

CHEST DRAINAGE AS A THERAPEUTIC INTERVENTION

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Normal Anatomy and Physiology

CHEST DRAINAGE AS A THERAPEUTIC INTERVENTION

The clinical need for chest drainage arises anytime 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 unit is to evacuate the air and/or fluid from the chest cavity to help re-establish normal intrathoracic pressure. This facilitates the re-expansion of the lung to restore normal breathing dynamics. The need also arises following heart surgery to prevent the accumulation of fluid around the heart.

Patients with continual air or fluid leaks have a chest tube, also called a thoracic catheter, inserted. The distal end, which will be inside the patient's chest, has a number of drainage holes. The last eyelet can be detected on a chest x-ray as intermittent breaks in the radiopaque line. Once the chest tube has been properly positioned and secured, the x-ray should be checked to ensure that all drainage holes are inside the chest wall.

The location of the chest tube depends on what is being drained. Free air in the pleural space rises, so the tube is placed above the second intercostal space at the mid-clavicular line. Pleural fluid gravitates to the most dependent point, so the tube is placed at the 4th to 5th intercostal space along the mid-axillary line (figure 1). Mediastinal tubes placed to drain the pericardium after open-heart surgery are positioned directly under the sternum (figure 2). Once the chest tube is in place, it is connected to a chest drainage unit.

NORMAL ANATOMY AND PHYSIOLOGY

Before we discuss the chest drainage unit in detail, it is important to briefly review normal anatomy and physiology of the thorax with emphasis on the physiology of respiration. This will help us understand what can go wrong in the structure and function of the chest and how these problems can be treated.

CHEST WALL

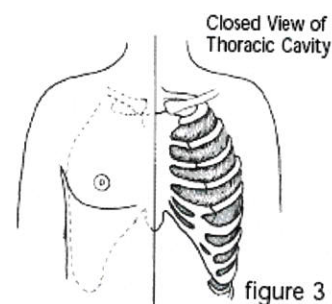
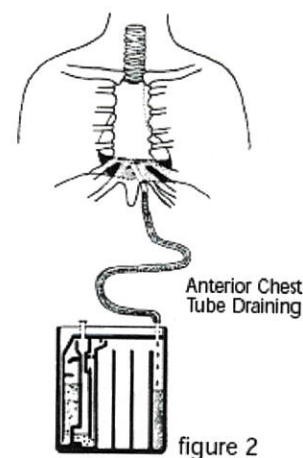
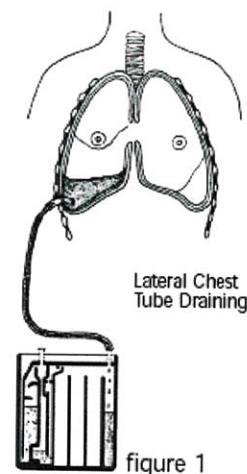
The chest wall is made up of bones and muscles. The bones, primarily ribs, sternum and vertebrae, form a protective cage for the internal structures of the thorax. The main muscles of the chest wall, the external and internal intercostals, extend from one rib to the rib below (figure 3). The external intercostals enlarge the thoracic cavity by drawing the ribs together and elevating the rib cage, while the internal intercostals decrease the dimensions of the thoracic cavity.

MEDIASTINUM

Within this musculoskeletal cage of the thorax are 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 (figure 4).

LUNGS

The lungs consist of airways (trachea and bronchi) that divide into smaller and smaller branches until



they reach the air sacs, called alveoli. The airways conduct air down to the alveoli where gas exchange takes place (figure 5).

The lung itself is covered with a membrane called the visceral (or pulmonary) pleura. The visceral pleura is adjacent to the lining of the thoracic cavity which is called the parietal pleura. Between the two membranes is a thin, serous fluid which acts as a lubricant – reducing friction as the two membranes slide across one another when the lungs expand and contract with respiration. The surface tension of the pleural fluid also couples the visceral and parietal pleura to one another, thus preventing the lungs from collapsing. Since the potential exists for a space between the two membranes, this area is called the pleural cavity or pleural space (figure 6).

