Online Appendix 8 How to set up a chest drain bottle/underwater seal drain

A chest drain should be connected to a drainage system that includes a valve mechanism to prevent air from entering the pleural cavity. The most common is the underwater seal bottle. The closed underwater seal bottle is a system in which a tube is placed under water at a depth of approximately 3 cm with a side vent which allows the escape of air or connection to a suction pump.[1]

Equipment

The equipment and tray set up needed for a chest drain bottle/underwater seal drain is shown in Box 1 and Figure 1 respectively.

Box 1: Equipment needed for a for a chest drain bottle/underwater seal drain
Sterile gloves and apron
Drain tubing
3 way tap and fir tree to luer tubing connector (if Seldinger drain)
2 clamps
Closed drainage system (sterile water if underwater seal drain)
Clinical waste bag

Figure 1: Tray set up for chest drain bottle/underwater seal drain

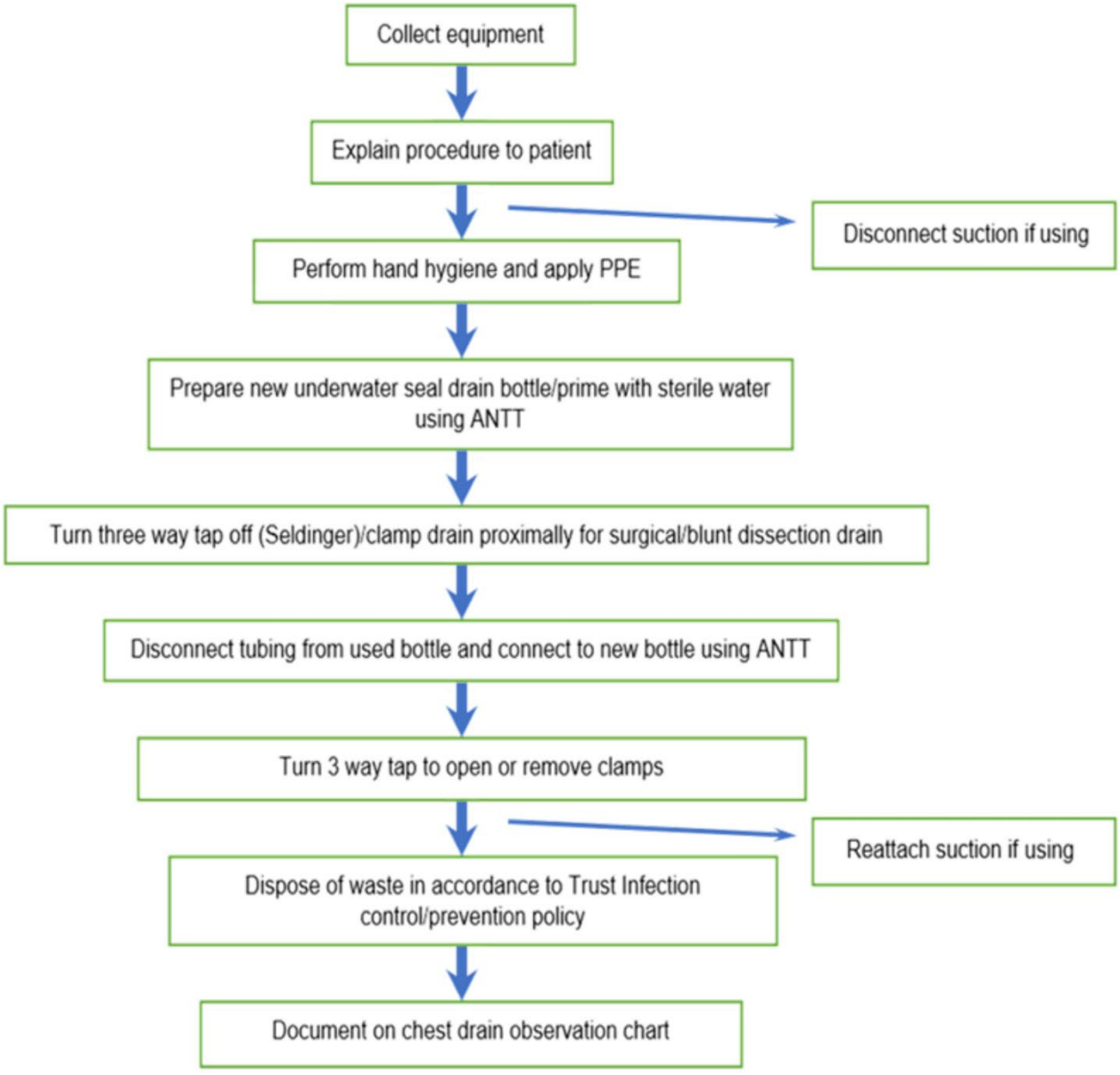
Procedure

The drain bottle is prepared using an aseptic non touch technique (ANTT). The chest drain bottle is filled with sterile water to the underwater seal line (the line is marked as zero and will take about 500 ml of water, or to the 2 cm line in an Atrium bottle). The drain tubing is connected to the chest drain bottle and the 3-way tap connected to the chest tube for a Seldinger drain. Suction may then be applied if required. The drainage bottle may be replaced when it is half full and should be replaced if the underwater seal drainage systems sterility has been compromised (see Box 2).

