

Chest-tube care: The more you know, the easier it gets

Caring for patients with chest tubes can be daunting. This article helps make it less intimidating.

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MANY NURSES find chest-tube care intimidating—but it doesn't have to be. Once you understand the basics, you can be confident when caring for patients who have chest tubes.

The practice of using a cannula to drain air or fluid from the pleural space dates back to antiquity. It's one element in the trinity of life-saving medical procedures. (The others are endotracheal intubation and venous cannulation.) Hippocrates and Celsus recorded using hollow tubes to drain loculated empyemas. By the 1800s, catheters frequently were used to drain and irrigate empyematous cavities.

It's all about negativity

A brief review of pulmonary anatomy and physiology helps you understand where chest tubes are placed and how they work. Chest tubes aren't placed in the lungs but in the pleural space—a potential rather than actual space between the parietal and visceral pleurae. The parietal (outer) pleura covers the chest wall and diaphragm. It contains a small amount (about 50 mL) of serous fluid that coats the opposing surfaces, allowing the visceral and parietal pleurae to glide over each other without friction while enabling the pleural surfaces to adhere to each other. Think of two glass plates with a

thin coating of water; when you place the second piece of glass atop the first, the two plates slide smoothly. But when you try to separate them, they stick together.

The ability to adhere creates negative pressure within the pleural space, which becomes more negative as the visceral and parietal pleurae are pulled in opposite directions during inspiration. (Picture those two glass plates.) The negative intrapleural (and thus intrapulmonary) pressure generated causes air to flow from positive (atmospheric) pressure into the lungs. Expiration increases intrapleural and intrapulmonary pressures to the point where they exceed atmospheric pressure, creating an opposite pressure differential and causing air to flow out of the lungs into the surrounding atmosphere.

A breach in pleural integrity creates a separation between the parietal and visceral pleurae, allowing

air or fluid to fill this potential space. (Using the glass-plate analogy, the two plates have become separated). The visceral pleura collapses inward along with the lungs, while the parietal pleura recoils outward along with the chest wall.

Indications for chest tubes

Chest tubes are used to treat conditions that disrupt the pleural space. The body can absorb small volumes of fluid or air over time. But larger volumes limit lung expansion, causing respiratory distress. In extreme cases, a tension pneumothorax may develop. This condition occurs when injured tissue forms a one-way valve or flap, enabling air to enter the pleural space and preventing it from escaping naturally. Seen mainly with thoracic trauma and line placement, this condition rapidly progresses to respiratory insufficiency, cardiovascular collapse, and ultimately death if unrecognized and untreated. It requires immediate live-saving treatment by inserting a needle to relieve pressure (needle thoracentesis), followed by chest-tube insertion. (See *Conditions that disrupt the pleural space.*)

Chest tubes also may be used to prevent or mitigate postoperative complications. For example, after cardiac surgery or chest trauma, one or more chest tubes may be

CE
1.6 contact
hours

LEARNING OBJECTIVES

1. Identify the purposes and functions of chest tubes.
2. Describe chest-tube insertion.
3. Discuss nursing care for patients with chest tubes.



Conditions that disrupt the pleural space

The following conditions can disrupt the pleural space and may warrant chest-tube insertion:

- **Chylothorax:** lymphatic fluid accumulation in the pleural space, as from chest trauma, an expanding tumor, or surgery within the mediastinum. Its hallmark is milky-white pleural fluid.
- **Empyema:** collection of pus within the pleural space, caused by an infection
- **Hemothorax:** presence of air and blood (hemothorax) in the pleural space
- **Hemothorax:** blood in the pleural space, as from blunt or penetrating trauma or chest surgery. A massive hemothorax occurs when blood accumulates rapidly in the chest cavity; most often, it stems from penetrating trauma that disrupts systemic vessels, although it sometimes results from blunt trauma.
- **Pleural effusion:** excessive fluid in the pleural space. Causes include left ventricular failure, pulmonary embolism, pneumonia, cancer, and conditions that impede pleural fluid drainage (such as a tumor that blocks the lymphatic system). It also may arise as a complication of surgery or fluid shifts, as in liver or renal failure.
- **Pneumothorax:** air in the pleural space, as from trauma, lung disease, invasive pulmonary procedures, forceful coughing, central-line placement, or mechanical ventilation; in some cases, pneumothorax occurs spontaneously or as a surgical complication.

