Best Practices: Chest Tube Management

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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.

By Mark Bauman, MSN, RN, CCRN, and Claudia Handley, MS, RN, MBA

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.

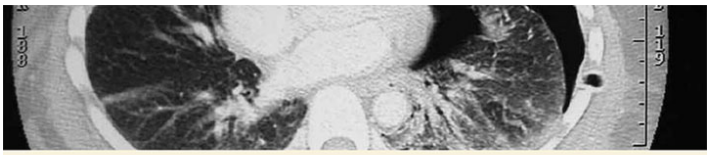
The ability to adhere creates negative pressure within the pleural space, which becomes more negative as the visceral and parietal pleurae are pulled in opposite directions during inspiration. (Picture those two glass plates.) The negative intrapleural (and thus intrapulmonary) pressure generated causes 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 inserted in the mediastinum to drain blood and prevent cardiac tamponade. In addition, for proper chest tube care, 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*)



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
- **Hemopneumothorax:** 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.

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.

Managing pleural-space disruptions

The overall goal of chest-tube therapy (chest tube care) 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 nurse practitioner may insert a chest tube at the bedside, in the operating room, or in an interventional radiology suite. When-ever 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.

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 indi-

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 H_2O 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.

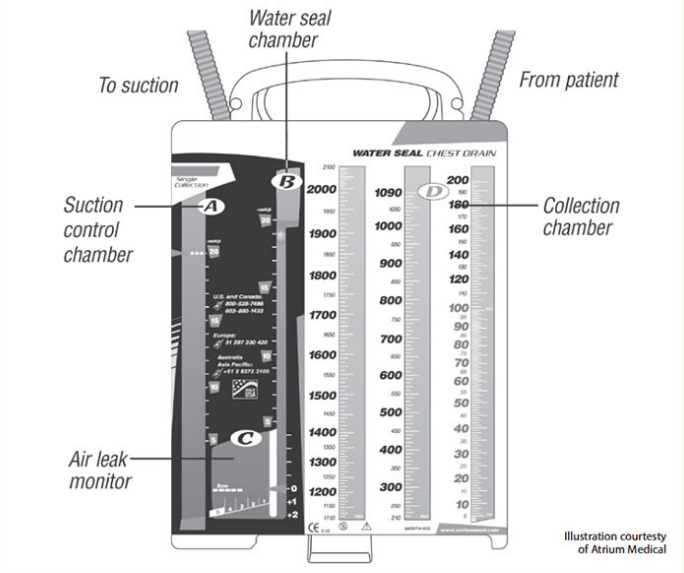


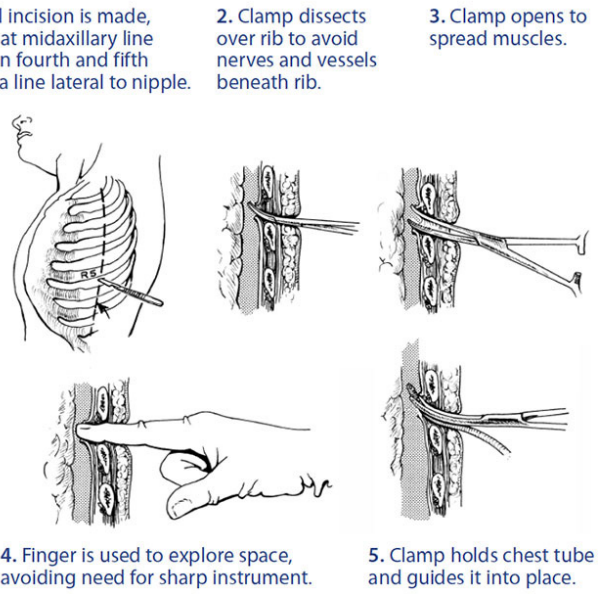
Illustration courtesy of Atrium Medical

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.

A view of chest-tube insertion

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



cate 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 subcutaneous 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.

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 chest 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.

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.

Chest Tube Care: 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.

Gather the supplies you'll need, including sterile gloves, goggles, gown, mask, dressing supplies, sterile suture-removal kit, rubber-tipped hemostats, and wide occlusive 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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Managing chest tubes: Air leaks and unplanned tube removal

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Once treated only in high-acuity settings, patients with chest tubes now receive care in inpatient medical-surgical floors, outpatient procedural areas (such as interventional radiology), and other settings. More recently, to help shorten hospital stays and reduce readmissions, patients are being discharged with smaller, more portable chest tubes. This allows them to continue to recover from thoracic surgery at home or, in some cases, to receive palliative care.

A chest tube is indicated when negative pressure in the pleural space is disrupted, as from thoracic surgery or unanticipated trauma. The tube helps restore negative pressure, preventing further respiratory complications. (See *Chest-tube indications*.)

Although they can save lives, chest tubes can pose significant risks unless assessed and managed properly. To help prevent complications, clinicians must be familiar with basic thoracic and pleural anatomy, insertion-site care, dressing changes, and proper chest-tube management. Even then, unanticipated events and complications can occur.

This article can help you feel more confident when caring for patients with chest tubes. It discusses several complications and describes how to prevent and manage problems during tube removal. (The authors assume readers have basic knowledge about chest-tube function and care.)

Managing air leaks

Although air leaks commonly resolve without intervention, they must be evaluated fully before chest-tube removal to ensure adequate restoration of negative pressure in the pleural space. Prolonged leaks–those lasting more than 5 days after thoracic surgery–are more dangerous than acute leaks. They indicate that negative pressure hasn't been restored and the injury isn't resolving. Such leaks can increase hospital stays and lead to pneumonia, infection, and other complications. The patient may require a long-term chest tube or replacement of the current tube if it's malpositioned. In some cases, chemical or mechanical pleurodesis may be indicated.

