Figure 11. [5]

NURSES ROLE IN THE INSERTION OF AN INTER COSTAL CATHETER

The nurse's role in insertion of an ICC is to:

- Administer strong analgesia to the patient prior to the procedure and observe for side effects.
- Set up equipment as per proceduralists preference, including sterile gloves, mask, gown, prep, ICC, and local anaesthetic.
- Set up the UWSD system according to instructions (usually all is required is filling the water seal to the indicated level and clamping all lines and adding sterile water if using a wet suction system)
- The position of the patient will depend on the position of the site of insertion but generally the patient should be upright to encourage maximal lung expansion (the patient may rest over a table supported with a pillow). The patient may also be asked to lift the arm up around their head on the insertion side to aid visualization for the inserter
- Connect patient to a cardiac and continuous oxygen saturation; monitor, observe and report any changes to baselines observations to the medical officer throughout the insertion procedure
- Ensure emergency equipment is operational and emergency medication available (some facilities administer a premedication of Atropine 600mcg IV or subcut to avoid a vasovagal episode during insertion of the tube)
- Communication with the patient during the procedure is essential and should include adequate explanations

Once an ICC is inserted it is connected to a length of connecting tubing that leads to a drainage collection chamber. The tubing should be of a length to allow the person to move and turn, and reduce the chance of drainage being drawn back into the chest should a deep breath be taken. The collection chamber, known as an **UWSD system**, is placed below the person's chest so gravity promotes the flow of drainage. A chest x-ray is required post procedure to confirm placement.

Dependant upon the UWSD system used the nurse will:

- Connect the ICC to the patient and secure connection with tape ensuring connections remain sterile. All connections should be secured in such a way that they can still be directly observed
- Release all clamps and observe the UWSD for tidaling, bubbling, type and amount of drainage and **most** importantly, the patient's respiratory status.

REFER Check your local hospital policy and procedures regarding the current UWSD system that you use and how the system is to be set up and secured

LINK For viewing of an ICC insertion go to:

[Insertion of Pleural Drain via Seldinger Technique video | Agency for Clinical Innovation (nsw.gov.au)]

THE UNDER WATER SEAL DRAINAGE SYSTEM

In 1967, Deknatel introduced the first integrated disposable chest drainage unit based on the three-bottle system. Until about 25 years ago, this type of chest drainage systems consisted of three glass bottles and 16 separate pieces. Then a single, disposable plastic unit with three integrated chambers was developed that could be used as a one, two or three bottle system depending on the type and severity of the pneumothorax. This creation has reduced the amount of dead space which was problematic with the traditional system. Although more compact, easier to use, and less prone to contamination than the traditional three-bottle system, the principles of modern chest drain units are the same. UWSD systems come in a variety of forms dependant upon the product supplied to your hospital. This tends to be the main issue that impedes nurses from confidently managing UWSD. However, when a thorough understanding of the concepts behind UWSD and respiratory pathophysiology are achieved, it enables the nurse to competently and confidently care for a patient with any kind of UWSD system.

HOW AN UNDER WATER SEAL DRAINAGE SYSTEM WORKS

As previously mentioned, the Under Water Seal Drainage system has three major components:

1. Fluid Collection Chamber
2. Water Seal
3. Suction

Traditional UWSD systems could either function as a single, two, three or four bottle system, depending on the requirements of the pneumothorax. For example, a straight forward pneumothorax with very minimal drainage could function on a single bottle system utilizing the concept of gravity drainage alone to evacuate air from the pleural space. In comparison, a heamopneumothorax may have required a three-bottle system, the first for drainage of blood, the second for the water seal and the third for the application for suction. The three in one systems are supplied with the three major components incorporated into the system. This means that the disposable unit may be used for either a straight forward pneumothorax on gravity drainage alone to a heavily exudating heamopneumothorax that requires the application of suction.

THREE IN ONE SYSTEM

1. Fluid Collection Chamber

The ICC directly connects to the tubing from the UWSD system. Drainage from the pleural cavity flows through the tubing into the collection chamber. Drainage occurs on the concept of gravity by where the UWSD system is placed below the level of the patient's chest to evacuate air and or fluid from the pleural cavity. The fluid will remain in the fluid collection chamber and the air will continue to flow into the water seal chamber.

2. The water seal

Traditionally, the simplest closed chest drainage previously used one bottle. The connecting tubing attached directly to the chest tube into a single sterile bottle, which served as both a collection chamber and a water seal; the single bottle having a dual purpose. A rigid tube that was positioned inside the glass bottle was submerged under 2cm of sterile water so that air could escape into the bottle during expiration but was unable to re-enter the tube with inspiration; the water acting as a one-way valve.
An air vent in the top of the bottle allowed the pleural air to escape from the chamber into the atmosphere. If this vent was capped, pressure would build up preventing further pleural air from draining.

The bottle would also act as a collection chamber for any drainage. As the fluid in the bottle increased, however, so did the positive pressure, therefore, the greater the workload for the patient to expel air. This proved to be a disadvantage of this system because as fluid accumulated in the bottle, so to would be the force required to overcome the increasing water seal . To solve this problem, a second drainage bottle could be applied, the first bottle would then become the fluid collection chamber and the second the water seal.

One end of a short tube was inserted into the first bottle and the other end was inserted into the water seal bottle extending almost to the bottom. Another short tube inserted in the water seal bottle which provided the air vent or for the application of suction. Those patients who had significant volumes of fluid draining were best treated with a two-bottle system to avoid frequent bottle changes.

In the modern disposable three in one system, the second chamber, called the water seal contains also contains about 2cm of water (which the nurse fills when setting up an UWSD system). The water provides a barrier between the atmospheric pressure and subatmospheric (negative) intra-pleural pressure. As air and/or fluid drain, there is an increase in negative intrapleural pressure and re-expansion of the lung. Put simply the water seal prevents air being 'sucked' back into the pleural space.

On inspiration, fluid in the water seal should tidal upwards as seen in the manometer of the water seal (the manometer being a U-shaped tube within the water seal that measures the amount of negative pressure within the pleural cavity. This measurement is visualized as numbers on the outside of the water seal compartment). This directly reflects decreased intrapleural pressure and increased suction between the visceral and parietal pleura. This is observed when the patient inspires and the water in the water seal rises and then falls on exhalation. The air then exits the water seal (which is seen as bubbling in the water seal) and enters the suction control chamber, which regulates the maximum amount of negative pressure that can be applied to the pleural space. If suction is not being applied, this port should remain open so that air can escape from the system (see Figure 12).
Note: The pattern of tidaling seen with a ventilated patient is the opposite of that observed in a spontaneously breathing patient. This will be discussed in more detail further on.

In summary, the main purpose of the water seal is to allow air to exit from the pleural space on exhalation and prevent air from reentering the pleural cavity on inhalation.

