PROCEDURE

25 Closed Chest-Drainage System

Joya D. Pickett

PURPOSE: Closed chest-drainage systems are used to facilitate the evacuation of fluid, blood, and air from the pleural space, the mediastinum, or both; to restore negative pressure to the pleural space; and to promote reexpansion of a collapsed lung.

PREREQUISITE NURSING KNOWLEDGE

- The clinical need for chest drainage arises whenever the negative pressure in the pleural cavity is disrupted by the presence of air and/or fluid, resulting in pulmonary compromise. The purpose of a chest-drainage system (CDS) is to evacuate the air and/or fluid from the chest cavity to reestablish normal intrathoracic pressure.
- Closed CDSs are integrated disposable systems (also known as chest-drainage units) that are modeled after the classic three-bottle CDS.
- Normal anatomy and physiology of the thorax:
  - Under usual conditions, normal intrapleural pressures measure approximately −4 cm H_2O during expiration, whereas at end inspiration, pressure decreases to −8 cm H_2O.[15]
  - The mediastinum is within the musculoskeletal cage of the thorax and contains three subdivisions. The two lateral subdivisions hold the lungs. Between the lungs is the mediastinum, which contains the heart, the great vessels, parts of the trachea and esophagus, and other structures.
  - The lungs consist of the trachea and the bronchi, which divide into smaller branches until they reach the alveoli, known as the air sacs.
- Thoracic pathophysiology requiring a chest tube and CDS, which may occur spontaneously or as the result of trauma and/or surgery:
  - Pneumothoraces (e.g., open, closed, and tension)
  - Hemothorax
  - Pleural effusions
  - Chylothorax
  - Empyema
  - Pericardial effusions, including cardiac tamponade
- CDSs include the following types:
  - Dry suction with a traditional water-seal, dry suction with a one-way valve, and wet suction with a traditional water-seal
  - Those that implement the use of gravity, suction, or both to restore negative pressure and remove air, fluid, and blood from the pleural space or the mediastinum
- Some CDSs use dry suction with a traditional water-seal and either a regulator or a restricted orifice mechanism. Although water is added to the water-seal chamber, water does not need to be added to the suction chamber. Instead, the suction source (usually a wall regulator) is increased until an indicator appears.
- Some CDSs are waterless, referred to as dry-dry drains, and have a one-way valve, which eliminates the need to fill any chambers (except an air-leak indicator zone, as needed). A valve opens on expiration and allows patient air to exit, then closes to prevent atmospheric air from entering during inspiration. This one-way valve feature allows the system to be used in the vertical or horizontal position without loss of the seal. These systems are safe if accidentally tipped. The amount of suction delivered is regulated with an adjustable dial.
  - Advantages of dry suction are ease of setup; ease of application if higher, more precise levels of suction are needed; and a quiet system.
- CDSs may have some of the following components:
  - Tubing, which may or may not be latex free. See manufacturer guidelines for specific information
  - Collection chambers, which may be replaceable, allowing them to be removed when filled and replaced with a new collection chamber without changing the entire unit
  - Fluid-collection ports, which may be self-sealing ports or collection tubes for aspiration of drainage samples and removal of excess chamber fluid levels
  - A one-way mechanism created by a water-seal that permits air and fluid to be removed and prevents backflow into the chest[20]
  - Accessories that may be used to convert systems to autotransfusion units
- Examples of CDSs include the Pleur-Evac, Thora-Klex, Argyle, and Atrium systems.
- CDSs contain the following chambers (Fig. 25-1):
  - The collection chamber, the largest of the three chambers, generally on the far-right side of the CDS, is the drainage reservoir. This is where drainage from the pleural space accumulates. A window with calibrated markings is located on the exterior of the drainage collection for observation of the color, amount, and consistency of fluid.
  - The suction-control chamber, generally on the far-left side of the CDS, is the suction chamber that regulates the amount of negative pressure applied to the system.

