MAQUET
GETINGE GROUP

A Personal Guide to **Managing Chest Drainage**

Dry Seal
Chest Drainage

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Your personal guide to **Managing Dry Seal Chest Drainage** is a quick and easy reference to help extend your understanding of dry seal chest tube drainage and to help answer questions which may come up from time to time. It is provided as an educational service by Maquet. This booklet has been prepared as an educational aid only and is not intended to replace any medical or nursing practices or hospital policies. Due to numerous model types available, it is important to carefully read and follow each corresponding product insert prior to use.

Introduction

Making it simple to understand

The purpose of any chest drainage device is to help re-establish normal vacuum pressures by removing air and fluid in a closed, one-way fashion.

The need for chest drainage is also required following open heart surgery and chest trauma to evacuate any pooling blood which, if left in the mediastinal cavity, can cause cardiac distress or tamponade. Hence, chest drainage is indeed a life-saving procedure and one of the most important services a physician and nurse clinician can render.

While the practical application of dry seal chest drainage techniques are relatively simple, sometimes the chest drain and its accompanying terminology may appear complex. However, dry seal chest drainage systems are actually quite simple to manage and easy to understand. It is our hope that a review of the educational aid booklet will help enhance your working knowledge of chest drainage and further familiarize you with Maquet's easy-to-use dry seal operating system.

Customer service

If a question or need arises for customer service, product information, or to request inservice educational material, we invite you to call anytime.

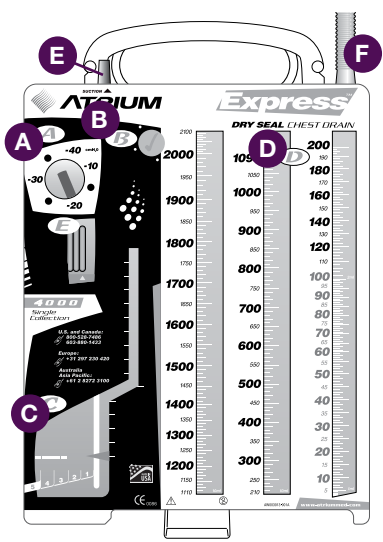
In the U.S.A. 1-800-528-7486
Outside the U.S.A. 603-880-1433
FAX 603-880-6718
www.maquet.com

For additional information about Atrium products refer to www.atriummed.com

How dry seal chest drains function

The basic operating system

Today's dry seal drainage systems are comprised of a one-piece, 3-chamber setup, which separates the functions of fluid collection, dry seal (which serves as a one-way valve), and suction control. Unlike Atrium's Ocean and Oasis series chest drains that utilize a traditional water seal for one-way seal protection, the Express features a dry seal valve as its seal. This mechanical one-way valve allows air to escape from the chest and prevents air from going back to the chest. The advantage of a dry seal valve is it does not require water to operate and it is not position sensitive like a water seal. On the other hand, a mechanical dry seal valve does not provide the same level of patient assessment as a traditional calibrated water seal. Dry seal drains must rely on other means to provide information such as a separate

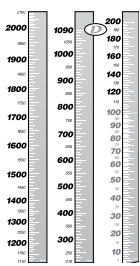


- A Dry suction control
- B Vacuum indicator
- C Air leak monitor
- D Collection chamber
- E Tube to suction
- F Tube from patient

air leak monitor for optional air leak detection and a vacuum indicator to determine when vacuum is present in the collection chamber.

Over the past several years, advances in engineering have enabled dry suction technology to be incorporated into familiar chest drain operating systems. Consequently, today's dry seal operating systems not only provide a simple and convenient method to maintain a required amount of vacuum in a patient's chest, but provide faster setup times, quiet operation and the ability to impose higher levels of controlled suction with the simple turn of the dial. Additionally, these new compact, lightweight chest drains better address the hospital's critical need for reduced disposal costs.