RESPIRATION

Respiration is a passive, involuntary activity. Air moves in and out of the thorax due to pressure changes. When the diaphragm, the major muscle of respiration, is stimulated, it contracts and moves downward. At the same time, the external intercostals move the rib cage up and out. The chest wall and parietal pleura move out, pulling the visceral pleura and the lung with it. As the volume within the thoracic cavity increases, the pressure within the lung decreases. Intrapulmonary pressure is now lower than atmospheric pressure; thus air flows into the lung — inhalation (figure 7a).

When the diaphragm returns to its normal, relaxed state, the intercostal muscles also relax and the chest wall moves in. The lungs, with natural elastic recoil, pull inward as well and air flows out of the lungs — exhalation (figure 7b). The lungs should never completely collapse for there is always a small amount of air, called residual volume, in them.

Under normal conditions, there is always negative pressure in the pleural cavity. This negative pressure between the two pleurae maintains partial lung expansion by keeping the lung pulled up against the chest wall. The degree of negativity, however, changes during respiration. During inhalation, the pressure is approximately -8 cm H₂O; during exhalation, approximately -4 cm H₂O. If a patient takes a deeper breath, the intrapleural pressure will be more negative. Under normal conditions, the mechanical attachment of the pleurae, plus the residual volume, keep the lungs from collapsing.

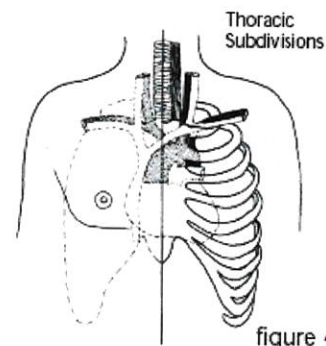


figure 4

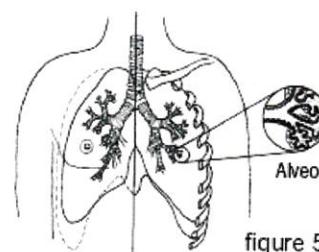


figure 5

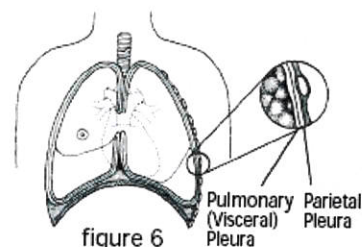
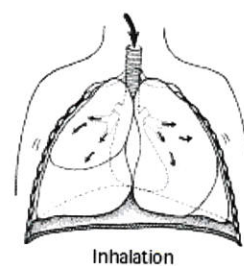
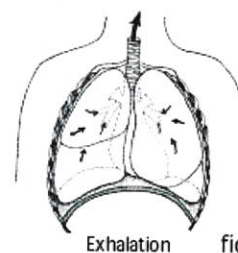


figure 6



Inhalation

figure 7a



Exhalation

figure 7b

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Chest Drainage Systems

TRADITIONAL CHEST DRAINAGE

In 1967, Deknatel introduced the first integrated disposable chest drainage unit based on the threebottle system. Now that we have reviewed normal anatomy, physiology, and pathophysiology, let's discuss each of the three chambers in detail.

COLLECTION CHAMBER

At the right side of the unit is the collection chamber (figure 13, D). The patient tubing connects the drainage unit directly to the chest tube. Any drainage from the chest flows into this chamber. The collection chamber is calibrated and has a write-on surface to allow for easy measurement and recording of the time, date, and amount of drainage.

WATER SEAL CHAMBER

The middle chamber of a traditional chest drainage system is the water seal. The main purpose of the water seal is to allow air to exit from the pleural space on exhalation and prevent air from entering the pleural cavity or mediastinum on inhalation. When the water seal chamber is filled with sterile fluid up to the 2 cm line, a 2 cm water seal is established (figure 14). To maintain an effective seal, it is important to keep the chest drainage unit upright at all times and to monitor the water level in the water seal to check for evaporation.

Bubbling in the water seal chamber indicates an air leak. The patient air leak meter indicates the approximate degree of air leak from the chest cavity (figure 14). The meter is made up of numbered columns, labeled from 1 (low) to 7 (high). The higher the numbered column through which bubbling occurs, the greater the degree of air leak. By documenting the number, the clinician can monitor air leak increase or decrease.