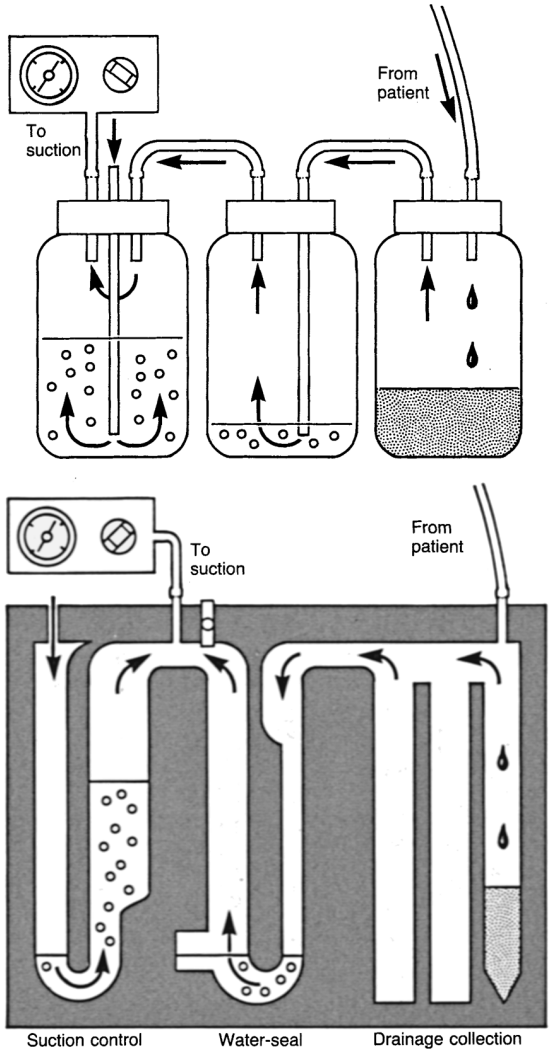

Figure 25-1 Disposable system correlates with three-bottle system. *(From Luce JM, Tyler ML, Pierson DJ: Intensive respiratory care, Philadelphia, 1984, Saunders.)*

- The water-seal chamber, in traditional water-seal CDSs (wet systems), is usually the middle chamber and provides a one-way relief valve between the atmospheric pressure and the patient's negative intrapleural pressure.
- Positive-pressure relief valves are used to prevent a tension pneumothorax if the suction tubing becomes accidentally occluded or if the suction source fails. In addition, automatic and manual pressure relief valves vent excessive negative pressure, such as may occur during deep inspiration or with milking of the chest tube.

- Suction guidelines include the following:
  - When clinically indicted, the addition of a suction source can enhance drainage when large volumes of air or fluid must be evacuated.
  - Currently guidelines recommend that a water-seal alone is safe for most patients with a pneumothorax or small air leak.[2–5,8,9,21] However, if the pneumothorax or air leak is large, expanding, or persistent, suction is recommended.[5,8,9]

TABLE 25-1 Pressure Conversion Chart*

cm H_2O	mm Hg
20	15
25	18
30	22
35	26
40	30
45	33
50	37
60	44

*Approximate values.
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  - The most common amount of suction pressure ranges from −10 to −20 cm H_2O.[1,3,8,14] High suction levels may cause persistent pleural air leaks, air stealing, lung tissue entrapment, and reexpansion pulmonary edema.[14,17]
  - There are differences in flow rates and in accuracy of delivered negative pressures noted in CDSs; however, they are not likely to be clinically important.[6,7]
  - Some systems contain an exit vent from the water-seal chamber that ensures the drainage unit remains vented when the suction device is off. Do not close or occlude the exit vent.[21,29] When using CDSs without an exit vent, the drainage systems should be disconnected from suction before they are turned off.[21,29]
  - Some wall-mounted suction devices need control and pressure gauges to regulate and monitor for potential surges in suction levels.[15,22,25]
  - If clinically appropriate, some wet suction with traditional water-seal drainage systems can provide suction levels greater than −25 cm H_2O. The suction-chamber vent holes can be occluded with nonporous tape or by replacing them with the manufacturer's special pronged vent plug and connecting directly to wall regulator suction. Suction levels must be converted from prescribed levels of cm H_2O suction to mm Hg of wall suction (Table 25-1).
- General guidelines in the proper care of the CDC include the following:
  - Greater pressure within the chest than within the system is needed to maintain proper functioning of the closed system; this requirement is accomplished by keeping the drainage unit at least 1 foot below the chest tube insertion site and the tubing free of dependent loops and obstructions,[1,11,13,25,27] which prevents siphoning of the contents back into the pleural cavity.[25]
  - Except for the exit vent, an airtight system is required to assist in maintaining negative pressure in the pleura and to prevent air entrapment in the pleural space.
  - Tidaling, fluctuations that occur with inspiration and expiration, provides a continuous manometer of the pressure changes in the pleural space and indicates overall respiratory effort. Absence of fluctuations suggests obstruction of the drainage system from clots, contact with lung tissue, kinks, loss of subatmospheric