Fluid collection

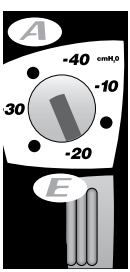


In a dry seal operating system, fluids drain from the patient directly into a large collection chamber via a 6-foot patient tube (3/8" I.D.). As drainage fluids collect in this chamber, the nurse will record the amount of fluid that collects on a specified schedule. Hence, an easy-to-read, well calibrated collection chamber is an important feature for any chest drainage system.

Dry seal valve & air leak monitor

The *dry seal valve*, located inside the chest drain, allows air from the patient (positive pressure) to pass through the mechanical one-way valve, and prevents air from returning to the patient. A dry seal valve is a simple, cost effective means for protecting the patient because it is not position sensitive. That means the patient is protected at all times even if the drain is knocked over. The air leak monitor (if filled with

pre-packaged sterile water provided) allows for visualization of a patient air leak. When bubbles are observed going from right to left, this will confirm a patient air leak. Intermittent bubbling will confirm the presence of an intermittent air leak. No bubbling will indicate no air leak is present. With the addition of a manual and automatic high negative pressure release valve, a patient is protected from the dangers of accumulating high vacuum pressures or high negativity, which can be induced from chest tube stripping or milking. Every Maquet chest drain model provides such patient protection both manually and automatically.



Dry suction control

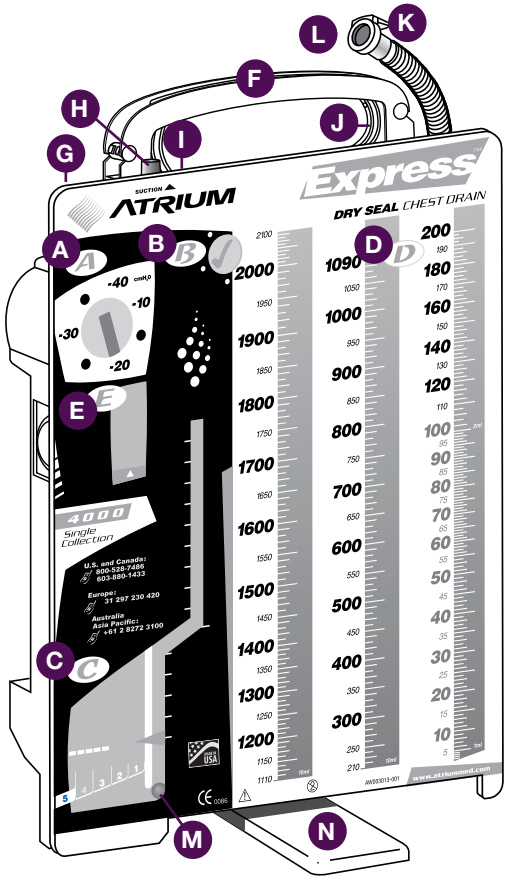
The addition of *suction* improves the *rate of and flow* of drainage, as well as helps overcome an air leak by improving the rate of airflow out of the patient. Today's advanced chest drains incorporate dry suction control technology to maintain safe and effective levels of vacuum to the patient. Similar to how a traditional calibrated water chamber controls suction, Maquet's dry suction control regulator works by **continuously balancing** the forces of suction and atmosphere. Maquet's dynamic automatic control valve (ACV), located inside the regulator, continually responds and adjusts to changes in patient air leaks and fluctuations in suction source vacuum to deliver accurate, reliable suction to the patient. Suction pressure can be set to any desired pressure between -10 cmH_2O and -40 cmH_2O by adjusting the rotary dry suction control dial. Expansion of the bellows across the suction monitor window (E) will readily confirm that suction is operating.

The Maquet system

All the water you need...and less!