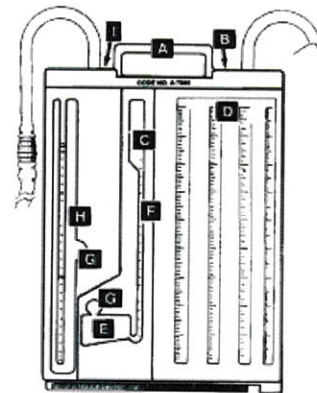
The water seal chamber also has a calibrated manometer to measure the amount of negative pressure within the pleural cavity (figure 13, F). The water level in the small arm of the water seal rises as intrapleural pressure becomes more negative. If there is no air leak, the water level should rise and fall with the patient's respirations, reflecting normal pressure changes in the pleural cavity. During spontaneous respirations, the water level should rise during inhalation and fall during exhalation. If the patient is receiving positive pressure ventilation, the oscillation will be just the opposite — the water level should fall with inhalation and rise with exhalation. This oscillation is called tidaling and is one indicator of a patent pleural chest tube.

At the top of the water seal chamber is a high negativity float valve and high negativity relief chamber (figure 13, C). These safety features maintain the water seal in the event of high negative pressures.

Three situations can cause high negative pressure:

1. The patient in respiratory distress, coughing vigorously, or crying;
2. Chest tube stripping;
3. Decreasing or disconnecting suction.

High negativity is indicated by rising water in the small arm of the water seal chamber. If the water rises



- A Carrying Handle
- B High Negativity Relief Valve
- C High Negativity Float Valve and Relief Chamber
- D Collection Chamber
- E Patient Air Leak Meter (A-7000 only)
- F Calibrated Water Seal
- G Self-Sealing Diaphragm in Water Seal Chamber and Suction Control Chamber
- H Suction Control Chamber
- I Positive Pressure Relief Valve

beyond -20 cm, the high negativity float valve will rise and impede the flow of water, allowing the patient to develop as much negativity as needed for inspiration. In instances of falsely imposed high negative pressure, such as stripping chest tubes, water will continue to rise, filling the high negativity relief chamber. The relief chamber automatically vents excessive negative pressure, thus preventing respiratory compromise from accumulated negativity.

Vigorous milking or stripping can create dangerously high negative pressures. Research has documented negative pressures as high as -450 cm H₂O. Pleurevac prevents accumulation of excessive high negative pressure as discussed above; however, the transient high negative pressures created by vigorous stripping can put the patient at risk for mediastinal trauma and graft trauma. Use extreme caution and follow your hospital policy.

A manual high negativity relief valve is located on top of chest drainage systems (figure 15). Depressing the high negativity relief valve allows filtered air into the system, relieving negativity and allowing the water level to return to baseline in the water seal. Use the high negativity relief valve with caution. If suction is not operative, or if operating on gravity drainage, depressing the high negativity relief valve can reduce negative pressure within the collection chamber to zero (atmosphere) with the resulting possibility of a pneumothorax.

WET SUCTION CONTROL

The chamber on the left side of the unit is the suction control chamber (figure 13, H). Traditional chest drainage units regulate the amount of suction by the height of a column of water in the suction control chamber. Note: it's the height of water, not the setting of the suction source, that actually limits the amount of suction transmitted to the pleural cavity. A suction pressure of -20 cm H₂O is commonly recommended. Lower levels may be indicated for infants and for patients with friable lung tissue, or if ordered by the physician.

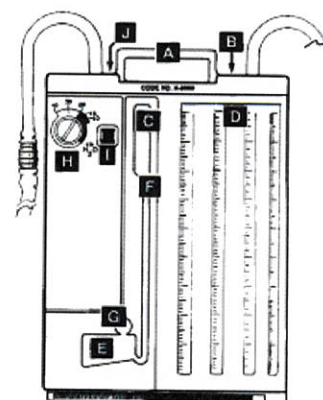
In a wet suction control system such as the Pleur-evac® A-7000/A-8000 series, fill the suction control chamber to the desired height with sterile fluid. Connect the short suction tubing to a suction source, and adjust the source suction to produce gentle bubbling in the suction control chamber. Increasing suction at the suction source will increase airflow through the system, but will have minimal effect on the amount of suction imposed on the chest cavity. Excessive source suction not only causes loud bubbling (which can disturb patients and caregivers), but also hastens evaporation of water from the suction control chamber. This results in a lower amount of suction applied to the patient as the level of water decreases. Self-sealing diaphragms are provided to adjust the water level in this chamber.