pressure from fluid-filled dependent loops, or complete reexpansion of the lung.[1,10,19]

- In general, clamping of chest tubes is contraindicated. ***Clamping a chest tube in a patient with a pleural air leak may cause a tension pneumothorax.*** The few situations in which chest tubes may be clamped briefly (i.e., less than a minute) include locating the source of an air leak, replacing the CDS, determining whether a patient is ready to have the chest tube removed, and during chest tube removal.[1,14,15,21,29]

EQUIPMENT

Disposable Setup (Wet and Dry Systems)

- Disposable chest-drainage unit
- Gloves
- Suction source and regulator
- Connecting tubing
- 1-L bottle of sterile water or normal saline (for systems that use water)
- 50-mL irrigation syringe (if not supplied with unit) for systems that use water
- Tape (1 inch), one roll, or zip ties (e.g., Parham-Martin bands)

PATIENT AND FAMILY EDUCATION

- Explain the procedure, the indication for the chest tube insertion, and how the closed CDS works. ***Rationale:*** This communication identifies patient and family knowledge deficits about the patient's condition, procedure, expected benefits, and potential risks and allows time for questions to clarify information and to voice concerns. Explanations decrease patient anxiety and enhance cooperation.
- After chest tube insertion, instruct the patient to sit in a semi-Fowler's position (unless contraindicated). ***Rationale:*** Proper positioning facilitates drainage from the lung by allowing air to rise and fluid to settle, enhancing removal via the chest tube. This position also makes breathing easier.
- Instruct the patient to turn and reposition every 2 hours to facilitate drainage. The patient may lie on the side with the chest tube but should keep the tubing free of kinks. ***Rationale:*** Turning and positioning prevents complications related to immobility and retained secretions. Keeping the tubing free of kinks maintains patency of the tube, facilitates drainage, and prevents the accumulation of pressure within the pleural space, which interferes with lung reexpansion.
- Instruct the patient to cough and deep breathe, with splinting of the affected side or sternum (if mediastinal tube is in place). ***Rationale:*** Coughing and deep breathing increase pressure within the pleural space, facilitating drainage, promoting lung reexpansion, and preventing respiratory complications associated with retained secretions. The application of firm pressure over the chest tube insertion site (e.g., splinting) may decrease pain and discomfort.
- Encourage active or passive range-of-motion exercises of the arm on the affected side. ***Rationale:*** The patient may limit the movement of the arm on the affected side to decrease the discomfort at the insertion site, which may result in joint discomfort and potential joint complications.
- Instruct the patient and family about activity as prescribed while maintaining the drainage system below the level of the chest. ***Rationale:*** The drainage system is maintained below the level of the chest to facilitate gravity drainage and to prevent backflow into the pleural space and potential infectious contamination into the pleural space.
- Instruct the patient and family about the availability of prescribed analgesic medication and other pain-relief strategies. ***Rationale:*** Pain relief ensures comfort and facilitates coughing, deep breathing, positioning, and range-of-motion exercises, and promotes healing.