All connections between the chest tube and the drainage bottle should be tight and secure. The tubing can be anchored to the patients' skin using an omental tape technique to prevent pulling of the drain which could

result in drain dislodgement. The bottle should be securely positioned either on its stand, hanging on the bedside or on the floor. The collection chamber should be kept below the drain insertion site at all times to prevent retrograde flow of fluid back into the pleural space. The tubing should have no kinks or blockages that may inhibit drainage.

Box 2: Summary of process to change an underwater seal drain/chest drain bottle



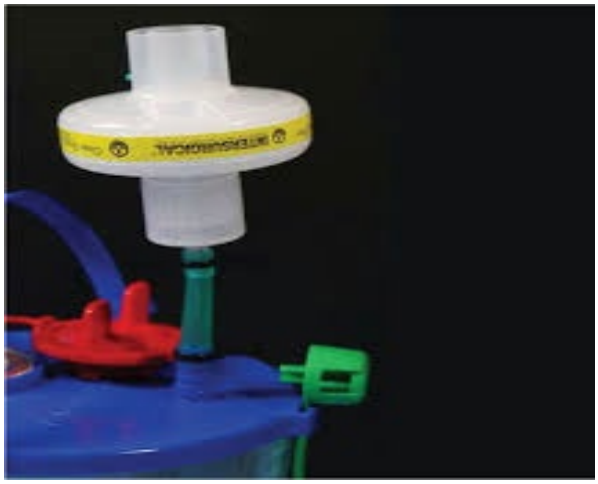
Connecting an antiviral filter

Although unclear if pleural procedures are aerosol generating, to mitigate the risk, patients with a confirmed or suspected aerosol-transmissible condition such as COVID-19 with a chest drain and air leak, should be considered for strategies to minimise droplet exposure via the chest drain circuit (Akhtar et al 2020). This can be achieved by connecting the chest drain bottle to wall suction at a low level to create a closed system (e.g. 5 cm H_20), using a digital chest drain system, or attaching a viral filter onto the suction port of the underwater seal drain bottle (Figure 2).

The equipment needed to connect an antiviral filter to an underwater seal vent is shown in Box 3.