NEW GENERATION CHEST DRAINS

DRY SUCTION

The next step in the evolution of chest drainage units was the development of dry suction control chambers. Dry suction control systems provide many advantages: higher suction pressure levels can be achieved, set-up is easy, no continuous bubbling provides for quiet operation, and there is no fluid to evaporate which would decrease the amount of suction applied to the patient.

Instead of regulating the level of suction with a column of water, the dry suction units are controlled by a self-compensating regulator. A dial to set the suction control setting is located on the upper left



- A Carrying Handle
- B High Negativity Relief Valve
- C High Negativity Float Valve and Relief Chamber
- D Collection Chamber
- E Patient Air Leak Meter
- F Calibrated Water Seal
- G Self-Sealing Diaphragm
- H Suction Control Dial
- I Suction Control Indicator Window with Fluorescent Float
- J Positive Pressure Relief Valve

figure 13



figure 14

side of each unit. To set the suction setting, rotate the dial until the red stripe appears in the semi-circular window at the prescribed suction level and clicks into place. Suction can be set at -10 , -15 , -20 , -30 , or -40 cm of water. The unit is pre-set at -20 cm of water when opened (figure 16).

Connect the short suction tubing or suction port to the suction source. Source suction must be capable of delivering a minimum of 16 liters per minute (LPM) air flow. Increase suction source until the orange float appears in the suction control indicator window.

The unique design of the Pleur-evac dry suction control immediately responds to changes in patient pressure (patient air leak) or changes in suction pressure (surge/decrease at the suction source). The setting of the suction control dial determines the approximate amount of suction imposed regardless of the amount of source suction — as long as the orange float appears in the indicator window.

Patient situations that may require higher suction pressures of -30 or -40 cm H₂O include: a large air leak from the lung surface, empyema or viscous pleural effusion, a reduction in pulmonary compliance, or anticipated difficulty in expansion of the pulmonary tissue to fill the hemithorax.

In the presence of a large air leak, air flow through the Pleur-evac may be increased by increasing source suction, WITHOUT increasing imposed negativity. It is not necessary to change the suction setting on the Pleur-evac unit to accommodate high air flows. The suction control level can be changed at any time as prescribed by simply rotating the dial to the new suction setting. Confirm that the orange float remains in the suction control indicator window at the new suction setting. If suction setting is changed from a HIGHER to a LOWER level, the patient negativity may remain at the higher level unless the negativity is relieved. Use the manual high negativity relief valve to reduce negativity to desired level.

Both the wet suction and dry suction series of Pleurevac have a positive pressure relief valve that opens with increases in positive pressure, preventing pressure accumulation (figure 15). Normally, air exits through the suction port. Obstruction of this route (i.e. a bed wheel rolls on top of the suction tube, or the suction port is capped after suction discontinued) could cause accumulation of air in the system leading to tension pneumothorax. This safety feature allows venting of the positive pressure automatically, thus minimizing the risk of tension pneumothorax.

ONE-WAY VALVE

In the Pleur-evac Sahara®, (figure 17) a one-way valve replaces the traditional water seal. No water is required to establish the one-way seal. Just connect the patient tube to the patient's thoracic catheter and the patient seal is established for patient protection. The one-way valve maintains the patient seal even if the unit is tipped over. Unlike a water seal system in which the seal may be lost when the unit is tipped, the Sahara dry seal protects the patient from atmospheric air.

If air leak diagnostics are desired, the patient air leak meter must be filled to the "Fill" line. The fluid in the patient air leak meter is used for air leak detection as described earlier and is not a water seal.