PATIENT ASSESSMENT AND PREPARATION

Patient Assessment

- Assess significant medical history or injury, including chronic lung disease, spontaneous pneumothorax, pulmonary disease, therapeutic procedures, and mechanism of injury. ***Rationale:*** Medical history or injury may provide the etiological basis for the occurrence of pneumothorax, hemothorax, empyema, pleural effusion, or chylothorax.
- Assess patient's baseline cardiopulmonary status (if patient's condition does not necessitate immediate intervention). ***Rationale:*** Provides reference points for future assessments upon completion of the procedure.
- Assess baseline cardiopulmonary status, as follows:
  - Vital signs (blood pressure, heart rate, respiratory rate)
  - Shortness of breath or dyspnea
  - Anxiety, restlessness, or apprehension
  - Cyanosis
  - Decreased oxygen saturation (e.g., pulse oximetry [Spo_2])
  - Decreased or absent breath sounds on the affected side
  - Crackles adjacent to the affected area
  - Asymmetrical chest excursion with respirations
  - Hyperresonance with percussion on the affected side (pneumothorax)
  - Dullness or flatness with percussion on the affected side (hemothorax, pleural effusion, empyema, or chylothorax)
  - Subcutaneous emphysema or crepitus (pneumothorax)
  - Sudden sharp focal chest pain
  - Tracheal deviation to the unaffected side (tension pneumothorax)
  - Neck vein distention (tension pneumothorax, cardiac tamponade)
  - Muffled heart sounds (cardiac tamponade)

  Rationale: Provides reference points for future tests upon completion of the procedure.
- Assess diagnostic tests (if patient's condition does not necessitate immediate intervention):
  - Chest radiograph
  - Arterial blood gases

Patient Preparation

- Ensure the patient understands preprocedural teachings. Answer questions as they arise, and reinforce information as needed. ***Rationale:*** This communication evaluates and reinforces understanding of previously presented information.
- Verify that the patient is the correct patient using two identifiers. ***Rationale:*** Before performing a procedure, the nurse should ensure the correct identification of the patient for the intended intervention.
- Administer prescribed analgesics or sedatives as needed. ***Rationale:*** Analgesics and sedatives reduce the discomfort and anxiety experienced, facilitating patient cooperation and improving outcomes.

Procedure for Dry Suction Closed Chest-Drainage Systems

Steps	Rationale	Special Considerations
1. HH		
2. PE		
3. Open sterile packages.	Maintains aseptic technique whenever changes are made to the system.	
4. Stabilize the unit. Some systems have a floor stand. For systems with an in-line connector, move the patient tube clamp down next to the in-line connector.	Keeping the clamp visible helps prevent inadvertent clamping.	Clamping of chest tubes can cause air trapped in the pleural space to accumulate and may cause tension pneumothorax.
5. *Dry suction with a traditional water-seal:* Remove the connector cap from the short tubing of the water-seal chamber and use the funnel provided or a 50-mL syringe to add sterile water or normal saline to the 2-cm level. Some systems provide prefilled sterile water containers.	Depth of solution required to establish a water-seal; the water-seal permits air and fluid to be removed from the patient and prevents the backflow of air into the chest.[1,19]	Water-seal levels greater than 2 cm increase the work of breathing; levels less than 2 cm can expose the water-seal to air and increase the risk for pneumothorax.[19]
Dry suction with a one-way valve: Fill air-leak monitor zone.		
6. Hang drainage unit from bed frame or set it on a floor stand. **(Level E*)**	Drainage unit must be kept below the level of the chest to promote gravity drainage and to prevent backflow of drainage into the pleural space, which interferes with lung expansion.[1,25]	Avoid hanging drainage unit from bed rails or other movable structures.
7. Connect the long tubing from the drainage collection chamber to the chest tube. **(Level C*)**	Creates the closed CDS; avoid dependent or fluid-filled loops.[13,24]	Avoid dependent or fluid-filled loops, which may create back pressure and decrease the effectiveness of suction.[13,24]
8. For gravity drainage, leave the suction-control chamber open to air. **(Level M*)**	Creates the exit vent for the escape of air.	*Clamping of chest tubes can cause air trapped in the pleural space to accumulate and may cause tension pneumothorax.*

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.
*Level M: Manufacturer's recommendations only.

