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Nursing practices: Troubleshooting thoracostomy tube management

Abeer El-Said, Hassane El-sol
Lecturer of Medical-Surgical Nursing, Faculty of Nursing, Menoufia University, Egypt

Abstract
Thoracostomy tube is a sterile tube with a number of drainage holes that is inserted into the pleural space. The pleural space is the space between the parietal and visceral pleura, and is also known as the pleural cavity. A patient may require a chest drainage system any time the negative pressure in the pleural cavity is disrupted, resulting in respiratory distress. It is connected to a closed chest drainage system, which allows for air or fluid to be drained, and prevents air or fluid from entering the pleural space. Specific common indications for thoracostomy tubes placement; as Pneumothorax. While coagulopathy is contraindication for its placement. When the nursing team provide their care to patients with thoracostomy tube; they had five priorities, they are closely monitoring of respiratory status, checking underwater seal for bubbles, milking not strip every 2 hours, assess the output color and maintain the chest site cover with sterile occlusive dressing. The management of patient with thoracostomy tube drainage systems need to efficient nursing practice to fully understand what to do in case problems arise. Rapid management for any troubleshooting or complication as potential pneumothorax/respiratory distress, air leak, accidental chest tube removal or chest tube falls out, accidental disconnection of the drainage system, bleeding at the insertion site, drainage suddenly stops and respiratory distress increases, sudden increase in bright red drainage and subcutaneous emphysema. Nurses are responsible for the safe delivery of care so they should be skillful practices about signs and symptoms of troubleshooting thoracostomy tube and interventions for each type.

Keywords: thoracostomy tube, troubleshooting thoracostomy tube, nursing management

1. Introduction

Thoracostomy Tube (TT) or chest drain, thoracic catheter, chest tube, and intercostal drain; is a flexible plastic tube that is inserted through the chest wall and into the pleural space or mediastinum. The pleural space is the space between the parietal and visceral pleura, and is also known as the pleural cavity. A patient may require a chest drainage system any time the negative pressure in the pleural cavity is disrupted, resulting in respiratory distress. Chest tubes are commonly made from clear plastics like PVC and soft silicone [1].

Tube thoracostomy is the most commonly performed surgical procedure in thoracic surgery**.** Today, TT placement remains among the most commonly performed procedures, from bedside to operating room, from life-threatening emergencies to postoperative chest drainage in elective surgery. It is widely used throughout the medical, surgical, and critical care specialties [2].

TT may be lifesaving and facilitates evacuation (and monitoring) of hemothorax, prevents the development of tension pneumothorax while promoting lung re-expansion, tamponade low pressure pulmonary bleeding, and improves respiratory function in the injured patient. In the surgical patient, chest tubes facilitate postoperative recovery. Patients with malignancies may benefit from symptomatic relief brought about by drainage of persistent, large pleural effusions [3&4].

1.1 Thoracostomy tube: Indications.

Physiologically, a potential space exists between the parietal pleura (abutting chest wall) and the visceral pleura (abutting lung parenchyma), which normally contains less than 25 mL of pleural fluid. The presence of excess fluid, air, blood, chyle, or pus in this pleural space results in displacement of pulmonary volume, which disrupts gas exchange [4].

There are numerous reasons for excess air and/or fluid in the pleural space. Specific common indications for thoracostomy tubes placement include:

- Pneumothorax: accumulation of air or gas in the pleural space.
- Symptomatic Pleural effusion: accumulation of fluid in the pleural space
- Chylothorax: a collection of lymphatic fluid in the pleural space
- Empyema: a pyogenic infection of the pleural space
- Hemothorax: accumulation of blood in the pleural space
- Hydrothorax: accumulation of serous fluid in the pleural space
- Penetrating chest trauma.
- Severe blunt chest trauma.
- Broncho-pleural fistula: an abnormal communication between a bronchus and the pleural cavity [5].