In the Pleur-evac Sahara, negative pressure exists in the collection chamber when the YES can be seen in the indicator window (figure 18). During gravity drainage before normal negative pressure has been re-established in the pleural cavity, the indicator may



figure 15



figure 16

intermittently indicate negative pressure with patient respiration. During suction drainage, the pressure indicator should indicate a negative pressure continuously. The negative pressure indicator does not confirm drainage tube patency. Routinely check the drainage tube patency.

The Pleur-evac Sahara system also has an automatic high negative pressure relief valve to limit the negative pressure to approximately -50 cm of H₂O. A manual high negativity relief valve is also provided to vent excessive negativity as described earlier.

GRAVITY DRAINAGE

Not all patients require suction. Suction may be discontinued to transport a patient; it may also be discontinued 24 hours before chest tube removal. Consult hospital policy to determine if an order is needed to institute or discontinue suction. If suction is discontinued, the suction tube or port should remain **UNCAPPED** and free of **OBSTRUCTIONS** to allow air to exit and minimize the possibility of tension pneumothorax.

TO CLAMP OR NOT TO CLAMP?

The decision whether to clamp a chest tube when the drainage system has been knocked over and disconnected or otherwise disrupted is based on your initial assessment of the water seal chamber and air leak meter. If there has been no bubbling in the water seal, you can deduce there is no air leak from the lung. Therefore, the tube may be clamped for the short time it takes to reestablish drainage. If there has been bubbling and your assessment has determined there is an air leak from the lung, you **MUST NOT** clamp the chest tube. Doing so will cause air to accumulate in the pleural cavity since the air has no means of escape. This can rapidly lead to tension pneumothorax.

The few times you should clamp a chest tube are when: 1) You are performing a physician-ordered procedure such as sclerosing, 2) Assessing for a leak, or 3) Prior to removing the chest tube to determine if the patient can do without the chest tube (with a physician order).

You should never clamp a chest tube during patient transport unless the chest drainage system becomes disrupted during patient movement, and then only if there is no air leak.

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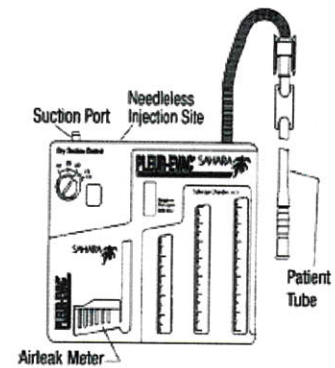


figure 17

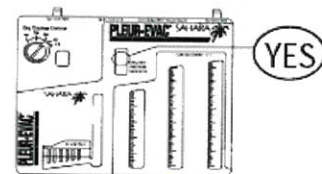


figure 18



Nursing Considerations and Troubleshooting

CHEST DRAINAGE AS A THERAPEUTIC INTERVENTION

Nursing assessment and trouble-shooting skills are essential to providing care for the patient with a chest tube. The following chart outlines a systematic approach for patient and chest drainage system assessment and lists the actions required for each assessment finding.

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AREA	ASSESSMENT	ACTION REQUIRED
RESPIRATORY STATUS	Are there signs of respiratory distress or a change from the baseline respiratory assessment?	In pleural chest drainage, the major hazard is tension pneumothorax. The most likely cause is obstructed tubing. Quickly assess the tubing's patency and notify the doctor immediately. Watch for signs and symptoms of recurring pneumothorax and pleural effusion.
CARDIAC STATUS (MEDIASTINAL TUBES)	Are there signs of cardiac tamponade?	If yes, notify surgeon immediately and follow emergency protocol for milking or stripping chest tubes to dislodge clots.
CHEST TUBE INSERTION SITE	Is dressing clean, dry, and intact?	Mark any drainage on dressing; notify doctor if significant.
	Is there crepitus upon palpation around the site?	Change dressing according to hospital policy. If new, notify doctor. Mark the borders of the crepitus and reassess periodically for any increase.
	Has the thoracic catheter been pulled out of the chest?	If there is a pleural air leak, apply a dressing with your hand, but release it periodically or at any sign of respiratory distress, so pleural air can escape. Notify the doctor immediately and prepare for replacement of the tube.
PATIENT DRAINAGE TUBES	Are all connections securely taped or banded?	Reconnect any loose connections and tape securely; assess for a new or increased air leak. Notify doctor if new or increased air leak present. If drainage tube is disconnected and contaminated, you may submerge the chest tube 1 to 2 inches (2-4 cm) below the surface of a 250 ml bottle of sterile water or saline until a new chest drainage unit is set-up. This establishes a water seal, allows the escape of air, and prevents the re-entry of air.
	Is the tube patent and free of kinks?	If no water is available and there has been bubbling in the water seal/air leak meter of a pleural tube, or there has been copious drainage from mediastinal tubes, leave the chest tube open. The entry of a small amount of air is not as dangerous as the potential for tension pneumothorax or cardiac tamponade.
	Are there any dependent loops in the tube?	Make sure tube is unclamped. Reposition as needed to avoid kinking of thoracic catheter or patient tube. Reposition tubing to eliminate dependent loops; fluid in the hanging loops causes resistance to flow out of the chest. You may coil the long tubing and secure it