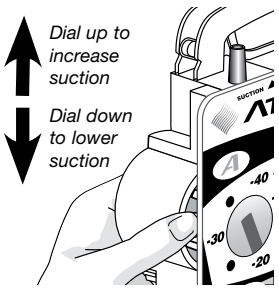
From the beginning, Maquet has pioneered advances in thoracic drainage with chest drains that are user friendly and cost effective. We've continued our commitment to product innovation with the latest series of Atrium Express™ dry seal chest drains, featuring a dry seal operating system with the enhanced performance and convenience of dry suction control. Maquet's family of dry seal chest drains has been carefully engineered to provide collection performance and satisfy today's critical need for more cost effective blood management.

- With pre-packaged water, system setup is fast and convenient.
- Dry seal valve protects patient like a water seal.
- Knock-over nozzles allow fluid levels to be recovered in the event of a knock-over.
- Finger-tip suction control dial can be adjusted to any suction setting between -10 cmH_2O and -40 cmH_2O for a wide range of chest drainage applications.
- Highly visible suction monitor bellows readily confirms suction operation.
- Large, easy-to-read graphics provide fast, accurate drainage assessment.
- Automatic high negativity pressure relief valve activates to limit system pressure at approximately -50 cmH_2O.
- Blue tint water in air leak monitor (if filled with sterile water provided) offers enhanced visibility for air leak detection.

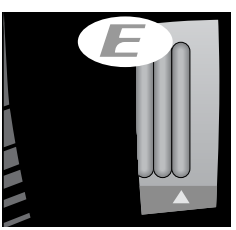


- **A** Dry suction regulator
- **B** Vacuum indicator
- **C** Air leak monitor
- **D** Collection chamber
- **E** Suction monitor bellows
- **F** Easy-to-grip handle
- **G** Positive pressure release valve
- **H** Suction port
- **I** Filtered manual high negativity vent
- **J** Multi-position hangers
- **K** In-line connector
- **L** Needleless access port
- **M** Patient pressure float ball
- **N** Swing out floor stand

Maquet's dry suction control regulator provides accurate, dependable suction for a wide range of chest drainage applications. The regulator design continually and automatically adjusts to changes in patient air leaks and/or fluctuations in hospital wall suction to help maintain a more consistent vacuum level to the patient. Suction pressure can be set to any desired pressure level between -10 cmH_2O and up to a maximum of -40 cmH_2O. Changing the suction pressure is accomplished by adjusting the rotary dry suction control dial located on the side of the drain. Dial down to lower the suction setting and dial up to increase the suction pressure setting.



Suction monitor bellows



Maquet's suction monitor bellows allows easy confirmation of vacuum operation. Expansion of the bellows across the suction monitor window will confirm suction operation.

Bellows expanded to ▲ mark or beyond confirms adequate suction operation.

Air leak monitor technology

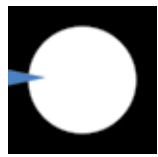
At the heart of every Atrium Express™ dry seal chest drain is an advanced air leak monitor design. Patient air leak assessment and system integrity are enhanced with Maquet's blue tint water and knock-over protection. Together with our automatic high negative pressure relief and an easy-to-use filtered manual

vent, patients have protection from accumulating high negative pressure.

Vacuum indicator

When vacuum is present in the collection chamber, a ✓ symbol will remain visible in the vacuum indicator window. When vacuum is not present (atmospheric pressure) no symbol will appear. All patient tube connections and the vacuum indicator window should be checked regularly for vacuum confirmation.

Vacuum is present



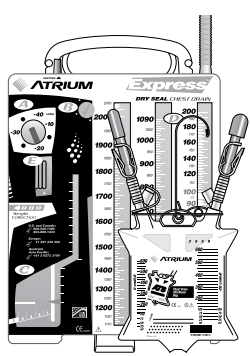
Vacuum is not present

Automatic high negativity relief

During prolonged episodes of extreme negative pressure (as with chest tube stripping), Maquet's controlled release system will automatically relieve excessive high negative pressure to a lower level (release set at approximately -50 cmH_2O).

System disconnection and options for autotransfusion

All models are equipped with in-line connectors. Maquet offers flexibility for prescribing post-op autotransfusion at any time. These locking patient tube connectors provide for disconnection after use or rapid in-line ATS blood bag attachment, when required.