Other indications include

- Postoperative use in thoracic/cardiac surgery; and Complicated Para pneumonic effusion or empyema to drain blood associated with the surgery.
- Chemical pleurodesis for benign and malignant conditions: Pleurodesis is a procedure used to treat patients with recurrent pleural effusions or recurrent

pneumothorax. This procedure involves administering a sclerosing agent into the pleural space which causes the visceral and parietal pleura to adhere to each other without the thin coating of fluid between them.
- Chemotherapy administration: May be administered through a chest tube [5, & 6].

1.2 Thoracostomy tube: Contraindications
The need for emergent thoracotomy is an absolute contraindication to tube thoracostomy.
Relative contraindications include the following:
- Coagulopathy
- Pulmonary bullae
- Pulmonary, pleural, or thoracic adhesions
- Pulmonary abscess
- Skin infection at the chest tube insertion site [5&7].

1.3 Characteristics of tube thoracostomy
Thoracostomy tubes are commonly made from clear plastics like PVC and soft silicone. Chest tubes are made in a range of sizes measured by their external diameter from 6 Fr to 40 Fr. Chest tubes, like most catheters, are measured in French catheter scale. Chest tubes are also provided in right angle, trocar, flared, and tapered configurations for different drainage need [8].
As well, some chest tubes are coated with heparin to help prevent thrombus formation, though the effect of this is disputed**.** Chest tube has an end hole (proximal, toward the patient) and a series of side holes. The number of side holes is generally 6 on most chest tubes. The length of tube that has side holes is the effective drainage length (EDL). In chest tubes designed for pediatric heart surgery, the EDL is shorter, generally by only having 4 side holes [9].
Channel style chest drains, also called Blake drains, are so-called silastic drains made of silicone and feature open flutes that reside inside the patient. Drainage is thought to be achieved by capillary action, allowing the fluids to travel through the open grooves into a closed cross section, which contains the fluid and allows it to be suctioned through the tube. Though these chest tubes are more expensive than conventional ones, they are theoretically less painful [10].

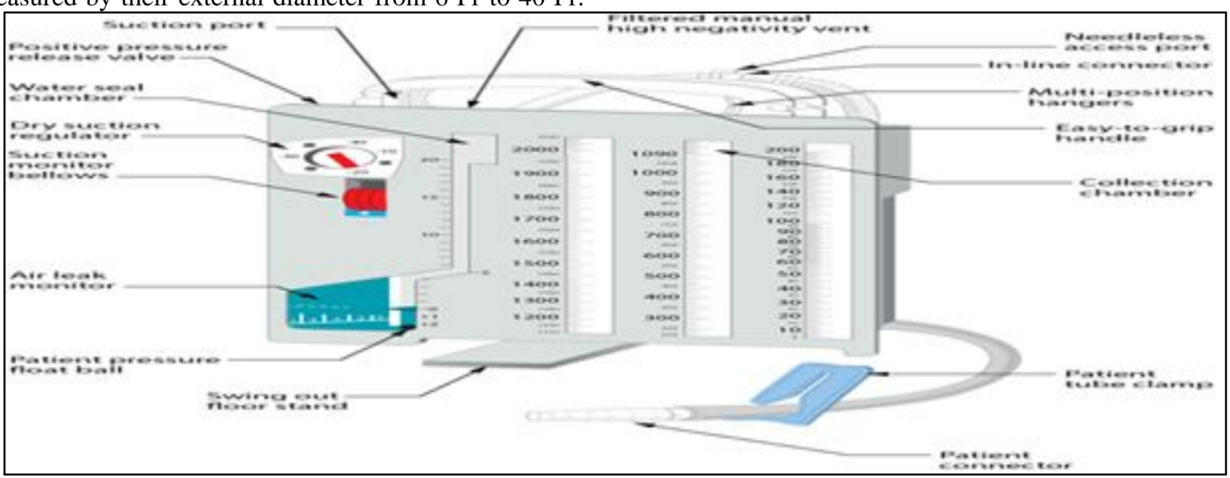


Fig 1: TT with labeled parts [11].

