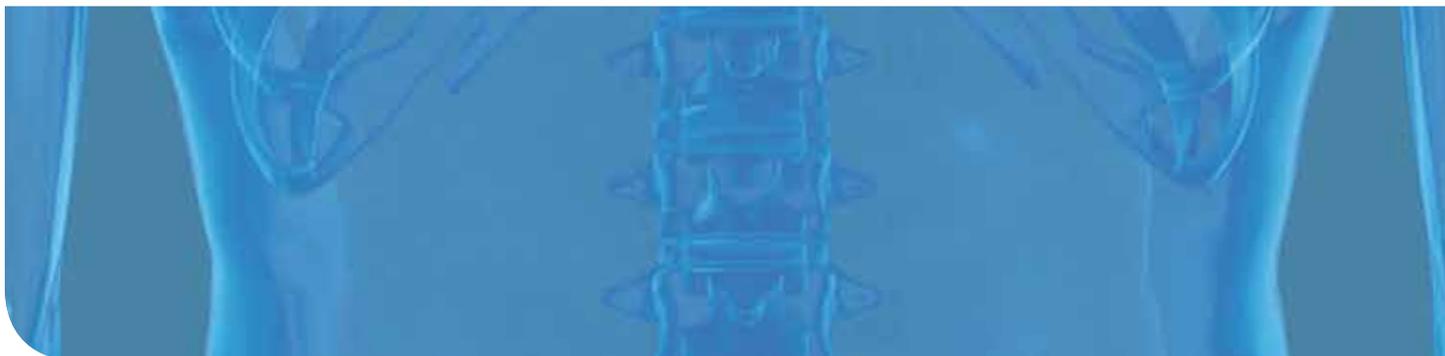




## UNDERSTANDING CHEST DRAINAGE



It is the ambition of Teleflex Medical to always be one step ahead of time. With all our products, from design through manufacturing to distribution, it is the healthcare customer we have on our mind. Striving for precision in every detail to provide utmost safety coupled with greatest comfort for both patient and caregiver.

Traditional chest drainage was based on a threebottle system. A disposable integrated chest drainage unit was introduced in 1967 by DEKNATEL for the first time. Dry suction control systems, which provide many advantages, were the next great step in the evolution of chest drainage systems. The newest generation of these dry suction control systems, e.g. Sahara™, has been designed by PLEUR-EVAC. DEKNATEL as well as PLEUR-EVAC are part of the Teleflex Medical brand family.

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## 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).

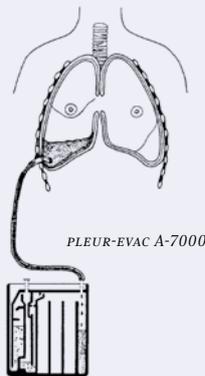


Figure 1:  
Lateral Chest Tube Draining

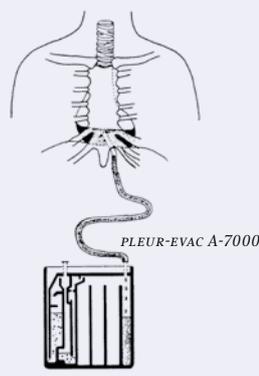


Figure 2:  
Anterior Chest Tube Draining



Figure 3:  
Closed View of Thoracic Cavity

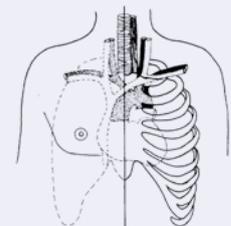


Figure 4:  
Thoracic Subdivisions

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  $-8 \text{ cm H}_2\text{O}$ ; during exhalation, approximately  $-4 \text{ cm H}_2\text{O}$ . 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.

## THORACIC SYSTEM PATHOLOGY

When air or fluid enters the pleural space, it: 1) separates the visceral pleura from the parietal pleura, thus disrupting the negative pressure that prevents the lungs from collapsing at the end of exhalation, and 2) compresses the lung. If only a small amount of air or fluid is present, it may be reabsorbed without intervention. However, if large enough, the fluid or air compromises normal respiration and must be evacuated from the pleural space.