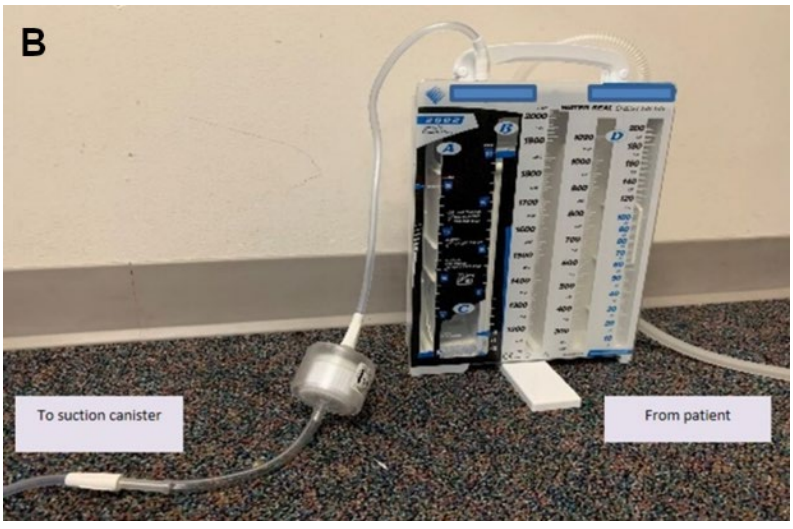
Box 3: Equipment needed to connect an antiviral filter to an underwater seal vent
Cable ties
Antiviral filter
Straight connector 22F to 6 mm oxygen stem
Oxygen tubing

Figure 2: Viral filter applied to underwater seal vent



Alternatively, a connector gasket and viral filter may be attached to the air vent on the underwater seal drainage bottle if available (Figure 3).

Figure 3: Connector gasket and viral filter (A) attached to the air vent on the underwater seal drainage bottle (B)



A dedicated chest drain observation chart should incorporate the good practice points outlined in the ARNS Good Practice Standards for Controlled Removal of Fluid from Chest Drains (Adults) 2020.[2] This should include clear instruction on the frequency of observation; including continuous direct observation for the first 15 minutes, red flag triggers for drain closure and local escalation procedure for patient deterioration before, during and after chest drain insertion.[3] For drains inserted for fluid the volume drained and nature of the fluid should be recorded. A change in colour of the fluid for example from serous to creamy or turbid could suggest the development of pleural infection or empyema requiring antibiotic or surgical intervention. Similarly, a change from haemoserous fluid to bright red fluid could indicate pleural haemorrhage requiring closer monitoring and urgent management. Recording the volume of fluid drained aids decision making regarding drain removal or optimum time for performing a pleurodesis.

Potential complications

Clamping a chest drain with continuing air leak could lead to the potentially life-threatening complication of tension pneumothorax and should be avoided, unless under specialist pleural supervision in particular circumstances.

Large pleural effusions should be drained in a controlled manner to reduce the risk of re-expansion pulmonary oedema. The recommended standard approach is to stop draining at 1000 ml by closing the three way tap, or at any point earlier if the patient develops any of the key red flags/triggers below:

- Severe pain or chest discomfort
- Persistent cough, worsening breathlessness, or vagal symptoms
- A deteriorating early warning score

Drainage can be restarted after 1 hour, allowing up to 500 ml per hour to drain before allowing free drainage.[2]

Troubleshooting

Absence of swing	Fluid within the tubing should swing with respiration due to changes in intrapleural pressure. The presence of swinging in the tubing indicates that the drain is patent and functioning. The absence of swing could indicate that the lung has re-expanded. However unexpected cessation of swinging may indicate that the drain is occluded, kinked or no longer in the pleural space. • The drain, tubing and underwater seal chamber should be examined to ensure the drain has not fallen out or become dislodged. Assess for possible surgical emphysema. • Check the tubing and drain are not twisted, kinked or blocked and that the drain bottle is not full. • If the drain is attached to suction, ensure all connections are functioning. • If there is no obvious external problem flush the drain. • It may be necessary following clinical assessment and unsuccessful flushing of the drain to request an X-ray to determine the underlying cause.
Drain is dislodged/partially out of the chest wall	• Check patients NEWS. • Assess for surgical emphysema. • Check LoCSSIPs information which should document the depth of insertion. • May require a CXR, removal and possible replacement dependent on CXR review.