inserted in the mediastinum to drain blood and prevent cardiac tamponade. In addition, chest tubes can be used to instill fluids into the pleural space, such as chemotherapy drugs or sclerosing agents to treat recurrent pleural effusions (a procedure called pleurodesis). Also, blood collected from chest tubes may be used for autotransfusion. (See *Autotransfusion: Risks, benefits, and nursing care.*)

Managing pleural-space disruptions

The overall goal of chest-tube therapy is to promote lung reexpansion, restore adequate oxygenation and ventilation, and prevent complications. For treatment of pleural-space disruptions, chest-tube therapy should focus on three primary objectives:

- removing air and fluid as promptly as possible
- preventing drained air and fluid from returning to the pleural space
- restoring negative pressure within the pleural space to reexpand the lung.

Preparing for chest-tube insertion

Depending on the urgency of the situation, the practitioner may insert a chest tube at the bedside, in the operating room, or in an interventional radiology suite. Whenever possible, informed consent should be obtained; caregivers should reinforce the benefits of the procedure (for instance, easier breathing with lung expansion).

The practitioner administers a local anesthetic, although use of a sedative/amnesic and analgesic agent or moderate sedation should be considered for patients without artificial airways. Provide supplemental oxygen and monitor the patient as you would during any invasive procedure. After chest-tube insertion, the patient may lose several hundred milliliters of blood or transudate, potentially leading to hypotension. So make sure emergency airway equipment and patent vascular access are available.

Equipment to gather

Obtain a thoracotomy tray and

one or more chest tubes (sometimes called thoracic catheters) of the appropriate size. Available in sizes ranging from infant to adult, chest tubes use the French sizing system—the larger the size, the larger the tube. Generally, larger tubes are used to drain blood and transudate, while smaller tubes are for air removal. Adults commonly require tube sizes between 24 and 40 French. Chest tubes also come in different configurations (curved or straight) and different materials (PVC or silicone) and are available with a heparin coating to reduce friction on insertion.

Set up the chest drainage unit (CDU) according to manufacturer's instructions. (See *Understanding chest drainage units.*)

Patient positioning

Patient positioning depends on the insertion site, whether air or fluid will be drained, and the patient's clinical status. Generally, the patient is positioned flat, with a small wedge or bolster (several folded towels or a blanket) placed under the shoulder blades to elevate the body and give the practitioner easier access. The arm on the procedural side must be kept out of the way; usually, it's brought over the patient's head and secured. Pendulous breasts or excessive adipose tissue may need to be secured out of the way as well.

The specific insertion site may vary with the condition being treated. Commonly, a chest tube is inserted at the midaxillary line between the fourth and fifth ribs on a line lateral to the nipple. (See *A view of chest-tube insertion.*)

Potential complications

Chest-tube insertion may cause bleeding, especially if a vessel is accidentally cut. Usually, bleeding is minor and resolves on its own, but bleeding into or around the lung may warrant surgical intervention.



Autotransfusion: Risks, benefits, and nursing care

In autotransfusion, blood lost from trauma, injury, or surgery is reinfused back to the same patient, avoiding the need to give banked donor blood. In many cases, blood for autotransfusion is obtained from chest tubes.

A massive hemothorax and certain other conditions call for blood-volume restoration. Other indications for autotransfusion include blunt or penetrating chest trauma, massive or acute blood loss with or without available homologous blood, a rare blood type, and a history of transfusion reactions. Contraindications include cancer, infection, enteric contamination, preexisting coagulopathy, preexisting liver or kidney dysfunction, and injuries older than 3 hours.

The table below lists the benefits and risks of autotransfusion.