### PNEUMOTHORAX

Air in the pleural space is called a pneumothorax, which can be classified as spontaneous or traumatic. Dyspnea and chest pain are the most common symptoms of pneumothorax. Decreased breath sounds and lack of movement on the affected side may also be observed.

### SPONTANEOUS PNEUMOTHORAX

Spontaneous pneumothorax is usually caused by the rupture of a small bleb (enlarged air sac) on the lung's surface (figure 8). It typically occurs in tall, thin men who smoke where mechanical stresses at the apex (top) of the lung weaken

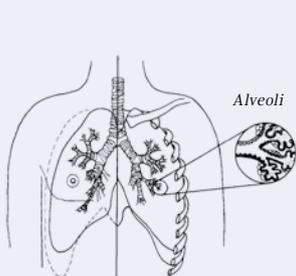


Figure 5

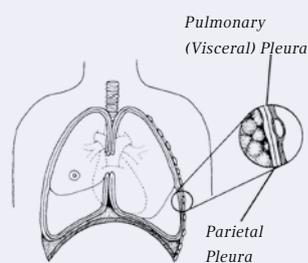


Figure 6

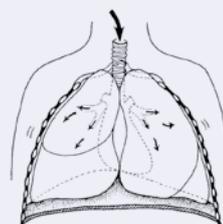


Figure 7a:  
Inhalation

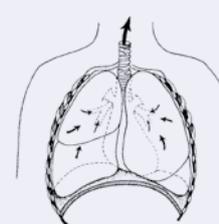


Figure 7b:  
Exhalation

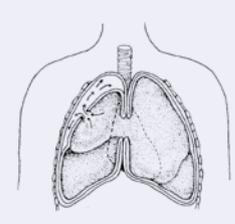


Figure 8:  
Closed Pneumothorax

the lung tissue. It may also result as a complication of pre-existing lung disease that weakens the lung, making it more prone to rupture. Common causes include chronic obstructive pulmonary disease, cystic fibrosis, necrotizing pneumonia and AIDS patients with *Pneumocystis carinii* infection.

### TRAUMATIC PNEUMOTHORAX

Traumatic pneumothorax may result from:

- 1) Internal trauma, such as rib fracture, where the rib punctures the lung (figure 9). If there is no opening to the outside of the chest wall, it is called a closed pneumothorax.
- 2) External trauma, such as a stab wound or bullet wound, that penetrates the chest wall and may puncture the lung (figure 10). This is called an open pneumothorax or a sucking chest wound.
- 3) Invasive or therapeutic procedures, such as transthoracic needle aspiration, subclavian needle stick or thoracentesis, that inadvertently puncture the lung. This is called iatrogenic pneumothorax. The use of positive end-expiratory pressure (PEEP) with mechanical ventilation can also result in iatrogenic pneumothorax, particularly in patients with acute respiratory distress syndrome (ARDS) where the lung tissue is weakened.

### TENSION PNEUMOTHORAX

Tension pneumothorax occurs when air accumulates in the pleural space more rapidly than it can be evacuated. Pressure builds up which not only collapses the lung, but can also shift the mediastinum and severely impede venous return and cardiac output (figure 11). A tension pneumothorax quickly becomes life-threatening and must be relieved promptly.

Signs/symptoms of tension pneumothorax include: rapid, labored respirations; tachycardia; cyanosis; hypoxemia; and sudden chest pain that extends to the shoulders. In a mechanically ventilated patient, the high inspiratory pressure alarm may also sound. Tracheal deviation (the trachea is skewed away from the side of the tension pneumothorax) signifies that a mediastinal shift has occurred and is an ominous sign.