Excessive bubbling	Bubbling in the underwater seal chamber generally suggests a continued visceral-pleural air leak. Persistent bubbling throughout the respiratory cycle may indicate a continuing broncho-pleural air leak, faulty connections, entrained air through the skin incision or a dislodged drain whereby the drain is partly out of the thorax and one of its holes is open to the atmosphere (it should be noted that thoracic suction may increase bubbling). • The drain should be checked for disconnection, dislodgement and loose connections and the patient for evidence of surgical emphysema. • If the drain has become dislodged it may require removal and replacement if pneumothorax persists.
Disconnected tubing	• In the event that the tubing becomes disconnected, in an emergency situation it may be necessary to reconnect the tubing immediately (e.g. if the drain was bubbling right up to the moment of disconnection). • In all other situations the drain should be clamped or turned off at the 3 way tap, the end of the drain/fir tree connector is cleaned and new sterile tubing is attached before re-opening the 3 way tap/removing the clamp.
Chest drain bottle knocked over	• If a chest drain bottle is accidently knocked over it should be returned to an upright position immediately ensuring the fluid level in the chamber still reaches the 'zero' mark. • If there is not enough water in the chamber it should be replaced. • If the patient is well and the drain continues to function no further action is required.
Drain has 'fallen' out	• Cover the drain site with an adhesive, occlusive dressing (may require 'steristrips' or suturing to aid wound closure if a surgical drain). • Check patients NEWS. • Assess for possible surgical emphysema. • Note if any sign of infection at drain site, swab if necessary. • Ensure the drain is complete/not fractured with possible remnant in pleural cavity. • Request CXR to determine whether a replacement drain is needed and the urgency of this.

Waste disposal

After changing a chest drain bottle/underwater seal drain all items should be taken to the dirty utility on the clinical trolley and disposed of in accordance with local Trust Infection, control and prevention policies. If available a solidifying agent may be added to the pleural fluid in the bottle and once solid, double bagged with two orange clinical waste bags for contaminated waste and put in the clinical waste bin. If a solidifying agent is not available ensure the bottle is sealed as per individual manufacturer recommendations, double bag with two orange clinical waste bags and place in clinical waste bin.

Clinical practice points

- Chest drains should be managed on wards familiar with chest drains and their management.

- ANTT should be employed when changing a chest drain bottle/underwater seal drain or drain tubing.
- The drain bottle must be kept below the insertion site at all times.
- The drain must be kept upright at all times.
- The drain must have adequate water in the system to cover the end of the tube.
- For patients with pneumothorax and suspected/confirmed COVID-19, a viral filter should be considered to minimise the risk of droplet exposure via the chest drain circuit.
- Drains should be checked daily for wound infection, fluid drainage volumes and the presence of respiratory swinging and/or bubbling should be documented on a dedicated chest drain observation chart.
- Clamping a bubbling chest tube should be avoided unless under specialist pleural supervision and in specific circumstances only.
- Instructions related to chest drain clamping/rate of fluid drainage must be given and recorded.[2,3]
- Drainage of a large pleural effusion should be controlled to prevent the potential complication of re-expansion pulmonary oedema.

References

1. Havelock T, Teoh R, Laws D, Gleeson F, Group BTSPDG. Pleural procedures and thoracic ultrasound: British Thoracic Society Pleural Disease Guideline 2010. *Thorax.* 2010;65 Suppl 2:ii61-76.
2. ARNS Good Practice Standards for Controlled Removal of Fluid from Chest Drains (Adults). Available at: <https://arns.co.uk/wp-content/uploads/2020/11/Good-Practice-Standards-Rapid-Offload.pdf> [Accessed 24 May 2022].
3. Deterioration due to rapid offload of pleural effusion fluid from chest drains. National patient safety alert. Available at: <https://www.england.nhs.uk/wp-content/uploads/2020/12/NatPSA-Pleural-Effusion-FINAL-v3.pdf> [Accessed 29 April 2022].