Procedure for Dry Suction Closed Chest-Drainage Systems—*Continued*

Steps	Rationale	Special Considerations
9. To initiate suction, connect the CDS to the suction source and dial in the prescribed amount of suction (usually −10 to −20 cm H_2O), and then increase suction source until indicator mark appears according to manufacturer's guidelines.	Activates suction.	Apply suction as per manufacturer's guidelines. For example, to apply −20 cm H_2O suction, use a minimum vacuum pressure of −80 mm Hg. Suction source vacuum should be >−80 mm Hg when multiple chest drains are used. For a suction level <−20 cm H_2O, any observed bellows expansion across the monitor window confirms adequate suction operation. To decrease suction, set the dial, confirm patient on suction, then depress the high-negativity vent, venting to the newer lower amount.
10. Tape all connection points in the CDS (see Fig. 21-2). A. One-inch tape is placed horizontally, extending over the connections (a portion of the connector may be left unobstructed by the tape). B. Reinforce the horizontal tape with tape placed vertically so that it encircles both ends of the connector.	Except for the exit vent, a secure and airtight system is required to avoid inadvertent disconnection that could cause air entrapment in the pleural space and decreased pleural negative pressure. This technique secures the connections but allows visualization of drainage in the connector.	Zip ties (Parham-Martin bands) may be used to secure connections instead of tape.
11. Dispose of soiled equipment and supplies and remove PE.		
12. HH		

Procedure for Wet Suction Closed Chest-Drainage Systems

1. HH		
2. PE		
3. Open sterile packages.	Maintains aseptic technique whenever changes are made to the system.	
4. Stabilize the unit. Some systems have a floor stand. For systems with an in-line connector, move the patient tube clamp down next to the in-line connector.	Keeping the clamp visible helps prevent inadvertent clamping.	Clamping of chest tubes can cause air trapped in the pleural space to accumulate and may cause tension pneumothorax.
5. Remove the connector cap from the short tubing of the water-seal chamber and use the funnel provided or a 50-mL syringe to add sterile water or normal saline to the 2-cm level.	Depth of solution required to establish a water-seal; the water-seal permits air and fluid to be removed from the chest and prevents backflow of air.[1,19]	Water-seal levels >2 cm increase the work of breathing; levels <2 cm can expose the water-seal to air and increase the risk for pneumothorax.[19]
6. For gravity drainage, leave the short tubing from the suction control chamber open to air by turning stopcock to "open" or "on" position.	Creates the exit vent for the escape of air.	Clamping or occlusion of the exit vent can cause air to remain trapped in the pleural space, which may cause tension pneumothorax.

Procedure continues on following page

Procedure for Wet Suction Closed Chest-Drainage Systems—*Continued*

7. For suction drainage, fill the suction-control chamber with sterile water or normal saline to the prescribed level (usually −10 to −20 cm H_2O suction). Connect the short tubing from the suction-control chamber to the suction source.	Suction is regulated by the height of the solution level in this chamber.	Refill the solution level as necessary to the prescribed amount to replace solution lost through evaporation. Remove excess fluid as necessary via self-sealing grommet.
8. Hang chest-drainage unit from bed frame, or set it on a floor stand. **(Level E*)**	Drainage unit must be kept below the level of the chest to promote gravity drainage and to prevent backflow of drainage into the pleural space, which interferes with lung expansion.[1,25]	Avoid hanging drainage unit from bed rails or other movable structure.
9. Connect the long tubing from the drainage collection chamber to the chest tube. **(Level C*)**	Creates the drainage-collection system; avoid dependent or fluid-filled loops.[13,24]	Dependent or fluid-filled loops may create back pressure and decrease the effectiveness of suction.[13,24]
10. Turn on the suction source, if prescribed, to elicit gentle constant bubbling. Leave stopcock between CDS and suction source fully open and adjust force of bubbling at suction source to decrease risk for pneumothorax.	Activates suction.	Some systems have a suction-control feature to maintain the desired suction level automatically despite fluctuations in the suction source. The stopcock should be kept fully in "open" or "on" position and force of bubbling should be adjusted at suction source.
11. Tape all connection points in the CDS (see Fig. 21-2).[15] A. One inch tape is placed horizontally extending over the connections (a portion of the connector may be left unobstructed by the tape). B. Reinforce the horizontal tape with tape placed vertically so that it encircles both ends of the connector.	Except for the exit vent, a secure and airtight system is required to avoid inadvertent disconnection that could cause air entrapment in the pleural space and decreased pleural negative pressure. This technique secures the connections but allows visualization of drainage in the connector.	Zip ties (Parham-Martin bands) may be used to secure connections instead of tape.
12. Dispose of soiled equipment and supplies and remove PE.		
13. HH		