**COLLECTION
CHAMBER**

Is the clamp open?

to a draw sheet with a safety pin (allowing enough tubing so that the patient can move in bed comfortably) to prevent dependent loops.

The tube should be open unless:
a. You are changing the unit. Clamp only briefly.
b. Specifically ordered by the doctor.

Do not clamp the chest tube during transport or ambulation unless specifically ordered by the doctor. Clamping the chest tube in patients with an air leak increases the chance for pneumothorax.

Position the open clamp away from the patient to avoid accidental closure.

What is the character of the drainage; is it bloody, strawcolored, or purulent?

Document findings. Notify doctor if character of drainage is a significant change, (i.e. straw-colored drainage at last check is now bloody).

What is the rate of drainage?

Position the tubing and drainage system below the patient's chest at all times to allow for gravity drainage and prevent fluid backflow.

Mark the level of drainage with date and time of measurement.

Has the drainage stopped suddenly?

Sudden hemorrhage in a postoperative cardiac patient is likely caused by a ruptured suture line or blown graft. The patient can lose 1,000 to 1,500 ml of blood in a matter of minutes. Immediately alert the surgeon and prepare for return to the operating room.

A sudden (not gradual) cessation of drainage in the patient with mediastinal tubes can be caused by accumulated clotted blood occluding the tube. This can lead to life-threatening cardiac tamponade. To keep the tubes patent, or to dislodge clots, gently milk the tube.

If the patient's condition is deteriorating rapidly, follow the emergency procedures of milking/stripping to dislodge clots.

If the patient appears stable, make sure the unit is low enough so gravity can assist drainage; raise the bed, lower the Pleur-evac or turn the patient on his affected side.

Are the columns only partially filled?

Check tubing for kinks or bends. Make sure tube is not clamped.

If the drainage has been tapering off over the past few shifts, lack of drainage may be normal.

Surface tension of the fluid may pull drainage into the next column if the drainage nears the top OR the unit has tipped over.

Is the collection chamber full?

In a water seal unit:
• Check the fluid level in the water seal and adjust to 2 cm.
• Assess for new or increased air leak; notify doctor if present.
• Mark the level of drainage in each column and add to calculate the total drainage.
• If water from a wet suction control unit entered the collection chamber, note the