Benefits	Risks
Immediate blood supply available for transfusion	Sepsis from handling of autotransfusion system
No risk of transfusion reactions as patient receives own blood	Air embolism, coagulopathies, damage to red blood cells, and renal and pulmonary insufficiency due to free circulating hemoglobin
More oxygen provided to vital organs than with banked blood	Potential for systemic bleeding due to citrate (anticoagulant) toxicity

Nursing care

Each facility should have policies and procedures on autotransfusion and provide training to assure staff competency. To perform autotransfusion, don appropriate personal protective equipment, such as a cap, mask, eye protection, and gloves. Obtain the autotransfusion system (ATS) bag and attach it to the chest-tube drainage access port. Then activate the ATS bag to collect blood. **Important:** Blood must be reinfused within 6 hours of collection; preferably, it should be infused immediately.

Attach a microemboli blood filter and I.V. blood set to the ATS bag. Prime the I.V. administration set with normal saline solution and attach it to the patient, making sure all remaining air in the I.V. circuit is evacuated before patient connection. Once the circuit is primed and connected to the patient, infuse the blood into the patient.

Nursing responsibilities during the procedure include monitoring vital signs, maintaining equipment sterility, monitoring for and correcting breaks in the system, monitoring and controlling suction, monitoring pertinent laboratory data during and after transfusion, and observing collected blood for clots and contamination.

Infection risk increases with duration of tube placement. Regular dressing changes done according to facility policy can help identify and prevent site infections. Note changes in drainage amount and character, which may indicate increased bleeding or new-onset infection.

Subcutaneous emphysema may arise as pleural-space air leaks into subcutaneous tissue. When this happens, tissues of the neck, face, and chest swell and you may note crepitus on palpation. Notify the physician if you suspect subcuta-

neous emphysema; tube placement and suction level must be evaluated.

Nursing care: From patient to system

At least every 2 hours, document a comprehensive pulmonary assessment, including respiratory rate, work of breathing, breath sounds, and arterial oxyhemoglobin saturation measured by pulse oximetry (SpO₂). Inspect the dressing and note any drainage. Assess the insertion site for subcutaneous emphysema and tube migration. Keep all

tubing free of kinks and occlusions; for instance, check for tubing beneath the patient or pinched between bed rails. Take steps to prevent fluid-filled dependent loops, which can impede drainage.

To promote drainage, keep the CDU below the level of the patient's chest. Monitor water levels in the water-seal and suction-control chambers. Water in both chambers evaporates, so be sure to add water periodically to maintain the water-seal and suction levels.

Be aware that tidaling—fluctuations in the water-seal chamber with respiratory effort—is normal. The water level increases during spontaneous inspiration and decreases with expiration. However, with positive-pressure mechanical ventilation, tidaling fluctuations are the opposite: the water level decreases during inspiration and increases during expiration. If tidaling doesn't occur, suspect the tubing is kinked or clamped, or a dependent tubing section has become filled with fluid. Also, don't expect tidaling with complete lung expansion or with mediastinal tubes, because respirations don't affect tubes outside the pleural space.

Intermittent bubbling, corresponding to respirations in the water-seal chamber, indicates an air leak from the pleural space; it should resolve as the lung reexpands. If bubbling in the water-seal chamber is continuous, suspect a leak in the system. To locate the leak's source, such as a loose connection or from around the site, assess the system from the insertion site back to the CDU. When searching for the source of an air leak, use rubber-tipped or padded clamps to momentarily clamp the tubing at various points; bubbling stops when you clamp between the air leak and water seal. If you've clamped along the tube's entire length and still can't find the source, the CDU might be faulty; replacement should be considered.