In the even more modern UWSD units, a one-way valve replaces the traditional water seal. No water is required to establish the one-way seal. Once connected to the patient's tube and clamps are released, the patient seal is established for patient protection.

High Negativity Relief Valve

The modern three in one units have been installed with a High Negativity Relief Valve. This is indicated by rising water in the small arm of the water seal chamber when the water rises beyond 20cm. The relief chamber automatically vents excessive negative pressures, thus preventing respiratory compromise from accumulated negativity. In instances of highly imposed negative pressures such as stripping chest tubes, excessive coughing or crying, manual negative relief valves may be pressed to relief these excessive pressures. Suction MUST be operational if using this valve otherwise the negative pressure in the system may be reduced to zero (atmospheric pressure) which may reaccumulate the pneumothorax.

Air Leak Meter

Air leak meters have been included on some of the three in one systems. These are a part of the water seal. The patient air leak meter indicates the approximate degree of air leak from the chest cavity. The meter is made up of numbered columns from low to high i.e.; 1-7. The higher the number the greater the degree of air leak and the size of the pneumothorax. By regularly documenting the number, the nurse can monitor an air leak increase or decrease from the pleural space.

REFER Check the instructions on your current UWSD system and find out what mechanism it has for the relief of excessive negative pressure and whether it has an air leak meter

3. Suction

Traditionally, levels of suction were always established by filling a chamber with an ordered amount of sterile fluid known as "wet" suction. Newer systems have been developed using "dry" suction. There continue to be three-in-one systems that operate using wet suction but most newer systems use the dry form for ease of operation.

Suction is applied to encourage reinflation of the lung by facilitating greater pressures to drain either fluid or air. Suction increases the pressure difference between the pleural space and the UWSD system by *pulling air* from the UWSD system and therefore lowering the pressure in the bottle and enhancing drainage. Usually between 10-20cm of suction may be applied if:

- gravity drainage is not enough
- drainage of empyema or viscous pleural effusions
- the patient has a weak respiratory effort or poor cough causing a reduction in pulmonary compliance
- air is leaking into the pleural space faster than it can be removed by a simple gravity drainage system
- to speed up drainage

Wet Suction

Traditional chest drainage units regulated the amount of suction by the height of a column of water in the suction control chamber. Suction was never applied to the same chamber as the drainage and/or water seal chambers therefore a separate chamber was required. Suction could be applied to a two or three bottle water seal system (see figure 12).

The suction chamber contained a long tube with its top end open to atmospheric air and its lower end immersed in water. The maximum level of suction was determined by how deeply the control tube was submerged; the deeper the tube was immersed in water, the more suction (negative pressure) was created. Suction was applied by turning the wall suction outlet on until gentle bubbling was seen from the control straw. Increasing the source of suction (i.e.; wall suction outlet) only caused more air to travel through the air vent, the vigorous bubbling only causing evaporation. The deeper the column was immersed in water; the more suction was created.

It was therefore, the height of water, not the setting of the suction source, that determined the amount of suction transmitted to the pleural cavity. Passing through water slowed the air, and thus controlled the suction force. This is why it was, and continues to be, in the three in one USWD systems, so important to monitor the amount of water in the suction control bottle.

A suction of -20cmH20 equates to an atmospheric pressure of 746mmHg. In a wet suction control system in the three in one unit, the suction control chamber is filled to the desired height with sterile fluid. With the application of suction, air travels from the person's pleural cavity via the water seal, through the air vent, into the suction chamber, and then to the suction source.

The suction tubing is connected to a suction source and the source suction is adjusted to produce gentle bubbling in the suction control chamber. As in the traditional bottle system, excessive source suction not only causes loud bubbling (which can disturb patients and caregivers), but also hastens evaporation of water from the suction control chamber. This results in a lower amount of suction applied to the patient as the level of water decreases.

Dry Suction

Dry suction control systems have been shown to provide many advantages

- Higher suction levels can be achieved
- Quieter operation
- Set up is easy
- No fluid to evaporate which would decrease the amount of suction applied to the patient

Instead of regulating the level of suction with a column of H_20 (as in the 'wet system'), the dry suction units are controlled by one of two methods of limiting the amount of negative pressure applied by suction. One is a **self compensating regulator** that automatically adjusts to changes in negative pressure from the suction source or within the patient. The second is a **one-way valve.** The regulator is usually located on the upper left-hand side of the three in one unit. External wall suction can be inconsistent and inaccurate for suction regulation. Therefore, a suction control chamber is an aid for providing a constant and consistent suction level. A suction system operates by creating a negative pressure at its source. The negative pressure at the source creates a pressure gradient, whereby fluid is moved from an area of higher pressure (the pleural cavity) to that of a lower pressure (the drainage container). To set the suction, the dial is rotated until an indicator of some sort (i.e.: an orange float appears in a window on the PLEUROVAC system) to indicate that suction has been achieved (thus enough suction may be created by as little as 5cmH20).

The suction control level can be changed at any time if prescribed by a medical officer by simply rotating the dial to the new suction setting.

Suction force greater than 50cm H_2O may cause lung damage. Too much suction may draw air out of the lungs and delay healing.

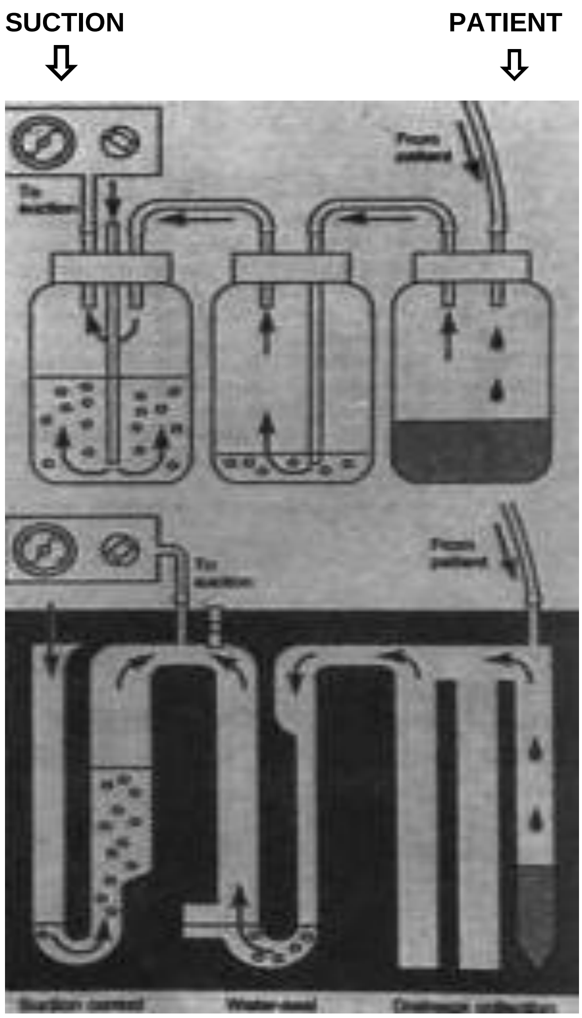


Figure 12 [25] Comparison of principles from a three-bottle system to a three in one enclosed drainage system. As you will see the flow of air is almost the same for each system, the only difference from the above units is where the outlet to the atmosphere is situated. On the three-bottle system, it is situated in the suction chamber, in the three in one system, the outlet is situated in between the suction and the water seal chambers. The appearance of the UWSD system being the only real difference in the flow of air and fluid.