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

Expected Outcomes

- Removal of air, fluid, or blood from the thoracic cavity
- Fluctuation or tidaling noted in the water-seal chamber (until lung reexpanded)
- Relief of respiratory distress
- Reexpansion of the collapsed lung as validated with chest radiograph

Unexpected Outcomes

- Tension pneumothorax
- Hemorrhagic shock
- Absence of drainage and fluctuation or tidaling, or continuous bubbling in the water-seal chamber with continued respiratory distress
- No evidence of reexpansion of lung
- Fever, purulent drainage, and redness around the insertion site or purulent drainage in the chest tube

Patient Monitoring and Care

Steps	Rationale	Reportable Conditions
		These conditions should be reported if they persist despite nursing interventions.
1. Assess every 1–2 hours and with any change in patient condition or according to institution protocol.	Provides baseline and ongoing assessment of patient's condition.	• Tachypnea • Decreased or absent breath sounds • Hypoxemia • Tachycardia • Dysrhythmias • Hypotension • Muffled heart tones • Subcutaneous emphysema (crepitus) • Neck vein distention • Tracheal deviation • Fever • Absence of fluctuations in water-seal chamber with respiratory distress
2. Monitor the amount and type of drainage by marking the drainage level on the outside of the drainage-collection chamber in hourly or shift increments (depending on the amount of drainage) or in time increments established by institution policy or per practitioner orders. Monitor amount and type of drainage.	Marking container provides reference point for future measurements. Volume loss can cause patients to become hypovolemic or can signal intrapulmonary bleeding. Drainage should decrease gradually and change from bloody to pink to straw colored. Sudden flow of dark bloody drainage that occurs with position change is often old blood. Decreased or absent drainage associated with respiratory distress may indicate obstruction; decreased or absent drainage without respiratory distress may indicate lung reexpansion. Autotransfusion: if chest-drainage transfusion (autotransfusion) is being considered, please see Autotransfusion (Procedure 20).	• Drainage >100 mL/hr[1] or according to practitioner order • Sudden decrease or absence of drainage • Change in characteristics of drainage, such as unexpectedly bloody, cloudy, or milky • New onset of clots