1.4 Thoracostomy tube drainage holes
A chest tube drainage system; is a sterile, disposable system that consists of a compartment system that has a one-way valve, with one or multiple chambers, to remove air or fluid and prevent return of the air or fluid back into the patient. In general, a traditional chest tube drainage system will have these three chambers**:**
Collection or drainage chamber: The chest tube connects directly to the collection chamber, which collects drainage from the pleural cavity [12].
Water-seal chamber: This chamber has a one-way valve that allows air to exit the pleural cavity during exhalation but does not allow it to re-enter during inhalation due to the pressure in the chamber. The water-seal chamber must be filled with sterile water and maintained at the 2 cm mark to ensure proper operation, and should be checked regularly [13].
Wet or dry suction control chamber: Not all patients require suction. If a patient is ordered suction, a wet suction system is typically controlled by the level of water in the suction control chamber and is typically set at -20 cm on the suction control chamber for adults. Monitor the fluid level to ensure there is gentle bubbling in the chamber. A dry suction system uses a self-controlled regulator that adjusts the amount of suction and responds to air leaks to deliver consistent suction for the patient. If suction is discontinued, the suction port on the chest drainage system must remain unobstructed and open to air to allow air to exit and minimize the development of a tension pneumothorax [13].

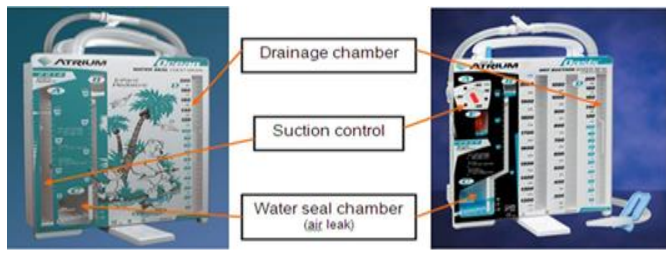


Fig 2: Thoracostomy tube system [11].

1.5 Process of chest tube placement
Selecting appropriate tube sizes [5].
It is significant for the clinician to select the best proper tube

size according to patient's age before tube insertion. As, obvious in the following table:

Table 1: The best proper tube size according to the patient's age.

Patient's age.	Thoracostomy tube size
Newborn	8 FR–12 FR
Child	18 Fr
Adult male	28–32 Fr
Adult female	28 Fr
Larger adult sizes	36 FR–40 FR

Table 2: Equipment for tube thoracostomy [14].

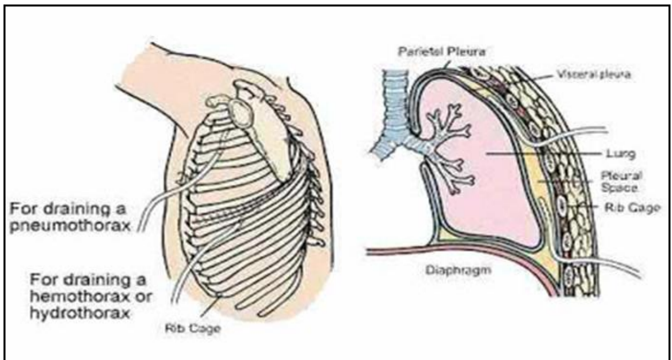
❖ Sterile gown and gloves
❖ Antiseptic solution, i.e. Providone-iodine or Chlorhexidine
❖ Sterile drapes
❖ Local anesthesia, e.g. 1% or 2% lidocaine
❖ Syringes and needles
❖ Scalpel and blade
❖ Suture, e.g. 1/0 or 2/0 silk
❖ Forceps (round tipped) or Kelly clamp for blunt dissection
❖ Chest drain Closed drainage system with connecting tubing (sterile water if underwater seal used)
❖ Guide-wire and dilators for Seldinger drains
❖ Formal 'cut down' theatre instrument set

Preparation: The nurse obtaining informed consent, shaving any hair from the insertion site, if necessary, disinfection e a large area on the affected chest side, from the armpit down to the abdomen and across to nipple. Preparation involves sterilizing the area and. Use an ultrasound to identify a good location for inserting the tube [15].