REFER Check the instructions on your current UWSD system and find out how the suction is operated

HEIMLICH VALVE

An alternative to UWSD was first devised in World War One when medical corpsmen created makeshift one-way valves as the glass bottle systems were cumbersome and impractical to use on the front. Then in the mid-1960s, Dr Henry Heimlich introduced the Heimlich valve which was utilized during the Vietnam War.

The Heimlich valve is attached directly to an ICC. This valve contains a piece of rubber tubing which is flattened at one end to act as a flutter valve by allowing air to pass in only one direction. The rubber tubing is enclosed in a hard, clear plastic case to prevent the tubing being compressed and therefore occluded. The Heimlich flutter valve allows trapped intrapleural air and drainage to escape during expiration without letting additional air to enter during inspiration.

The Heimlich valve is best suited for an uncomplicated pneumothorax that requires little or no drainage collection or suction. It is not recommended for a patient with large amounts of chest drainage (more than 50 mls) or many blood clots. The Heimlich Valve is still used today in patients with small, slowly resolving pneumothoraces or those requiring transport, particularly in emergency situations. Patients with long term air leaks and minimal drainage can also be discharged home with a Heimlich Valve with close support from healthcare professionals.

Advantages

- inexpensive
- lightweight and portable – mobilization is easy
- can function in any position; doesn't need to be below the level of the patient's chest
- simple to use – requires very little assembly
- reduces the amount of transport equipment (especially patients being retrieved)

Disadvantages

- easily obstructed by fluid – unsuitable for use if fluid is to be drained, eg, post thoracic surgery, haemothorax, haemopnuemothorax
- detection of persistent air leaks or the formation of new air collections is difficult
- education of staff required for safe use

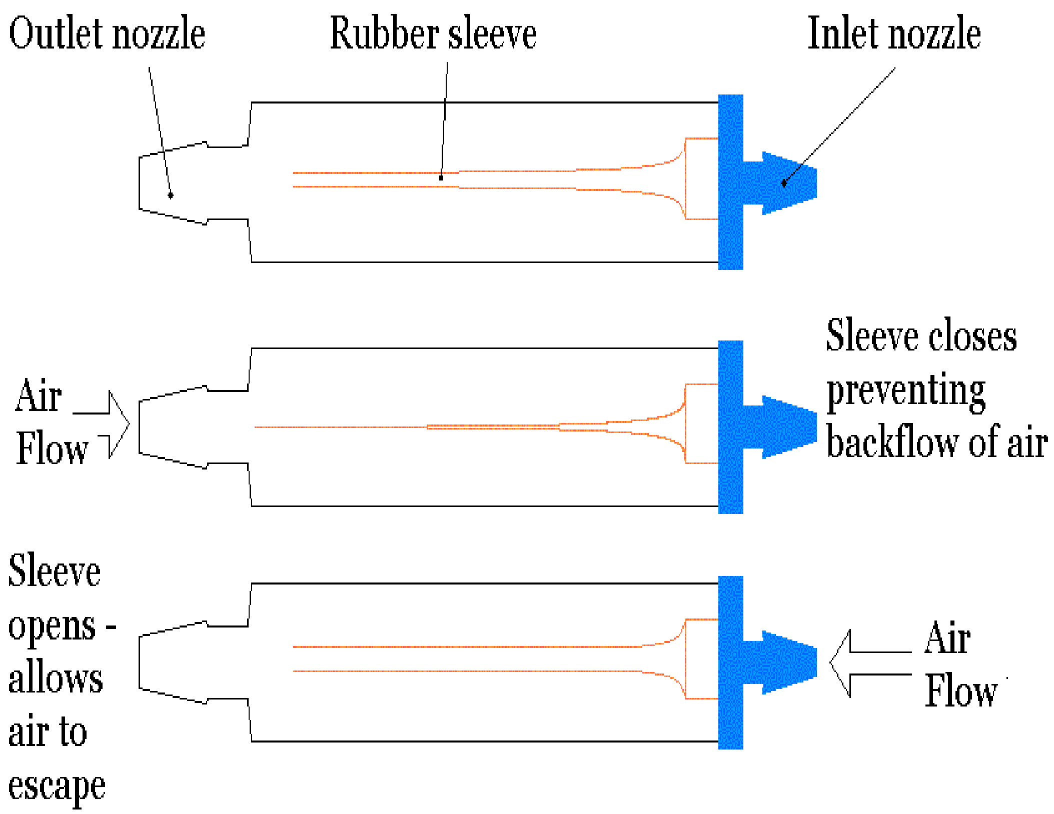


Figure 13. The movement of air through a Heimlich Valve [22]

Figure14. [23] Heimlich valve

COMPLETE SHORT ANSWER AND MULTIPLE-CHOICE QUESTIONS FOR PART TWO AND SUBMIT TO YOUR NURSE EDUCATOR

NAME: ______________________________ **DEPARTMENT:** ___________________

QUESTIONS: PART 2

1. Where is an ICC inserted for a
   a) pneumothorax and
   b) a haemothorax and what is the rationale for placement for both?

____

____

____

____

____

____

2. How is treatment decided for a Pneumothorax?

____

____

____

____

____

3. Summarize the nurse's role in the insertion of an ICC.

____

____

____

____

____

____

____

____

____

4. Describe the movement of air and/or fluid as it leaves the pleural cavity through the disposable three in one UWSD system (assuming suction has been attached).