Procedure continues on following page

Patient Monitoring and Care —*Continued*

Steps	Rationale	Reportable Conditions
3. Assess patient and CDS for an air leak. If a suction source has been added, momentarily turn suction off or pinch suction tubing to accurately assess.[1] An air leak is present if air bubbles are observed in the water-seal chamber or going from right-to-left in the leak detector zone. When assessing the air-leak chamber, ask the patient to take deep breaths in and out. If you do not note an air leak, ask the patient to cough.[8] When the patient's pleural space is leaking air, intermittent bubbling is seen corresponding to respirations. If bubbling is continuous, suspect an air leak in the system. To locate the source, intermittently pinch the chest tube or drainage tubing for a moment (i.e., less than a minute), beginning at the insertion site and progressing to the chest-drainage unit.[1]	Assessing for an air leak is one way to determine whether the patient is experiencing a pneumothorax. Bubbling when suction is initially turned on occurs with air displaced by fluid drainage in the collection chamber, loose connections in the system, or an air leak in the pleural space.[10] With a minor air leak, bubbling may occur only with coughing when airway pressures reach their peak.[8,29] An airtight system is required to help reestablish negative pressure in the pleural space. If bubbling in the water-seal chamber stops when the chest tube is occluded at the dressing site, the air leak is inside the patient's chest or under the dressing. If a new-onset air leak, reinforce the dressing and notify the physician. If the bubbling stops when the drainage tubing is occluded along its length, the air leak is between the occlusion and the patient's chest; check to ensure all connections are airtight.[1,8] If bubbling does not stop with occlusion, replace the CDS.	• New or increasing air leaks in the chest or around the chest tube insertion site • Chest tube drainage from a mediastinal tube does not normally cause bubbling in the water-seal chamber; if noted, it may indicate communication with the pleural space; notify physician • Notify physician of system knock over and changing of the CDS (e.g., chest radiograph may be ordered).[29]

4. Assess chest tube and CDS patency on insertion, every 1–2 hours, and with a change in patient condition. Routine chest tube stripping or milking is not recommended. Upon identification of a visible clot or other obstructing drainage, gently milk (manual squeezing and releasing of small segments of tubing, or fan-folding and compressing small segments of tubing[13]) between the fingers.[10–12,16,18,22,23,26, 28-30] **(Level C*)**
Ensure there are no clamps on the chest tubes during milking.
	Obstruction of drainage from the chest tube interferes with lung reexpansion or may cause cardiac tamponade.
	Stripping the entire length of the chest tube is contraindicated because it results in transient high negative pressures in the pleural space that could lead to lung entrapment.[11]
	No significant differences are reported in the amount of drainage when the tubing is milked as opposed to stripped.[12] Milking can cause excessive negativity. Use the high negativity relief value to restore negativity to prescribed levels (see Step 8). Milking with a clamp on can result in the build-up of excessive thoracic pressure.
		• Inability to establish patency
		• Excessive drainage
		• Signs and/or symptoms of increasing:
		  • Pneumothorax
		  • Cardiac tamponade
		  • Hemothorax

5. Maintain drainage tubing free of dependent loops (i.e., place the tube horizontally on the bed and down into the collection chamber, coiling the tubing on the bed). If a dependent loop cannot be avoided, lift and drain the tubing every 15 minutes.[13,14,24] **(Level C)**	Drainage that accumulates in dependent loops obstructs chest drainage into the collecting system and increases pressure within the lung.[10,12,13,15,22,24] Allow enough length for patient movement.	• Loops or kinks that cannot be removed

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.