Anesthesia: The doctor may inject an anesthetic into patient skin. The medication will help make more comfortable during the chest tube insertion, which can be painful [16].

Incision: By a scalpel, doctor will make a small (¼- to 1 ½-inch) incision between ribs, near the upper part of the patient chest. The incision site depends on the reason for the chest tube [17].

Patient position and insertion: Patient positioning depends on the insertion site, and the patient's clinical status. Usually, the patient is flat, with a small sterile folded towels or a blanket placed under the patient shoulder. Commonly, a chest tube is inserted at the mid-axillary line between the fourth and fifth ribs on a line lateral to the nipple [5]. If the chest drainage tube is to be used to drain air, the tube is placed at second intercostal space. If the tube is to drain fluid, the tube is placed posteriorly near at fifth or sixth intercostal space Figure (3&4). In the hemothorax; it may be placed at the base of the lung as well as at the apex [18].



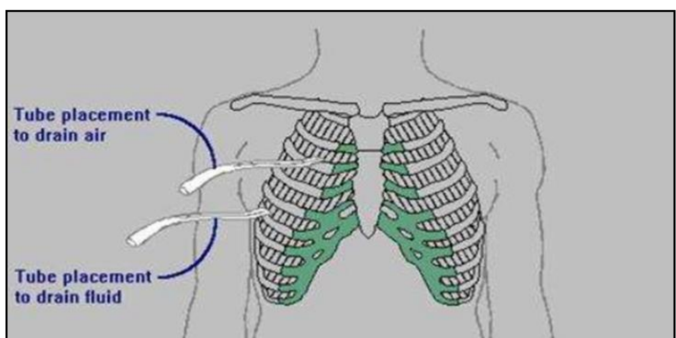


Fig (3&4): common sites of chest tube insertion [11].

Doctor will then gently open a space into the chest cavity and guide the tube into a chest. Chest tubes come in various sizes for different conditions. The doctor will stitch the chest tube in place to prevent it from moving. After chest-tube insertion, connect the tube's distal end to the chest drainage system. Secure the tube at the insertion site with sutures. The nurse apply an occlusive sterile petroleum gauze dressing around the tube; then apply a dry, sterile split 4x 4 dressing over everything. Secure all tube connections from the chest tube to the drainage container, using either tape or zip ties [12&15].

Drainage: The tube is then attached to a special one-way drainage system that allows air or fluid to flow out only. This prevents the fluid or air from flowing back into the chest cavity. While the chest tube is in, patient will probably need to stay in the hospital. Once the drain is in place, a chest radiograph will be taken to check the location of the drain. A nurse will monitor patient breathing and check for possible air leaks [15&17].

Stayment Length: the chest tube is left in depends on the condition that caused the buildup of air or fluid. Some lung cancers can cause fluid to re-accumulate. Doctors may leave the tubes in for a longer period of time in these cases [17].

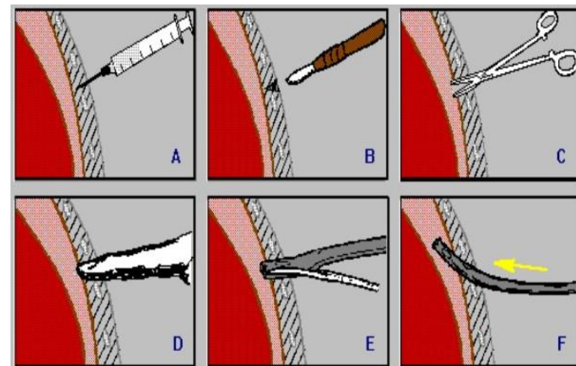


Fig 5: Steps of thoracostomy tube insertion [11].