5. Describe the differences between wet suction and dry suction.

MULTIPLE CHOICE QUESTIONS

1. An ICC inserted in the midclavicular line, high in the anterior chest wall is to drain air only

   a. True
   b. False

2. The three in one UWSD systems were developed because of:

   a. Increased risk of contamination
   b. Ease of transportation
   c. Decreased amount of dead space
   d. All of the above

3. In a single bottle system (on the traditional 'old' UWSD system), moderate drainage (>150-200mls) would prevent further drainage of air or fluid thus a second bottle could be attached

   a. True
   b. False

4. The air leak meter on the 3 in one system detects:

   a. The amount of drainage
   b. The amount of air being evacuated from the pleural space
   c. When the system should be changed
   d. How much pain the patient is in

5. When performing post insertion observations of the UWSD system, the nurse observes for:

   a. Presence of tidaling in the water seal
   b. The amount and type of drainage
   c. the presence/absence of air/bubbling in the water seal on exhalation
   d. all of the above

6. Shallow breathing would demonstrate less tidaling in the water seal and more in heavy breathing as seen on the manometer

   a. True
   b. False

7. The new three in one systems suction control chamber that uses dry suction requires H20 to measure the amount of suction being applied to the pleural cavity

   True
   False

8. Measurement of the amount of suction used in the 'wet' system is demonstrated by:

   a. The amount of vigorous bubbling
   b. The amount of suction dialed up at the suction outlet
   c. the depth in which the control tube is submerged in the H20
   d. all of the above

9. To observe the desired level of suction dialed up on the suction control dial on an UWSD system using 'dry' suction being achieved, an indicator would be shown as either a symbol or a float device

   a. True
   b. False

10. The Heimlich Valve may be used for transporting a patient to a metropolitan hospital. With which type of pneumothorax would it be appropriate to remove the UWSD unit and replace with the valve?

   a. Haemothorax
   b. Pneumothorax with moderate surgical emphysema (persistent air leak)
   c. Spontaneous Pneumothorax with minimal drainage
   d. haemopneumothorax

PART THREE

ASSESSMENT
MANAGEMENT
DOCUMENTATION and
TROUBLESHOOTING

of the patient with an Under Water Seal Drainage System

ASSESSMENT

When any patient has an UWSD system or drainage device from the pleural cavity in place, it is imperative that the patient is always assessed first.

PATIENT ASSESSMENT

When observing the drainage system, we must initially observe the patient. It is only when both the patient and the UWSD system are assessed that any conclusions or trouble shooting can be determined. The following assessments need to be performed on the patient with an UWSD system:

- Haemodynamic state: vital signs initially hourly including blood pressure, heart rate, skin color and peripheral perfusion
- Neurological assessment
- Pain assessment – having an ICC insitu is very uncomfortable and painful for patients therefore encourage analgesia prior to physiotherapy and on a regular basis to encourage normal respirations compared to shallow respirations. Does the patient require education regardingpain relief and does the patient understand the purpose of the UWSD?
- Respiratory assessment (rate, depth, pattern). Auscultate to determine altered breath sounds.
- Palpate the insertion site and surrounding tissue for subcutaneous emphysema (free air passing into the subcutaneous tissue). Subcutaneous emphysema can occur if one or more drainage holes are situated outside of the pleural space or if the tubing is blocked or kinked.
- Physiotherapy: is the patient performing deep breathing and coughing to facilitate the exit of air from the pleural space. Coughing raises intrapleural pressure which facilitates emptying of an accumulation in the pleural space of air and/or fluid
- Frequent position changes to promote drainage

Note any improvement and report and deterioration in any area. Always remember to document observations and your actions in response to changes in observations.

SYSTEM ASSESSMENT

- Drainage – amount, color
- Presence or absence of tidaling – (also referred to as 'swinging' or 'oscillating')
- Presence or absence of bubbling
- Maintenance of water seal level
- Maintenance of water level in suction control chamber if using a 'wet' suction system
- Degree of air leak
- Checking of the insertion site and of all tubing and clamps

Drainage

It is important to monitor the blood or serous loss from the intercostal catheter. Initially, drainage should be assessed hourly. What is the character of the drainage; is it bloody, straw-colored or purulent? What is the rate of drainage? Any there any changes in color or the amount of drainage? Excess of 100mls in one hour should be reported to the medical officer. The literature suggests that under normal circumstances, ICC insertion in contraindicated in patients who are either anticoagulated or those with a predisposition to bleeding or abnormal clotting profiles.

Tidaling

Remembering that the UWSD is in a sense an extension of the pleural space, tidaling is a direct reflection of respiration and the negative pressure in the pleural space. Tidaling is characterized by the fluid column in the water seal chamber moving towards the patient on inspiration (due to decreased intrapleural pressure) and away from the patient on exhalation. Tidaling demonstrates the changing of intra pleural pressures in the ventilatory cycle. It is important to note that tidaling will be affected by suction therefore it should be disconnected prior to UWSD observations. When removing suction do not clamp the UWSD tubing, simply turn off at the suction source and remove suction tubing (so as air can escape from the system). Replace tubing and turn suction on to previous setting.

*If a patient is mechanically ventilated on Positive Pressure Ventilation the fluctuations are reversed as the respiratory pressures are reversed. This occurs due to the pressure within the thorax becoming positive during inspiration which forces the fluid in the manometer of the water seal down.

Bubbling

An air leak is characterized by bubbling in the water seal chamber of the UWSD system and demonstrates air being expelled from the pleural space into the UWSD system on expiration, or when the patient coughs (as long as the pneumothorax still exists). If bubbling is observed in the UWSD unit, the chest drain should never be clamped as this is allowing air to escape. If the UWSD unit is clamped, the air cannot escape and a pneumothorax may develop. The only exception being in patients who are receiving positive end expiratory pressure (PEEP) from a ventilator. In these cases, while a pneumothorax exists continuous bubbling is most likely observed. Bubbling will

disappear as the lung re-expands. If continuous bubbling is observed in the absence of suction, this indicates that the seal in some area between the insertion site and the unit has been broken.
Note – It is important to know when caring for a patient whether bubbling has been present so that any changes can be noticed and acted on as necessary.

REFER Check your local policy regarding the removal of suction temporarily for assessing tidaling and bubbling from the UWSD system

Suction

When suction is applied to the patient with an UWSD system, there is usually continuous bubbling visible in the UWSD system (for the 'dry' system bubbling will be visible in the water seal). Remembering that suction is controlled by the UWSD and not the wall suction outlet, suction is turned on only until:

- wet suction systems – gentle bubbling is observed in the suction control chamber
- dry suction systems – titrated until a symbol or device appears in a window indicating suction is present

To apply the suction for the 'wet' three in one UWSD system:

- place sterile water in suction control chamber up to level as prescribed by physician, usually 20cmH20
- attach one end of suction tubing onto suction port on UWSD system and the other end to the source suction
- turn on wall suction until gentle bubbling appears in the suction control chamber

Note – some units have a suction control regulator. If this is present, turn the regulator to "closed" and then turn on the source suction. Once source suction is on, start to open the suction control regulator until gentle bubbling appears in the suction control chamber.