### PLEURAL EFFUSION

Fluid in the pleural space is called pleural effusion. The fluid may be lymph (chylothorax), pus (empyema), blood (hemothorax), or non-specific serous fluid. The mechanism of distress in pleural effusion is direct compression of lung tissue; the fluid occupies space the lung would usually fill (figure 12). On examination, you would detect muffled or absent breath sounds and dullness to percussion.

### HEMOTHORAX

Hemothorax is defined as the presence of blood in the pleural space. This is caused primarily by chest trauma where virtually every blood vessel in the chest can bleed into the pleural space. Iatrogenic hemothorax may occur, mostly as a complication of a central venous catheter placement.

### CARDIAC TAMPONADE

Blood may also accumulate in the mediastinum, specifically the pericardial sac, after cardiac surgery. Accumulation of fluid around the heart can cause cardiac tamponade. Because it compresses the heart and interferes with venous return, it can be life-threatening. Signs reflect the decreased venous return: cardiac output drops severely, jugular veins distend, pulmonary artery (PA) pressures increase, central venous pressure (CVP) increases, and blood pressure falls. These are ominous signs and require immediate emergency actions.

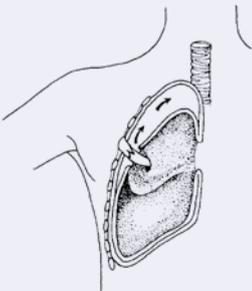


Figure 9:  
Blunt Trauma Pneumothorax

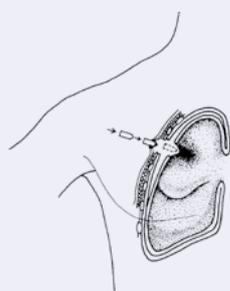


Figure 10:  
Open Pneumothorax

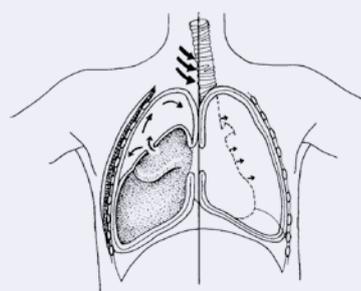


Figure 11:  
Tension Pneumothorax/Mediastinal Shift

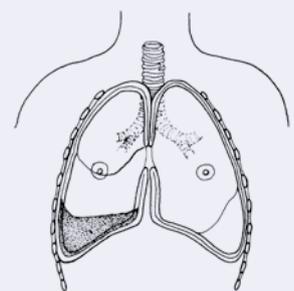


Figure 12:  
Pleural Effusion

# CHEST DRAINAGE SYSTEM

## TRADITIONAL CHEST DRAINAGE

In 1967, Deknatel introduced the first integrated disposable chest drainage unit based on the three-bottle 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.

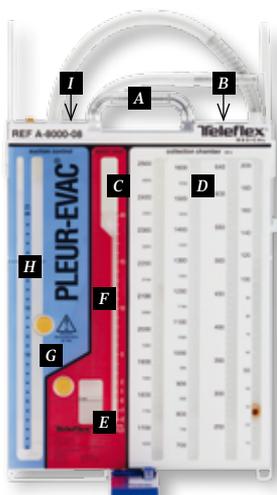
The water seal chamber also has a calibrated manometer to measure the amount of negative pressure within the pleural cavity (figure 13, F). The water level in the small arm of the water seal rises as intrapleural pressure becomes more negative.

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.

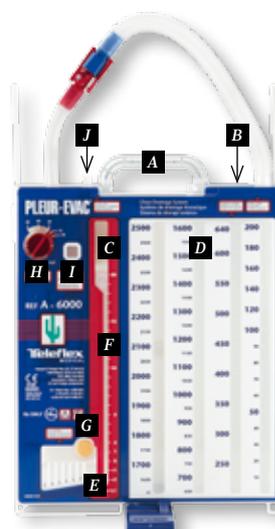
Three situations can cause high negative pressure:

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



**Figure 13:**  
PLEUR-EVAC A-7000/A-8000

- 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



**Figure 13:**  
PLEUR-EVAC A-6000

- 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

High negativity is indicated by rising water in the small arm of the water seal chamber. If the water rises 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 H<sub>2</sub>O. 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 H<sub>2</sub>O 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.