Patient Monitoring and Care —*Continued*

Steps	Rationale	Reportable Conditions
6. Monitor fluid levels in the CDS chambers by briefly turning off the suction and refill (usually every 8 hours for suction chamber and every 24 hours for water-seal) or remove solution levels as necessary to the prescribed amount.	To maintain prescribed water-seal and suction levels and to prevent complications. Water-seal levels >2 cm increase the work of breathing; levels <2 cm expose the water-seal to air and increase the risk for pneumothorax.[1,19]	• Inability to maintain a water-seal or to keep suction at prescribed level
7. Assess for CDS patency: note fluctuations or tidaling of fluid level in the water-seal chamber (disposable CDS) or the long straw of the water-seal bottle (bottle CDS) with respirations.[1,19] If a suction source has been added, momentarily turn suction off or pinch suction tubing to accurately assess for fluctuations or tidaling.	Tidaling, fluid fluctuation up and down or back and forth, indicates effective communication between the pleural space and drainage system and provides an indication of lung expansion. Fluctuations or tidaling stops when the lung is reexpanded or when the tubing is obstructed by a kink, a fluid-filled loop, the patient lying on the tubing, or a clot or tissue at the distal end.[1,10,19] Suction must be turned off to accurately assess for tidaling.	• Absence of fluctuations or tidaling
8. Assess CDS equipped with a float valve for increases in the patient's negative intrathoracic pressure. Inspect water-seal chamber for increased levels (e.g., after milking of chest tube or when decreasing the amount of suction). Ensure the CDS is operating on suction. Second, temporarily depress the filtered manual vent until the float valve releases and the water column lowers.	Changes in the patient's intrathoracic pressure are reflected by the height of the water in the water-seal column. Do not lower water-seal column when suction is not operating or when patient is on gravity drainage. Resume suction while performing this operation. If suction is not operative, or operating on gravity drainage, depressing the high-negative relief valve can reduce negative pressure within the collection chamber to zero (atmosphere), possibly resulting in a pneumothorax.	• Sustained increases in negative pressures
9. Assess insertion site and surrounding skin for the presence of subcutaneous emphysema (crepitus) and signs of infection or inflammation daily and with each dressing change. Dressings should be changed when soiled, per institution protocol, or when ordered by practitioner. Routine petroleum dressings are not recommended.[15] **(Level E*)**	Crepitus may indicate chest tube obstruction or improper tube position. Skin integrity is altered during insertion and can lead to infection. Petroleum gauze dressing has been noted to cause skin maceration, potentiating the risk of infection.[15]	• New or increasing subcutaneous emphysema (crepitus) • Fever • Redness around insertion site • Purulent drainage

*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

Procedure continues on following page

Patient Monitoring and Care —*Continued*

Steps	Rationale	Reportable Conditions
10. Monitor collection chamber for total amount of fluid. Change CDS when approaching full or if system integrity is interrupted (i.e., cracked). Assess cardiopulmonary status and vital signs (including Spo_2) before and after procedure. Prepare new CDS according to manufacturer's instructions. Then, briefly (i.e., for less than a minute) cross clamp the chest tube close to the patient's chest. Attach the new system, unclamp the chest tube, check connections, and assess function of drainage system.	When the patient has an air leak or pneumothorax, clamping of the chest tube may precipitate a tension pneumothorax because the air has no escape route and may accumulate in the pleural space.[1,15,17] Clamping of the chest tube should be as brief as possible.	• Respiratory distress noted during or after procedure • Changes in breath sounds after procedure • Nonfunctioning CDS
11. During gravity drainage, ambulation, or transport with gravity drainage, ensure CDS is upright, below the chest tube insertion site, and maintain the suction control stopcock in the "on" or "open" position. Do not clamp chest tube during transport.[1,25] **(Level E*)**	The suction control stopcock should always remain in the "on" or "open" position. Do not clamp or cap the suction line. Leaving the port open allows air to exit and minimizes the possibility of tension pneumothorax.	• Notify physician of inadvertent clamping or capping of the suction line
12. Follow institution standard for assessing pain. Administer analgesia as prescribed.	Identifies need for pain interventions.	• Continued pain despite pain interventions.
13. Obtain a drainage specimen from some disposable CDSs. Cleanse the site with antiseptic solution and use a syringe with a smaller (e.g., 20-gauge) needle to withdraw the specimen from the self-sealing diaphragm, or self-sealing drainage tubing, as available. Momentarily forming a dependent loop in the fluid collection tubing may be necessary to obtain a specimen.	Provides a specimen for analysis.	• Inability to obtain specimen

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Documentation

Documentation should include the following:

- Patient and family education
- Pain assessment, interventions, and effectiveness
- Cardiopulmonary and vital sign assessment
- Type of drainage system used
- Amount of suction, fluctuation or tidaling, type and amount of drainage
- Air leak: absence, presence, severity, and resolution
- Respiratory, thoracic, and vital sign assessment at baseline and with changes in therapy
- Completion and results of the postinsertion chest radiograph and any other ordered diagnostic tests
- Unexpected outcomes
- Nursing interventions
- Patient's tolerance of the therapy

References and Additional Readings

For a complete list of references and additional readings for this procedure, scan this QR code with any freely available smartphone code reader app, or visit http://booksite.elsevier.com/9780323376624.