To apply suction in the 'dry' UWSD system:

- Turn suction dial to prescribed level
- Apply suction tubing onto suction port on UWSD unit
- Turn on wall suction only until indicator appears (i.e. an orange float appears in the Pleurovac UWSD whilst a green float appears in the Altitude UWSD system when the suction level is achieved)
- Observe patient response when suction is applied

MANAGEMENT

- The UWSD unit must **always** be below the level of the patient's chest to avoid siphoning of fluid back into the pleural cavity.
- Position system as far below patient as possible to facilitate drainage
- If on floor rotate footstand for added stability (if available on specific unit)

- Avoid dependant loops in tubing. Drained fluid from the pleural cavity may pool in lengths of the tubing that is not tunneling directly into the UWSD system. This fluid may impede further drainage of air thus increasing the pressure in the tubing and the accumulation of air in the pleural space that is unable to be evacuated.
- Suction may be temporarily ceased if a patient requires transfer to X-Ray only if the patient condition allows (this needs to be decided by the treating Physician). If the patient is deemed unstable to have suction stopped then the patient will either require a portable suction unit to travel with them to the X-Ray department or a portable chest X-Ray will be required. Ensure when suction is stopped that the tubing is removed to allow the escape of air from the UWSD unit
- Never clamp tubing for transport alone.

Routine checks and observations of the UWSD system

At the commencement of each shift (following initial patient assessment) the nurse should assess the UWSD system for the following:

- Presence of swing. NB: swing may be affected by suction therefore may need to be briefly disconnected prior to observation by an experienced RN
- Presence or absence of bubbling
- Measurement of air leak meter (i.e.; to indicate size of pneumothorax)
- Amount, color and consistency of drainage
- The amount of drainage in the UWSD over a 24 period should be marked on the UWSD unit and charted on both the fluid balance chart and the fluid balance summary.
- Correct taping of connections. There is ongoing debate about the type of tape to secure connections. Some physicians advocate that taping the connection secures it to avoid potential disconnection, but others argue that taped tubes may disconnect without being seen. Generally, all connections should be secured in a way that they can be directly observed i.e.; connection should be able to be seen, not wholly covered by non-transparent tapes
- Correct amount of water (H_20) in water seal
- Correct amount of H_20 in suction chamber (if wet suction only)
- That the amount of suction that has been ordered corresponds with the amount of suction dialed up on the regulator (in dry suction units only)
- Appropriate air vents are open (in the case of simple gravity drainage the air vent <u>must</u> remain open so that pressure does not build up in the drainage bottle or could worsen pneumothorax and potentiate a tension pneumothorax)
- Insertion site: check dressing and ensure firmly fixed to prevent kinking or friction. Are any eyelets of the ICC exposed? Change as required according to local hospital policy. Is there any crepitus around the insertion site?
- That two rubber tubing clamps are clearly visible at the beside in case the drainage bottle has to be raised to or above chest level for any reason (see 'Clamp or not to clamp' below regarding clamping of ICC's)
- That the tubing of UWSD has no dependent fluid filled loops in tubing
- That there is a second unit on the ward they are working on and where it is located. This ensures that if there is an accidental disconnection, then minimal time is wasted setting up the second unit for connection

To clamp or not to clamp?

The literature suggests that an ICC must never be clamped for greater than 60 seconds (except when re-expansion of the lung is confirmed) as this may cause an accumulation of positive pressure and if left clamped for an extended period of time in the lung that has not reinflated, a tension pneumothorax. NEVER LEAVE A PATIENT UNATTENDED WHILE AN ICC IS CLAMPED AND NEVER CLAMP FOR TRANSPORT! (the only exception is when the medical officer orders the ICC to be clamped prior to removal)

Dependant on the organization within which you work clamping may be advocated in the event of an accidental disconnection of the tubing from the UWSD system while a second system is quickly prepared. Other guidelines suggest placing the ICC on a sterile towel unclamped while a new UWSD system is set up and to contact a medical officer immediately. Other alternatives include the placement of the ICC in approximately 2cm sterile water whilst a second UWSD unit is prepared or the application of a Heimlich valve whilst the new UWSD unit is being prepared.

Exceptions (again dependant on the organization):

- changing UWSD system – prepare everything first (i.e.: add correct amount of H20 to water seal, remove tapes on connection, prepare new tapes specific to your organization)
- when it is necessary to lift bottle above the level of the bed
- briefly clamping to locate an air leak (only by an experienced staff member or under direct supervision of an experienced staff member)

REFER As evident from the above suggestions on clamping ICC's, it is imperative that you are aware what your local hospital policy is regarding the clamping of ICC's. Go to your policies and procedures and check what your local policy is regarding clamping of ICC's.

DOCUMENTATION

- Following insertion of an ICC and connection to the UWSD unit, 15 minutely vital signs should be performed until the patient is stable and thereon 1-2 hourly unless otherwise indicated. Documentation should also include the presence or absence of;
- bubbling, tidaling and the amount and type of drainage
- Time and date chest drainage began
- Suction level being applied (if applicable)
- Patient's respiratory status
- Vital signs
- Neurological status

Ongoing documentation should also include:

- Frequency of patient and drainage system assessments.
- Dressing changes
- Patient education
- Presence or absence of complications i.e.; episodes of respiratory distress, causes and interventions
- Pain management administered and effectiveness of medication given

TROUBLESHOOTING

The main reasons for malfunction of an UWSD system include:

- Large amounts of air leaking into the pleural space or into the drainage apparatus
- Occlusion from the pleural cavity down to the UWSD system
- Problems with the suction source

Previous management of UWSD systems indicated the ‘milking’ or ‘stripping’ of ICCs in the event of a clot in the actual ICC or the tubing from the ICC to the UWSD system. Current literature and clinical practice now generally regard this practice as dangerous to the fragile pleural cavity. Milking and stripping may cause extreme negative pressures within the pleural cavity causing complications.

The following table indicates what is 'normal' to see from the patient and then action to be taken when problems arise

NORMAL	PROBLEM	ACTION REQUIRED
• Drainage of blood or serous fluid into the UWSD system resulting from a haemopneumothorax, heamothorax, pleural effusion or empyema	• Sudden cessation of drainage • Patient is experiencing increasing shortness of breath (SOB) and pain on inspiration +/- shoulder tip pain. Dependant on compensation mechanisms of the patient, oxygen (02) levels may have dropped from baseline, the patient may be hypertensive and tachycardic	Usually indicates a blockage in the system from either kinking in the tubing or a clot in either the ICC or the tubing. • Check tubing from ICC insertion site down to the UWSD system and unkink if observed. Watch for return of drainage and correction of patient’s respiratory status • Blockage in the ICC caused by either lung tissue, adhesions or clotted fluid: apply O2 at 10 Litres, sit patient upright, generate MET Call (Medical Emergency Team), record vital signs, reassurance, analgesia, prepare for reinsertion of another ICC as per policy • Clot in the tubing: clamp ICC at insertion site and then at the distal end of the ICC. Apply O2 at 10Litres, sit patient upright, prepare new UWSD system and replace (change system according to hospital policy)