Figure 14



Figure 15



Figure 16



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 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 H<sub>2</sub>O 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 PLEUR-EVAC 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

Figure 17



Figure 18



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 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 H<sub>2</sub>O. 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 minimise 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.



Figure 19

## SPECIAL CONSIDERATIONS

### NEWBORNS

Newborns with idiopathic respiratory distress syndrome (hyaline membrane disease) may develop multiple pneumothoraces requiring multiple chest tubes. Newborn lung tissue is immature and delicate, and the lack of surfactant makes the lungs stiff and difficult to ventilate. To overcome this stiffness, relatively high positive airway pressure may be necessary during mechanical ventilation, which may be associated with pneumothorax.

Within the PLEUR-EVAC line are units specifically designed for neonatal and infant use, with smaller collection chambers having finer calibrations to allow more accurate measurement of small drainage volumes (figure 19). The connecting tube has a narrower diameter to allow connection to the smaller chest tubes used in these patients.

### MASSIVE PLEURAL AIR LEAK

Massive pleural air leaks can be seen in patients with necrotising pneumonia or massive chest trauma and in those receiving mechanical ventilation with high positive airway pressures. Studies have shown that air from such large air leaks has participated in gas exchange, and need not be compensated for in mechanical ventilator settings.

Such massive air leaks may overwhelm the suction flow capacity through a chest drainage system. Turning up the source suction will increase air flow through the system, not suction pressure. In the case of a massive pleural leak, increased air flow may be necessary to pull the air through the system fast enough to evacuate the pleural cavity before the next breath. With wet suction, you will see vigorous bubbling in the water seal chamber and no bubbling in the suction control chamber if suction flow capacity has been overwhelmed. With dry suction, the orange float will not appear in the window. Again, turn up the suction source until the orange float reappears.

## NURSING CONSIDERATIONS & TROUBLESHOOTING

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.

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. Change dressing according to hospital policy.
	Is there crepitus upon palpation around the site?	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 no pleural air leak, apply an occlusive dressing and notify the doctor, who will decide if the tube should be replaced.  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.

AREA	ASSESSMENT	ACTION REQUIRED
Patient Drainage Tubes	Are all connections securely taped or banded?	<p>Reconnect any loose connections and tape securely; assess for a new or increased air leak. Notify doctor if new or increased air leak present.</p> <p>If drainage tube is disconnected and contaminated, you may submerge the chest tube 2–4 cm (1 to 2 inches) 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.</p> <p>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.</p>
	Is the tube patent and free of kinks?	Make sure tube is unclamped. Reposition as needed to avoid kinking of thoracic catheter or patient tube.
	Are there any dependent loops in the tube?	<p>Reposition tubing to eliminate dependent loops; fluid in the hanging loops causes resistance to flow out of the chest.</p> <p>You may coil the long tubing and secure it to a draw sheet with a safety pin (allowing enough tubing so that the patient can move in bed comfortably) to prevent dependent loops.</p>
	Is the clamp open?	<p>The tube should be open unless:</p> <ol style="list-style-type: none"> <li>You are changing the unit. Clamp only briefly.</li> <li>Specifically ordered by the doctor.</li> </ol> <p>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.</p> <p>Position the open clamp away from the patient to avoid accidental closure.</p>