Understanding chest drainage units

Understanding chest drainage units

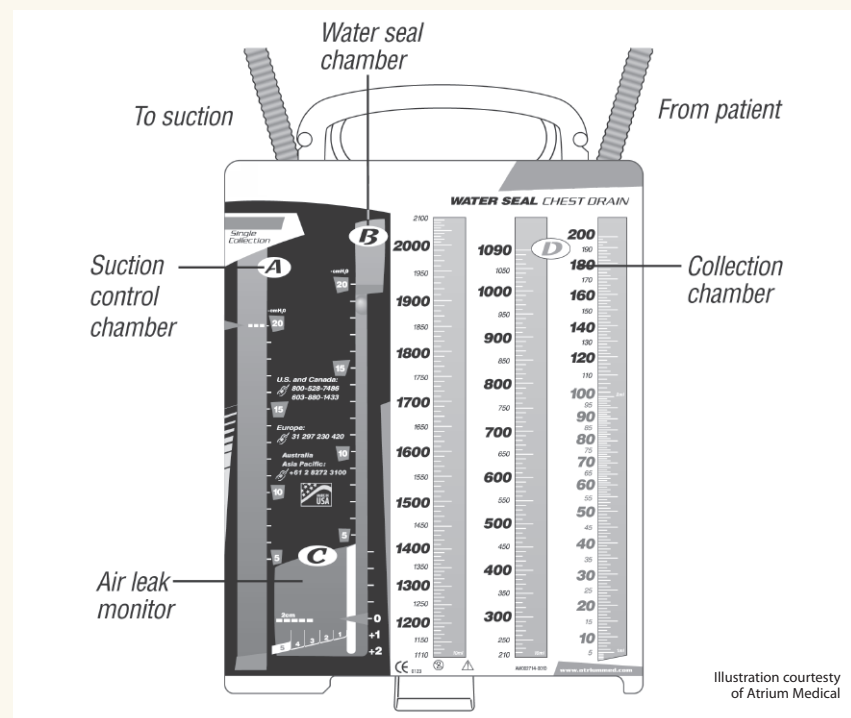
An integrated chest drainage unit (CDU) is a variation of the old three-glass-bottle system in which one bottle was used for collection, one for water seal, and a third for suction. CDUs have a water-seal chamber, a suction-control chamber, and a collection chamber; a one-way valve prevents air and fluid from returning to the chest. Almost all newer systems are self-contained and provide everything needed for rapid set-up and function. You'll need a vacuum gauge and tubing ready to apply suction to the CDU.

Start by filling the water-seal chamber to the level specified by the manufacturer (usually the 2-cm mark). Next, fill the suction-control chamber with sterile water to the -20 cm H₂O level, or as ordered. Keep in mind that the water level in this chamber determines the suction level, not the amount of vacuum applied from the vacuum gauge to create the negative pressure that draws air out of the pleural space.

Connect the drain to the vacuum, and slowly increase the suction until you see gentle bubbling in the suction-control chamber. Excessive bubbling is loud; besides disturbing the patient, it may cause rapid evaporation, which lowers the suction level. Monitor water levels, adding sterile water when necessary.

You can gain useful information by assessing the water-seal chamber. As air leaves the chest, bubbling appears here, indicating an air leak. Also, the water level may reflect intrapulmonary dynamics: A slow, gradual rise over time indicates more negative pleural-space pressure and signals healing.

After chest-tube insertion, connect the tube's distal end to the CDU. Secure the tube at the insertion site with sutures. Apply an occlusive sterile petroleum gauze dressing around the tube; then apply a dry, sterile split 4" × 4" dressing over everything. Secure all tube connections from the chest tube to the drainage container, using either tape or zip ties. A postinsertion chest X-ray confirms proper tube position and lung expansion.



Dry suction systems

Dry suction systems also are available. These are controlled by a self-compensating regulator rather than a column of water; a dial is used to set the suction level. Advantages of dry suction include higher suction-pressure levels, easier set-up, quieter operation (no bubbling sound), and more constant pressure because no water is lost to evaporation.

Assess drainage

Assess the color of drainage in the drainage tubing and collection chamber. Know that old drainage in the collection chamber may inaccurately reflect current drainage as shown in the tubing. At regular intervals (at least every 8 hours), document the amount of drainage and its characteristics on the clinical flow sheet. Report sudden fluctuations or changes in chest-tube output (especially a sudden increase from previous drainage) or changes in character (especially bright red blood or free-flowing red drainage, which could indicate hemorrhage). Frequent position changes, coughing, and deep breathing help reexpand the lung and promote fluid drainage.