NORMAL	PROBLEM	ACTION REQUIRED
• Tidaling is visible in the water seal as the patient inspires and falls as the patient exhales. This may be difficult to assess when suction is operational with the pulling force of suction negating the inspirational pressure. • Tidaling reduces as pneumothorax resolves • Level of water seal may remain elevated from base with either nil or minimal tidaling once resolved due to suction drawing the lung up against the holes in the chest tube with no further air to be evacuated. This sustained negative pressure keeps the water seal elevated	• Sudden cessation of tidaling • Patient is experiencing increasing SOB and pain on inspiration +/- shoulder tip pain	• Blocked or kinked tubing. Perform systematic assessment from ICC down to the UWSD system ensuring that the tube is unclamped. Position the open clamp away from the patient to avoid accidental closure. Reposition patient (instruct patient to sit upright or lean to opposite side to ICC to view ICC closely at insertion site and to prevent further kinking)

NORMAL	PROBLEM	ACTION REQUIRED
• Bubbling on exhalation or coughing in the UWSD system demonstrates air being evacuated from the pleural space • When all the air has been removed from the pleural space, bubbling on exhalation will stop • When suction is operational gentle continuous bubbling may be evident	• Sudden cessation of bubbling and tidaling • Continuous bubbling (in the absence of suction and absent or reduced tidaling)	• Blockage or kink in the ICC or tubing • Indicates a leak in the system. • Check and tighten all connections • To assess for the leak, firstly apply pressure with gloved hand around the chest tube insertion site. If leak stops, may require resuturing in. Check for exposed eyelets on the ICC and notify medical staff immediately if observed • Secondly, test tubing for leaks by momentarily clamping the ICC using a padded clamp at various points along its length. Start at the proximal end and work your way down. Bubbling will stop when you clamp between the air leak and the water seal. If you've clamped along the tube's entire length and still can't find the source, the UWSD system might be cracked and need to be replaced

NORMAL	PROBLEM	ACTION REQUIRED
ICC insertion site should be dry, clean and intact with minimal swelling around the insertion site	• Crepitus upon palpation around the site (subcutaneous emphysema) • ICC falls out	• Mark the borders of the crepitus and monitor closely. Crepitus may spread to arms, chest and neck and there is the potential for airway impairment in severe cases. Report immediately especially if new • May occur as a result of one of the eyelets of the ICC being dislodged from the pleural space. An additional chest tube may be required • If patient is asymptomatic, apply an occlusive dressing and notify doctor immediately to decide whether reinsertion

		is required • If patient is symptomatic (often air will be audible leaking from the insertion site), generate MET Call, (if available; if not notify medical officer immediately). Apply an occlusive three-sided dressing so that pleural air can escape and set up for reinsertion of an ICC
The tubing of the UWSD system is free of dependant loops	• Dependant loops evident with fluid tidaling in the hanging loops	• Drain fluid into the UWSD unit and prevent further dependant loops which cause resistance to flow out of the pleural cavity. To achieve this, stabilize tubing by coiling and securing the tubing to a stabilizing device
UWSD system is positioned upright on the floor with the footstand of the system in use. The UWSD system is always kept below the level of the patients chest	• UWSD unit tips over	• Quickly stand bottle upright to reestablish water seal. If water has drained into collection chamber, add sterile water to water seal level. Inform medical officer of occurrence (to account for extra fluid in fluid collection chamber). Reassess patient for any signs of respiratory distress or dyspnoea.

QUICK SUMMARY OF TROUBLESHOOTING

WATER SEAL CHAMBER		ASSESSMENT AND MANAGEMENT OR AIR LEAK
Tidaling Yes	Bubbling Yes	Indicates patient air leak (i.e. from pneumothorax) exists and lung is not Re-expanded. The greater the degree of bubbling and tidaling, the greater the extent of air leak (pneumothorax) and the greater the degree of lung collapse. Patient may have respiratory distress but is important to distinguish whether is due from pain or respiratory compromise (i.e blocked ICC)
Tidaling No	Bubbling No	Indicates resolution of air leak and lung re-expansion (slight tidaling may be seen) Be sure patient ICC and UWSD tubing is not kinked or obstructed; verify lung expansion with a Chest X-Ray
Tidaling No	Bubbling Yes	Indicates a possible connection or system air leak. Momentarily pinch or clamp off the thoracic catheter. If bubbling continues, a connection leak exists. Secure and tape all connections.
Tidaling Yes	Bubbling No	May be observed when lung re expanded or with partial or total pneumonectomy. May also be associated with decreased lung compliance (stiff lungs)

REMOVAL OF INTERCOSTAL CATHETER

The decision to remove the ICC is usually made by the attending physician. However, there are several signs that nurses can communicate to the physician to assist in their decision making. These include:

- Scant or no drainage
- Tidling has ceased or is minimal
- Air/bubbling in water seal chamber has ceased for 24 hours
- Bibasal equal air entry on auscultation
- Lung is fully inflate d on chest x-ray with no fluid observable in the pleura

The nurse may be instructed to clamp the ICC for 24 hours prior to removal to ensure the pneumothorax does not recur.

Procedure:

- Verify written medical orders for removal
- Two staff members are required to perform the procedure of removal of the ICC, one to remove the drain and one to tie the purse string or mattress suture or in the absence of either suture, to apply an occlusive dressing (only perform if within scope of practice and according to local hospital policy)
- Analgesia should be administered prior to the procedure and given time to take effect
- Full explanation regarding breathing technique on removal should be given to the patient to ensure co-operation and reduce the risk of complications (see Valsavla Maneuver below)
- Check for air leakage in the water seal chamber of the UWSD system by asking the patient to cough. If an air leak is detected notify the medical officer before proceeding to remove
- Ensure that the purse string suture is viable before removable otherwise a second purse string suture may be inserted by the doctor. *Please check local protocol regarding the removal of the ICC and who is permitted to perform*.

Valsalva Maneuver

One of the main complications associated with removal of ICC's is a recurrent pneumothorax caused by movement of atmospheric air into the pleural cavity. This is more likely to occur if the patient breaths **in** while the ICC is removed. The Valsalva Maneuver was created in an effort to equalize intrapulmonary and atmospheric pressure. This maneuver is performed by breathing out against a closed glottis i.e.: a forced expiratory effort (*strain*) against a closed airway and instruct the patient to take three deep breaths and then hold their breath while the drain is removed.