		amount of water that entered the chamber and subtract from the total drainage. Refill the suction control chamber to the desired level.
		Change the chest drainage unit according to the set-up instructions printed on the front of each Pleur-evac.
WATER SEAL CHAMBER	Is the water level correct at 2 cm?	Adjust the level, if needed, using a syringe and 18 gauge (or smaller) needle through the self-sealing diaphragm on the front of the water seal.
OR		
ONE-WAY VALVE	Is the negative pressure indicator (YES) visible?	During gravity drainage, the indicator may intermittently indicate a negative pressure in the collection chamber with patient respiration. The negative pressure indicator (YES) should remain visible continuously when the intrapleural pressure remains negative throughout the patient's respiratory cycle. During suction drainage, the pressure indicator should indicate a negative pressure continuously.
		CAUTION: If the negative pressure indicator does not show the YES as described, 1) check patient connections for leaks, 2) check tubing connections on the unit. If all connections are secure and the YES does not appear, replace the unit. The negative pressure indicator does not confirm drainage tube patency. Routinely check the drainage tube patency.
AIR LEAK METER	Is there bubbling?	Identify the source of the air leak: <ul style="list-style-type: none"> • Check and tighten connections. • Test the tubing for leaks.* • If leak is in the tubing, replace the unit. • If the leak may be at the insertion site, remove the chest tube dressing and inspect the site. Make sure the catheter eyelets have not pulled out beyond the chest wall. If you cannot see or hear any obvious leaks at the site, the leak is from the lung. Replace the dressing. • Check patient history. Would you expect a patient air leak?
	Is the bubbling continuous or intermittent?	Note the pattern of the bubbling. If it fluctuates with respirations (i.e. occurs on exhalation in a patient breathing spontaneously), the most likely source is the lung.
		Notify doctor of any new, increased, or unexpected air leaks that are not corrected by the above actions.
		Document the magnitude of a patient air leak using the air leak meter. The higher the numbered column through which the bubbling occurs, the greater the degree of air leak. If bubbling is noted in first two columns of airleak meter, document 'Airleak 2'.

* To test the system for the site of an air leak: Using a boot (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 8-12 inch (20-30 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.

	<p>If there is no bubbling, does the fluid move up and down with respirations?</p> <p>Has water risen in the small arm of the water seal/air leak meter?</p>	<p>In a patient with a pleural chest tube, tidaling is normal. Oscillations are more apparent when suction is momentarily turned off.</p> <p>If there is no tidaling, consider 1) an occlusion somewhere between the pleural cavity and the water seal, 2) a full expansion of the lung where suction has drawn the lung up against the holes in the chest tubes, or 3) PEEP, which can dampen oscillation. Check tubing for occlusion as noted previously. Oscillations may also be dampened in one-way valve units.</p> <p>In a patient with a mediastinal tube, there should be no bubbling or movement in the water seal/air leak meter. Lack of bubbling is normal.</p> <p>Depress the high negativity relief valve until the water level reaches the desired level. CAUTION: If suction is not operative, or if operating on gravity drainage, depressing the high negativity relief valve can reduce negative pressure within the collection chamber to zero (atmosphere) with the resulting possibility of a pneumothorax.</p>
WET SUCTION CONTROL	<p>Is there continuous bubbling?</p> <p>Is the chamber underfilled or overfilled?</p>	<p>Gentle continuous bubbling indicates suction is operative. Vigorous bubbling speeds the evaporation of fluid which results in a lower level of suction.</p> <p>If no bubbling:</p> <ul style="list-style-type: none"> • Make sure the suction tubing is connected and not occluded. • Turn the source suction higher. • If the patient has a large pleural air leak, the amount of air flowing out is more than the suction can handle. You are likely to see this only in patients receiving mechanical ventilation, and you will see vigorous bubbling in the water seal chamber. <p>Momentarily discontinue suction to observe the fluid level in the suction control chamber.</p> <p>If underfilled, add fluid through the atmospheric vent on top of the Pleur-evac.</p> <p>If overfilled, withdraw fluid from the self-sealing diaphragm on the front of the suction chamber until desired level is achieved.</p> <p>Resume suction.</p>
DRY SUCTION CONTROL	<p>Is the dial set at the prescribed suction?</p> <p>Is the orange float in the indicator window?</p> <p>Does the water rise in the small arm of the air leak meter when the dry suction setting is lowered?</p>	<p>Turn the dial to click into the correct suction setting. -20 cm H₂O suction is most common for adults.</p> <p>If not, check the suction tubing to make sure it's not disconnected or occluded.</p> <p>Turn up the source suction until the orange float appears.</p> <p>This is normal. It simply reflects the previous higher setting. If the patient does not have an air leak, vent the excess negativity by depressing the high negativity relief valve.</p>

GRAVITY DRAINAGE

Is the suction tube/port open?

If gravity drainage is prescribed, the short suction tube or port should remain **UNCAPPED, UNCLAMPED**, and free of **OBSTRUCTIONS** to allow air to exit and minimize possibility of tension pneumothorax.

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