Assess for air leaks at least once per shift and as needed, based on your patient's respiratory status. Start by examining the air-leak detection chamber in the water seal of the drainage device. An air leak presents as small air bubbles; the amount of bubbling indicates the degree of the leak. If you notice bubbling, determine location of the leak. Leaks can occur outside the patient's body (such as within the drain or tubing connections) or within the patient (for instance, at the tube insertion site or inside the chest cavity).

To determine where the leak is, clamp the tubing as close as possible to the patient. If bubbling continues, suspect a leak in the tubing or damage to the drainage device (as from inadvertent lowering of the bed onto the drain). Commonly, air leaks occur at the point where the distal end of the tube connects to the drainage device tubing. Check this juncture to ensure it hasn't become loose. Consider using securements, such as plastic fasteners (zip ties), to help prevent accidental disconnection here.

If bubbling disappears when you clamp the tubing, suspect an air leak at the insertion site or from within the chest wall. Assess the insertion site; if you detect a leak, apply petroleum gauze and a sterile occlusive dressing to seal it off. If the leak persists, suspect it's coming from air remaining in the pleural space (an unresolved pneumothorax), a pleural injury, an exposed tube eyelet, or inappropriate communication between the bronchial and pleural spaces. With a significant internal air leak, you may be able to palpate subcutaneous emphysema or "crackling" under the skin. Whatever its source, an air leak must be addressed and resolved before the chest tube is removed. A large, persistent leak with no evacuation outlet can lead to tension pneumothorax, in turn causing cardiac tamponade–a life-threatening emergency.

Planned and unplanned chest-tube removal

A chest tube can be discontinued in two ways–planned or unplanned (accidental). Unplanned removal can be considered an emergency, but with quick action you can prevent patient harm.

Planned removal

Clinicians use various indicators to determine when a chest tube is no longer necessary– for instance, if drainage has become minimal and no longer concerning or if an air leak or the initial indication for the chest tube has resolved. If permitted by the state board of nursing or facility policy, clinical nurses with demonstrated competence in removing chest tubes can perform this procedure.

Here are the basic steps of chest-tube removal:

1. Discontinue wall suction from the chest drainage unit. Some literature suggests you should do this at least 24 hours before tube removal to eliminate a possible air leak.

2. To reduce pain caused by chest-tube removal, premedicate your patient as ordered; allow adequate time for the drug to take effect. (See *Managing pain during chest-tube insertion and removal*.)

3. Know that chest-tube removal is a sterile procedure. Gather needed sup-

plies, including a mask, sterile gloves, suture removal kit, petroleum gauze, dry gauze, tape, hazardous waste bag, and disposable pad.

4. Explain the procedure to the patient. Instruct the patient to practice taking deep breaths and holding them. To prevent air from re-entering the pleural space during tube removal, instruct the patient to hold the breath or to hum as you remove the tube.

5. After you've removed the dressing and sutures, clamp the tube. Ask the patient to take one more deep breath and hold it. With one hand, simultaneously remove the tube swiftly and place it on the disposable pad. Keep your other hand at the insertion site, covering the hole. If purse-string sutures are present, tie them off into several square knots. If desired, ask a colleague to hold the sutures while you pull the tube out. If these sutures aren't present, immediately apply an occlusive dressing, such as petroleum gauze. Again, the goal is to prevent air from reentering the pleural space.

6. Dress the site with a dry occlusive dressing and discard the chest tube and drainage device in the hazardous waste bag.

7. Obtain a postremoval chest X-ray if the physician has ordered it or facility protocol requires it. (How-ever, know that increasing evidence no longer supports routine postremoval chest X-rays.)

Unplanned removal

In an unplanned chest-tube removal, stay calm. With a gloved hand, immediately cover the open insertion site and call for help while staying with the patient. Ask for petroleum gauze to cover the site, along with dry gauze and tape to complete the dressing.

If you didn't witness chest-tube removal and the patient appears to be in respiratory distress, ask him or her to exhale forcefully as you lift your hand off the insertion site. Before the patient's next inhalation, quickly cover the site again. Have the patient repeat this a few times. If you suspect air entered the pleural space before you got to the scene, the patient may be at risk for a tension pneumothorax, which can become life-threatening unless the air is expelled from the pleural space quickly. Notify the practitioner, obtain a chest X-ray, and prepare for possible insertion of a new chest tube.

If you're walking with your patient and the chest tube becomes dislodged where it connects to the drainage tubing, immediately close off the tubing to air with your gloved hand by crimping it or using a clamp, if readily available. Or place the end of the tube in a bottle of sterile water, creating a water seal. Instruct a colleague to prepare a new sterile chest-drainage collection device, or retrieve a new sterile connector while you safely return the patient to bed. Observe the patient for signs and symptoms of respiratory decline. Then reconnect the chest tube to the new drain and unclamp it.

Postremoval nursing assessment

Whether chest-tube removal was planned or unplanned, monitor the patient closely for signs and symptoms of respiratory compromise, using such techniques as pulse oximetry (Spo2), end-tidal carbon dioxide (ETco2) monitoring, and breath sound auscultation. Monitor the patient's respiratory rate and effort. A repeat chest X-ray (if indicated) may be done to compare to previous films and evaluate for presence or return of a pneumothorax, an effusion, or other problem.

Other complications

Other chest-tube complications also can be dangerous. These include extremely high negative pressures within the system caused by aggressive tube stripping, as well as the re-expansion pulmonary edema phenomenon, which results from rapid removal of large amounts of air or fluid. Rarely, inadvertent chest tube misplacement in the liver, spleen, lung, or great vessel can occur on insertion. (See Chest-tube complications.)

Enhancing your knowledge of chest tubes and gaining the skills needed to manage them improve your confidence in delivering safe patient care.

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