Step by step removal

- Following analgesia, explanation and practicing of the valsalva maneuver, the patient is placed in a comfortable position (this may be leaning over a bed side table slightly tilted to the unaffected side. Ensure access to the ICC insertion site is achievable by both nurses/medical staff performing removal)
- Ensure the medical team are onsite and aware that removal of the ICC is about to occur
- The old dressing is removed, the site is cleaned and an airtight dressing is prepared
- Remove skin suture with suture cutter, ensuring the purse string suture remains intact
- Ensure ICC is clamped. Instruct patient to perform valsalva maneuvre. At same time, smoothly remove ICC while the second person pulls the purse string or mattress suture closed

- Avoid the attempt at removal if extreme resistance on the ICC is felt
- Apply an occlusive dressing, monitor patient's respiratory status closely following removal
- A chest X-ray should be ordered post removal to ensure that removal has not caused a pneumothorax
- Should air be heard escaping from the site, apply a three-sided dressing and generate MET Call (development of a pneumothorax caused by removal of the ICC) if available, otherwise notify medical officer immediately.
- The nurse is also required to observe the wound closure site for signs of bleeding (initially) and ongoing symptoms of infection. If the purse string suture is tied to tightly there is a potential for tissue necrosis, thus direct visual observation of the wound post removal is required. The purse string suture may be removed from 4-7 days dependant on physician request

COMPLETE SHORT ANSWER AND MULTIPLE-CHOICE QUESTIONS FOR PART THREE AND SUBMIT TO YOUR NURSE EDUCATOR ALONG WITH YOUR EVALUATION FORM

ORGANISE WITH YOUR NURSE EDUCATOR TO PERFORM THE CLINICAL COMPETENCY REGARDING DEMONSTRATION OF THE ABILITY TO ASSESS AND MANAGE A PATIENT WITH AN UWSD SYSTEM

ON SUCCESSFUL COMPLETION, YOU SHALL BE AWARDED A CERTIFICATE

REFERENCES

Alfred Health Guideline: Nursing management of chest drains and chest drainage systems (2019) accessed March 2023 PROMPT

Anderson, D. et al 2022 Comprehensive Review of chest tube management JAMA Comprehensive Review of Chest Tube Management: A Review | Cardiothoracic Surgery | JAMA Surgery | JAMA Network

Allibone, Liz. (2005) Principles for inserting and managing chest drains. *Nursing Times. 18 October 2005 Vol 101 No 42.pp45-49*

Atrium Oasis Dry Suction Water Seal Chest Drain (getinge.com)

Argyle™ Thora-Seal™ III Chest Drainage Unit (cardinalhealth.com.au)

Carroll, Patricia RN, C, CEN, RRT. Managing Chest Tubes: what is based on research, and what is not? *RN. Volume 58 (12), December 1995, pp46-56* Sourced from: www.http:/ovidsp.tx.ovid.com/spb/ovidweb.cgi?&S

Davis,C.P, (2022) Pleural Effusion article Sourced at Pleural Effusion Treatment, Causes, Symptoms & Prognosis (medicinenet.com)

Tortora, G. Nielsen, M. (2020) Principles of Anatomy and Physiology, 15th Ed. John Wiley and Sons

How to remove a chest tube. Retrieved from: http://www.youtube.com/watch?v=Cs_-eSoSX7g

http://www.cssolutions.biz/cts.html

Heimgartner, N (2021) Clinical Companion for Medical-Surgical Nursing 10th edition pp85-167 Elsiever Missouri

Insertion of Pleural Drain via Seldinger Technique video | Agency for Clinical Innovation (nsw.gov.au)

JBI Database of Systematic Reviews and Implementation Reports. 12(4):135-179, 2014. The clinical effectiveness of suction versus water seal for optimal management of pleural chest tubes in adult patients: a systematic review. 2014

Kas, Peter. Chest tube insertion on resus.com.au. Retrieved from http://www.youtube.com/watch?v=B0wGmWn8Ubs

Latrobe Regional Hospital Intercostal Catheters Insertion and Management, and Underwater Seal Drainage (UWSD) Management Protocol - Clinical/Departmental Guideline (2021) accessed March 2023 PROMPT

Lippincott Procedures - Chest tube drainage system monitoring and care, AU (lww.com)

National Lung Health Education Program (2022) Frontline Assessment of Common Pulmonary Presentations. Monograph. Frontline Series Sourced from: https://nlhep.org/?page_id=47

Pleural drains in adults: a consensus guide (nsw.gov.au)

Pleural Effusion - Pleural Conditions (brainkart.com)

Pleur-evac Understanding Chest Drainage, 2023. Teleflex Medical, USA. Product handbook Pleur-evac® | US | Teleflex

Pleurodesis - StatPearls - NCBI Bookshelf (nih.gov)

Clinical Guidelines (Nursing) : Chest drain management (rch.org.au)

Shelly P. Nascimiento, B. Simone, C. Chien, V. Chest tube insertion (2007)
` *The New England Journal of Medicine. 357;15.October 11, 2007.*
Sourced from: www.NEJMORG search Chest tubes

Swan Hill District Health Clinical Procedure: Insertion Management and Removal of ICC and use of underwater seal drainage (UWSD) and Heimlich valve procedure (2020) accessed March 2023 PROMPT

The respiratory system - ClinicalKey for Nursing

Understanding Pneumothorax. *Nursing 2002, Volume 32, Number 11, page 74-75*
Sourced from: www.nursingcentre.com

Urden, L. Stacy, K. (2021) Critical Care Nursing: Diagnosis and Management 9th ed Mosby Inc St Louis Missouri

Weigand, Debra.L,(2017) AACN Procedure Manual for High Acuity, Progressive, and Critical Care, Seventh Edition Elsiever

Zisis et al (2015) Chest Drainage Systems in Use
Chest drainage systems in use - Zisis - Annals of Translational Medicine (amegroups.com)

UWSD QUESTIONS: PART THREE

NAME: ______________________________ **DEPARTMENT:** ________________

1. What are the other references to tidaling commonly used and what does tidaling reflect in the UWSD unit?

____

____

____

____

2. What does bubbling reflect? What is normal to see in the UWSD system if the system is functioning properly and the patient continues to have an air leak (i.e. continues to have a pneumothorax)?

____

____

____

____

3. A patient has continuous bubbling in the UWSD system as seen in the water seal. How do you check for an air leak? What indications would there be if the air leak was from:

   a. around the insertion site
   b. the connections in the tubing?

____

____

____

____

____

____

____

____

4. Why is it important that the tubing of the UWSD system be free of dependant loops?

____

____

____

____

5. A) Who orders the application and removal of suction?
B) Can the nurse turn the suction up if the UWSD system is indicating that there is not enough suction?
C) How do you assess tidaling and bubbling when the suction is operational?