1.6 Safety considerations

- Nurses often assist physicians in the insertion and removal of a closed chest tube drainage system.
- After initial insertion of a chest tube drainage system, assess the patient every 15 minutes to 1 hour. If the patient is stable (vital signs within normal limits; drainage amount, color, or consistency is within normal limits; the

patient is not experiencing any respiratory distress or pain), assessment may be completed every 4 hours [12&13].

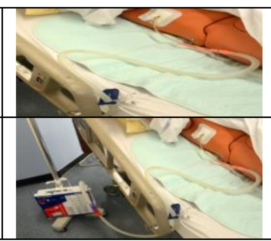
- Prior to managing a patient with a chest tube, review reason for the chest tube, the location of the chest tube, normal volume of drainage, characteristics of the drainage, date of last dressing change, and any previously recorded air leaks measurements [18].
- Safety/emergency equipment must always be at the patient's bedside. Safety equipment includes:
  - Two guarded clamps
  - Sterile water
  - Vaseline gauze (Jelonet)
  - 4 x 4 sterile dressing
  - Waterproof tape
- *Never* clamp a chest tube without a doctor's order or valid reason.
- Chest tube drainage systems are replaced only when the collection chamber is full or the system is contaminated [19].

1.7 Nursing considerations

- Do not strip or milk the chest tube: In practice, stripping is used to describe compressing the chest tube with the thumb or forefinger and, with the other hand, using a pulling motion down the remainder of the tube away from the insertion site. Milking refers to techniques such as squeezing, kneading, or twisting the tube to create bursts of suction to move clots. Any aggressive manipulation (compressing the tube to dislodge blood clots) can generate extreme pressures in the chest tube. There is no evidence showing the benefit of stripping or milking a chest tube [12, 13&19].
- The only exceptions to clamping a chest tube are 1) if the drainage system is being changed, 2) if assessing the system for an air leak, 3) if the chest tube becomes disconnected from the chest drainage system — the chest tube should not be clamped for more than a few minutes, or 4) if the condition of the patient is resolved and the chest tube is ready for removal (as per physician orders) [20].

Fig 6: Thoracostomy or chest tube: Nursing priorities [11].

Table 3: Nursing care for thoracostomy tube patients [12 & 18].

1-Review the patient chart for the reason for the chest tube and location and insertion date.	
2-Explain assessment process to patient. Create privacy to assess the patient and drainage system.	
3. Complete respiratory assessment, ensure patient has minimal pain, and measure vital signs. Place patient in semi-Fowler's position for easier breathing.	
4. Assess chest tube insertion site to ensure sterile dressing is dry and intact. Check insertion site for subcutaneous emphysema	
5. Maintain a closed system. Ensure all connections are taped and secured according to agency policy.	
6. Ensure tubing is not kinked or bent under the patient or in the bed rails, or compressed by the bed.	
7. Collection chamber (drainage system) is below the level of the chest and secured to prevent it from being accidentally knocked over.	
8. Periodically check water-seal chamber to ensure water level is to the dotted line (2 cm) — at least once every shift. Add water as necessary.	
9. Check water-seal chamber for tidaling (water moving up and down) with respirations. Gentle bubbling is normal as the lungs expand.	
10. Ensure suction control dial is set to ordered level (usually 20 cm).	
11. If suction is ordered, a "float" (or equivalent) must be visible clearly in the window.	
12. If suction is *not* ordered, ensure the suction port is left open to air. Suction window will appear blank if suction is not in use or not working.	