Don't milk, strip, or clamp the tube

Avoid aggressive chest-tube manipulation, including stripping or milking, because this can generate extreme negative pressures in the tube and does little to maintain chest-tube patency. If you see visible clots, squeeze hand-over-hand along the tubing and release the tubing between squeezes to help move the clots into the CDU.

As a rule, avoid clamping a chest tube. Clamping prevents the escape of air or fluid, increasing the risk of tension pneumothorax. You can clamp the tube momentarily to replace the CDU if you need to locate the source of an air leak, but never clamp it when transporting the patient or for an extended period, unless ordered by the physician (such as for a trial before chest-tube removal).

In the event of chest-tube disconnection with contamination, you may submerge the tube 1" to 2" (2 to 4 cm) below the surface of a 250-mL bottle of sterile water or saline solution until a new CDU is set up. This establishes a water seal, allows air to escape, and prevents air reentry.

A view of chest-tube insertion

The illustrations below show the main steps in chest-tube insertion.

Chest-tube removal

Indications for chest-tube removal include:

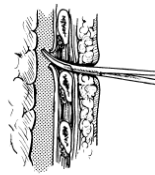
- improved respiratory status
- symmetrical rise and fall of the chest
- bilateral breath sounds
- decreased chest-tube drainage
- absence of bubbling in the water-seal chamber during expiration
- improved chest X-ray findings.

Before starting chest-tube removal, inform the patient that the chest tube will be removed, and briefly describe the steps involved. Make sure the patient is premedicated to relieve pain and ease anxiety. Teach the patient how to do the Valsalva maneuver, which he or she must perform before tube removal to prevent air from reentering the pleural space.

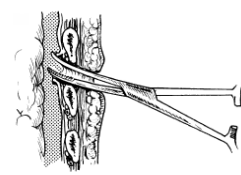
1. Small incision is made, usually at midaxillary line between fourth and fifth ribs on a line lateral to nipple.



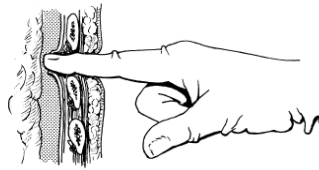
2. Clamp dissects over rib to avoid nerves and vessels beneath rib.



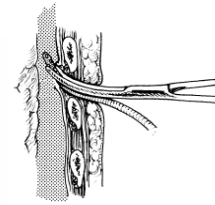
3. Clamp opens to spread muscles.



4. Finger is used to explore space, avoiding need for sharp instrument.



5. Clamp holds chest tube and guides it into place.



Avoid aggressive chest-tube manipulation, including stripping or milking, because this can generate extreme negative pressures in the tube and does little to maintain chest-tube patency.

Gather the supplies you'll need, including sterile gloves, goggles, gown, mask, dressing supplies, sterile suture-removal kit, rubber-tipped hemostats, and wide occlu-

sive tape. Place the patient in the semi-Fowler's position and put a pad underneath the chest-tube site to catch any drainage.

After the dressing is removed and the sutures are cut, the practitioner clamps the chest tube with hemostats. Instruct the patient to perform the Valsalva maneuver as the practitioner quickly removes the tube at maximum inspiration. Immediately after tube removal, apply an occlusive dressing to the site and secure it with tape. Another chest X-ray should be taken several hours later to ensure that the lung is still fully inflated.

Nursing care after chest-tube removal includes:

- ongoing respiratory assessment
- vital-sign documentation
- monitoring the site for drainage
- assessing the patient's comfort level.

De-stress over chest tubes

By understanding the indications for chest tubes and providing appropriate nursing care, from chest-tube insertion to removal and beyond, you'll find chest-tube care less stressful while helping your

patient breathe easier and recuperate without complications. ★

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PURPOSE/GOAL

To enhance nurses' understanding of chest tubes and chest-tube care

LEARNING OBJECTIVES

1. Identify the purposes and functions of chest tubes.
2. Describe chest-tube insertion.
3. Discuss nursing care for patients with chest tubes.

Please mark the correct answer online.

1. Which statement about the parietal and visceral pleurae is correct?

- a. A potential space exists between the two.
- b. A small space separates the two.
- c. The visceral pleura covers the chest wall and diaphragm.
- d. The parietal pleura covers the inside of both lungs.