____

____

____

____

____

____

____

MULTIPLE CHOICE QUESTIONS

1. Mr. Jones who has an UWSD unit system functioning, has started to complain of increased SOB and pain on inspiration radiating to his left shoulder. What could this indicate?

    a. Kinking in the tubing
    b. Dislodgement of the ICC
    c. A clot in the ICC
    d. A clot in the tubing of the UWSD
    e. All of the above

2. The main reasons for malfunction of an UWSD system include:

    a. Large amounts of air leaking into the pleural space or into the drainage apparatus
    b. Occlusion from the pleural cavity down to the UWSD system
    c. Problems with the suction source
    d. All of the above

3. You observe minimal tidaling in the water seal of the UWSD system and the absence of bubbling at the end of exhalation. The patient is asymptomatic. What could this indicate?

    a. The unit is not functioning correctly
    b. The pneumothorax has resolved
    c. The pneumothorax has not resolved
    d. Both a and c

4. You find the UWSD tipped over on the floor by the patient's bed side and notice that some of the water from the water seal has travelled into the drainage collection chambers. What do you do?

    a. Stand it back up quickly and make sure the stand in the unit has been set up correctly
    b. Stand it back up quickly, observe the patient and secure to the top of the cot side on the bed
    c. Stand it back up quickly making sure the stand is operational, correct the water seal with sterile H20 and observe the patient
    d. Stand it back up quickly and prepare to set up a new UWSD unit whilst clamping the ICC at the insertion site and end of the catheter

5. The physician is doing his morning round. He is assessing your patient who has an UWSD system connected to an ICC. There has been no bubbling in the last 6 hours and very minimal tidaling. The patient is asymptomatic. Suction has not been required. He asks the patient to cough while he observes the UWSD system. What is the main reason he would do so?

    a. To see if the patient is performing his chest physiotherapy correctly
    b. To see if there is any air left in the pleural cavity
    c. To make sure his pain relief is effective
    d. To make sure it is alright for him to have a shower

6. As the nurse looking after the patient with a functioning UWSD system, education for the patient includes:

   a. The purpose of the specific tube(s)
   b. The importance of not pulling/kinking the tube
   c. Importance of adequate pain relief
   d. How to manage the tube e.g.; showering, dressing
   e. All of the above

7. You are about to remove an ICC. In order of importance, what would you ensure *first*?

   a. That the ICC has been clamped
   b. That the lung has fully inflated on Chest X-Ray
   c. There are documented orders to remove
   d. That the patient is neurologically alert

8. Clamping on an ICC should be avoided except:

   1. When the patient requires to travel to the X-Ray department
   2. When the patient is having a shower
   3. When changing the UWSD system
   4. When the physician orders you to do so

   a. 1 and 3
   b. 2 and 4
   c. 2 and 3
   d. 3 and 4

9. You find your patient in respiratory distress, confused and observe that she has pulled out her ICC. What would you do?

   a. Generate a MET call (or call Medical Officer) and run to greet the team or doctor
   b. Generate a MET call (or call Medical Officer) and apply an occlusive dressing
   c. Generate a MET call (or call Medical officer) and apply a three sided occlusive dressing
   d. Generate a MET call (or call Medical officer) and stick your finger in the insertion site

10. Prior to removal of an ICC, it is MOST important to:

   a. Provide analgesia and educate the patient
   b. Ensure there is documented instructions to remove
   c. Allow the patient to shower prior
   d. Ensure the suction has been turned off at the suction source

CLINICAL SKILLS COMPETENCY - UNDERWATER SEAL DRAINAGE

NAME:________________________________ **DATE:**______________

DEMONSTRATES: The ability to assess and manage an underwater seal drainage system. Competency will be assessed by either direct observation or verbalisation **It is an expectation of the clinician being assessed to be familiar with local policy and protocols and performs within these guidelines**	**CRITERIA** **C** = Competent **S** = Requires supervision **D** = Requires development		
PERFORMANCE CRITERIA	**C**	**S**	**D**
1. Identifies indications for UWSD			
2. Demonstrates the guiding principles of positive patient identification – inclusive of the 3 patient identifiers			
3. Explains procedure to patient and gains patient consent			
4. Identifies equipment required at the bedside of a patient with an UWSD.			
5. Provides privacy			
6. Undertakes a respiratory assessment: • Color • Respiratory rate • Unequal chest movement • Oxygen saturation			
7. Undertakes cardiovascular assessment: a) Heart rate b) Blood pressure			
8. Provides patient with education on care of UWSD a) tube is sutured into place but avoid tugging on it b) not to kink or lie on tube c) encourage patient to be mobile but to keep the UWSD system below the level of the chest d) drainage to be expected e) fluctuations in fluid level and bubbling to be expected f) deep breathing and coughing exercises			
9. Observes UWSD for: a) kinks or dependent loops b) system is located below the level of the chest c) connections are securely taped lengthwise and the connection is visible d) dressing for drainage and intactness e) Maintains level of water seal at 2cm f) Maintains level of water in suction control bottle, as			

ordered (if applicable)			
10. If patient has UWSD function only, ensures that the suction port is open to atmosphere			
11. Maintains suction from wall at a steady gentle bubbling (if applicable)			
12. Checks and documents hourly: a) Bubbling b) Tidaling (swinging/oscillation) c) Fluid drainage amount			
13. Verbalises what bubbling demonstrates. If no bubbling/tidaling, checks for tube kinking, obstruction of vent or suction stopcock, encourages patient to cough or move, notifies nurse in charge			
14. If continuous bubbling, checks connections, dressing, notifies nurse in charge			
15. Verbalises that would not clamp longer than one minute if necessary			
16. Identifies criteria for removal of UWSD			
17. Leaves patient comfortable			
18. Documents findings appropriately			
19. Demonstrates correct hand hygiene techniques throughout procedure			
20. Demonstrates correct aseptic technique			
21. Demonstrates correct standard and transmission-based precautions, inclusive of donning/doffing PPE			

COMMENTS____
____
____
____

COMPETENT **YES**

NOT YET – REQUIRES FURTHER SUPERVISION

NOT YET – REQUIRES FURTHER DEVELOPMENT I.E. RE READING THE PACKAGE

Assessee: ______________________________

Assessor: ______________________________

CARE OF PATIENT UNDERWATER SEAL DRAINAGE

Date: __________ How long did this package take to complete? ________

Please indicate your response to each of these statements by ticking the appropriate box and return to Nurse Educator

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Overall, I found this learning package worth while	❑	❑	❑	❑	❑
2. The way in which the learning package presented made it easy to understand	❑	❑	❑	❑	❑
1. My knowledge of this topic was improved after completing this learning package	❑	❑	❑	❑	❑
2. My skills in this area have been enhanced since completing this learning package	❑	❑	❑	❑	❑
3. The resources provided were sufficient for me to answer the test adequately	❑	❑	❑	❑	❑
4. I would recommend this learning package to others	❑	❑	❑	❑	❑
5. I will be able to apply knowledge and skills acquired in my clinical practice	❑	❑	❑	❑	❑

Comments (Optional)

____

____

____

__________ ____

____

Thank you for taking the time to complete this evaluation. Your comments are valued and appreciated. Please return this form to your Nurse Educator