13. In wet suction systems, expect gentle bubbling in the chamber.	
14. Assess air leak meter to determine progress of patient's internal air level, measured as level 1 to 7. On every shift, document the level of air leak, and if the air leak occurs at rest or with coughing.	
15. Check that the clamp is open.	
16. Measure date and time, and the amount of drainage, and mark on the outside of the chamber. Record amount and characteristics of the drainage on the fluid balance sheet and patient chart.	
17. Encourage frequent position changes as well as deep-breathing and coughing exercises	
18. The following should be documented and assessed according to agency policy: ▪ Presence of air leaks ▪ Fluctuation of water in water-seal chamber ▪ Amount of suction ▪ Amount of drainage and type ▪ Presence of crepitus (subcutaneous emphysema) ▪ Breath sounds ▪ Patient comfort level or pain level ▪ Appearance of insertion site and/or dressing	

Table 4: Potential Troubleshooting and nursing management related to thoracostomy tube drainage systems [21, 22, 23 &24].

Troubleshooting	Nursing management
1-Potential pneumothorax /respiratory distress	▪ This is the primary concern for a patient with a chest tube drainage system. Signs and symptoms include decreased SaO_2, increased work of breathing (WOB), diminished breath sounds, and decreased chest movement, complaints of chest pain, tachycardia or bradycardia, hypotension. ▪ Notify the doctor. ▪ Request urgent chest X-ray. ▪ Ensure drain system is intact with no leaks or blockages such as kinks or clamps. ▪ Apply oxygen and take vital signs.
2- Air leak	▪ An air leak may occur from the chest tube insertion site or the drainage system. Do the following to test the system for the site of an air leak: ▪ Using a booted (or padded) clamp, begin at the dressing and clamp the drainage tubing momentarily. ▪ Look at the water-seal/air leak meter chamber. Keep moving the clamp down the drainage tubing toward the chest drainage system, placing it at 20 to 30 cm intervals. Each time you clamp, check the water-seal/air leak meter chamber. ▪ When you place the clamp between the source of the air leak and the water-seal/air leak meter chamber, the bubbling will stop. If bubbling stops the first time you clamp, the air leak must be at the chest tube insertion site or the lung.
3- Accidental chest tube removal or chest tube falls out	▪ A chest tube falling out is an emergency. ▪ Immediately apply pressure to chest tube insertion site and apply sterile gauze or place sterile gauze and dry dressing over insertion site and ensure tight seal. ▪ Apply dressing when patient exhales. ▪ If patient goes into respiratory distress, call a code blue. ▪ Notify the doctor and reinsert new chest tube drainage system.
4- Accidental disconnection of the drainage system	▪ A chest tube drainage system disconnecting from the chest tube inside the patient is an emergency. ▪ Immediately clamp the tube and place the end of chest tube in sterile water or normal saline. ▪ The two ends will need to be swabbed with alcohol and reconnected.
5- Bleeding at the insertion site	▪ Bleeding may occur after insertion of the chest tube. ▪ Apply pressure to site and monitor.
6- Subcutaneous emphysema	▪ Subcutaneous emphysema is painless tracking of air underneath the subcutaneous tissue.

	▪ It may be seen in the chest wall, down limbs, around drain sites, or around the head or neck. ▪ When the skin is palpated, it feels similar to having tissue paper trapped beneath the skin. ▪ Monitor and report to physician.
7- Drainage suddenly stops and respiratory distress increases	▪ The chest tube may be clogged by a blood clot or by fluid in a dependent loop. ▪ Assess the drainage system and the patient and notify primary health care provider if required.
8- Sudden increase in bright red drainage	▪ This may indicate an active bleed. ▪ Monitor amount of drainage and vital signs, and notify the physician.

2. Conclusion

The management of patient with thoracostomy tube drainage systems need to efficient nursing practice to fully understand what to do in case problems arise. Rapid management for any troubleshooting or complication as potential pneumothorax/respiratory distress, air leak, accidental chest tube removal or chest tube falls out, accidental disconnection of the drainage system, bleeding at the insertion site, drainage suddenly stops and respiratory distress increases, sudden increase in bright red drainage and subcutaneous emphysema. Nurses are responsible for the safe delivery of care so they should be skillful practices about signs and symptoms of troubleshooting thoracostomy tube and interventions for each type.

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