2. During normal breathing, exhalation:

- a. decreases intrapleural pressure.
- b. increases intrapleural pressure.
- c. causes intrapulmonary pressure to decrease compared to atmospheric pressure.
- d. causes the parietal pleura to recoil outward along with the chest wall.

3. A tension pneumothorax occurs when:

- a. injured tissue forms a one-way valve, enabling air to enter the pleural space.
- b. injured tissue scars over, trapping air inside the pleural space.
- c. a small amount of pus collects on the visceral pleura.
- d. a small amount of lymph collects on the parietal pleura.

4. Which statement about chest-tube sizes is correct?

- a. The larger the French size, the smaller the tube.
- b. Common tube sizes for adults are 10 to 15 French.
- c. Smaller tubes are used to drain blood; larger tubes to remove air.
- d. Larger tubes are used to drain blood; smaller tubes to remove air.

5. The first step in setting up an integrated chest drainage unit (CDU) is to:

- a. fill the water-seal chamber to the level specified by the manufacturer.
- b. fill the water-seal chamber to the 10-cm mark.
- c. connect the drain to the vacuum and rapidly increase the pressure.
- d. connect the drain to the vacuum and slowly increase the pressure.

6. Which statement about the water-seal chamber of a CDU is correct?

- a. It should be filled to the -10 cm mark, or as prescribed.
- b. It should be filled to the -30 cm mark, or as prescribed.
- c. Bubbling indicates an air leak.
- d. Bubbling is normal.

7. As needed, the suction-control chamber should be refilled with:

- a. sterile water.
- b. nonsterile water.
- c. sterile saline solution.
- d. nonsterile saline solution.

8. Which of the following is an advantage of a dry suction chest drainage system?

- a. Lower levels of suction pressure
- b. Variable bubbling, which indicates proper functioning
- c. A steady bubbling sound, which indicates proper functioning
- d. Higher levels of suction pressure

9. Before chest-tube insertion, the patient should be positioned:

- a. with the head of the bed elevated 90 degrees and nothing between the shoulder blades.
- b. with the head of the bed elevated 45 degrees and nothing between the shoulder blades.
- c. laterally, with a small wedge or bolster between the shoulder blades.
- d. flat, with a small wedge or bolster under the shoulder blades.

10. A common insertion site for a chest tube is the:

- a. midaxillary line between the fourth and fifth ribs.
- b. midaxillary line between the third and fourth ribs.
- c. posterior axillary line between the fourth and fifth ribs.
- d. posterior axillary line between the third and fourth ribs.

11. Crepitus on palpation of the skin surrounding the chest tube may indicate:

- a. deep-tissue emphysema.
- b. subcutaneous emphysema.
- c. excessive drainage.
- d. inadequate drainage.

12. To promote drainage, the CDU should be:

- a. alternated above and below the level of the patient's chest every 2 hours.
- b. alternated above and below the level of the patient's chest every 4 hours.
- c. kept below the level of the patient's chest.
- d. kept above the level of the patient's chest.

13. Which statement related to routine chest-tube care is correct?

- a. Clamp the chest tube for 10 minutes every 2 hours.
- b. Milk or strip the chest tube every 4 hours.
- c. Avoid milking or stripping the chest tube.
- d. Clamp and strip the chest tube once per shift.

14. If a chest tube becomes disconnected, the correct action is to:

- a. submerge the tube 3" to 5" (8 to 12 cm) below the surface of a 250-mL bottle of sterile saline solution.
- b. submerge the tube 1" to 2" (2 to 4 cm) below the surface of a 250-mL bottle of sterile water.
- c. remove the tube completely and place an occlusive dressing over the site.
- d. remove the tube completely and place a nonocclusive dressing over the site.

15. Which statement about chest-tube removal is correct?

- a. Do not premedicate because you want the patient to be fully cooperative.
- b. Ask the patient to perform the Valsalva maneuver as the practitioner removes the tube.
- c. The tube should be removed at maximum expiration.
- d. No post-removal chest X-ray is needed.