AREA	ASSESSMENT	ACTION REQUIRED
Collection Chamber	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?	<p>Position the tubing and drainage system below the patient's chest at all times to allow for gravity drainage and prevent fluid backflow.</p> <p>Mark the level of drainage with date and time of measurement.</p> <p>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.</p>
	Has the drainage stopped suddenly?	<p>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.</p> <p>If the patient's condition is deteriorating rapidly, follow the emergency procedures of milking/stripping to dislodge clots.</p> <p>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.</p> <p>Check tubing for kinks or bends. Make sure tube is not clamped.</p> <p>If the drainage has been tapering off over the past few shifts, lack of drainage may be normal.</p>
	Are the columns only partially filled?	<p>Surface tension of the fluid may pull drainage into the next column if the drainage nears the top OR the unit has tipped over.</p> <p>In a water seal unit:</p> <ul style="list-style-type: none"> <li>• Check the fluid level in the water seal and adjust to 2 cm.</li> <li>• Assess for new or increased air leak; notify doctor if present.</li> <li>• Mark the level of drainage in each column and add to calculate the total drainage.</li> <li>• 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.</li> </ul>
	Is the collection chamber full?	Change the chest drainage unit according to the set-up instructions printed on the front of each PLEUR-EVAC.

AREA	ASSESSMENT	ACTION REQUIRED
Water Seal Chamber or One-Way Valve	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.
	Is the negative pressure indicator (YES) visible?	<p>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.</p> <p>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.</p>

AREA	ASSESSMENT	ACTION REQUIRED
Air Leak Meter	Is there bubbling?	Identify the source of the air leak: <ul style="list-style-type: none"> <li>• Check and tighten connections.</li> <li>• Test the tubing for leaks.*</li> <li>• If leak is in the tubing, replace the unit.</li> <li>• 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.</li> <li>• Check patient history. Would you expect a patient air leak?</li> </ul>
	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'.
	If there is no bubbling, does the fluid move up and down with respirations?	In a patient with a pleural chest tube, tidaling is normal. Oscillations are more apparent when suction is momentarily turned off.  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.  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.
	Has water risen in the small arm of the water seal/air leak meter?	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.

\*To test the system for the site of an air leak: Using a booted (or padded) clamp, begin at the dressing and clamp the drainage tubing momentarily. Look at the water seal/air leak meter chamber. Keep moving the clamp down the drainage tubing toward the chest drainage system placing it at 20–30 cm (8–12 inch) 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.

AREA	ASSESSMENT	ACTION REQUIRED
Wet Suction Control	Is there continuous bubbling?	<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"> <li>• Make sure the suction tubing is connected and not occluded.</li> <li>• Turn the source suction higher.</li> <li>• 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.</li> </ul>
	Is the chamber underfilled or overfilled?	<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	Is the dial set at the prescribed suction?	Turn the dial to click into the correct suction setting. -20 cm H <sub>2</sub> O suction is most common for adults.
	Is the orange float in the indicator window?	<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>
	Does the water rise in the small arm of the air leak meter when the dry suction setting is lowered?	<p>This is normal. It simply reflects the previous higher setting.</p> <p>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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#### **YOUR CONTACTS FOR EUROPE, MIDDLE EAST AND AFRICA (EMEA):**

##### **TELEFLEX MEDICAL HEADQUARTER EMEA, IRELAND**

Teleflex Medical Europe Ltd., IDA Business Park, Athlone, Co Westmeath  
Phone +353 (0)9 06 46 08 00 · Fax +353 (0)14 37 07 73  
orders.intl@teleflexmedical.com

**AUSTRIA** +43 (0)1 402 47 72  
**BELGIUM** +32 (0)2 333 24 60  
**CZECH REPUBLIC** +420 (0)495 759 111  
**FRANCE** +33 (0)5 62 18 79 40  
**GERMANY** +49 (0)7151 406 0  
**GREECE** +30 210 67 77 717  
**HUNGARY** +36 (0)1 475 13 60  
**ITALY** +39 0362 58 911  
**NETHERLANDS** +31 (0)88 00 215 00  
**PORTUGAL** +351 22 541 90 85  
**SLOVAK REPUBLIC** +421 (0)3377 254 28  
**SOUTH AFRICA** +27 (0)11 807 4887  
**SPAIN** +34 918 300 451  
**SWITZERLAND** +41 (0)31 818 40 90  
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