Maquet product feature summary

Feature	Benefit	Function
Compact, lightweight chest drain design	Easy to store, handle, and transport. Less packaging.	Environmentally responsible. Less waste is more cost savings for the hospital.
Adjustable dry suction control	Continually and automatically adjusts to changes in patient air leaks and/or fluctuations in hospital wall suction.	Regulator dial can be set to any desired suction pressure between -10 cmH_2O and -40 cmH_2O. Provides accurate, reliable suction control for a wide range of chest drainage applications.
Suction monitor bellows	Easy confirmation of suction operation.	Large, bright colored bellows expands across suction monitor window when suction is operating.
*Pre-packaged water	Only the air leak monitor needs to be filled.	No more overfilled or underfilled air leak monitors. The ultimate in time and cost savings.
Blue tint air leak monitor	Efficient air leak detection.	Air leak monitor turns blue when filled.
Graduated air leak monitor	Fast, easy detection and monitoring of patient air leaks.	Air leak bubbling can range from 1 (low) to 5 (high) for monitoring patient air leak trends.
Filtered manual vent	Easy-to-use to lower the water column	Provides effective manual vent control when lowering height of air leak monitor.
High negative pressure protection	Advanced valve automatically vents high vacuum.	Valve design offers a controlled release during episodes of prolonged high negative pressure (set at approximately -50 cmH_2O).
Vacuum indicator	Quick and easy confirmation of vacuum when present in collection chamber.	✓ symbol remaining visible in the vacuum indicator window confirms vacuum. No symbol indicates no vacuum.

**patented*

Feature	Benefit	Function
Positive pressure protection	Tamper resistant positive pressure relief valve automatically filter protection patient from accumulating positive pressure.	Integral to the system, this valve automatically prevents tension pneumothorax during accidental suction line occlusion.
Autotransfusion Capabilities	Maquet provides numerous options for emergency or post-op autotransfusion on demand.	Fast, convenient ATS bag use or continuous ATS via infusion pump.
In-line connector	Smooth, low-profile design has audible locking mechanism.	Connector provides system disconnection or fast in-line ATS bag attachment.
Collection chamber graduations	Improved collection chamber design is easy to read.	Large collection window graduations provide fast and accurate volume assessment.
Maximum knock-over protection	Dry seal offers patient protection.	Dry seal integrity is preserved during transport and accidental knock-over.
Knock-over nozzles	Allows fluid volumes to be fully recovered when drain is returned to the upright position.	Reduces the incidence of interchamber spills.
Easy-to-grip handle	Comfortable design facilitates hand-off.	Makes patient ambulation and patient transport easy.
Flexi-hangers	Accommodates today's newer bed designs.	Flexible hangers (located inside the handle) allow drain to be hung from a single point.
Swing out floor stand	Secure system placement during set up or on floor.	Floor stand swings out for maximum stability, closes for transport.
Needleless access sampling port	In-line fluid removal. No needle necessary.	Connects to any standard luer-lock syringe.

System set up

Open package

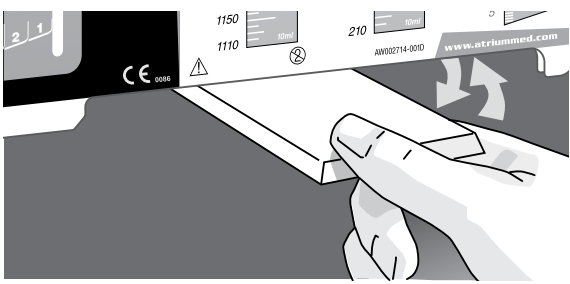
Remove non-sterile outer protective bag. Maquet chest drains are wrapped in CSR wrap and should be opened following hospital approved sterile technique.

Requirements for set up

30 ml of water will be required. Follow hospital's protocol for type of water to be used. Sterile saline should be used for ATS applications.

Four step set up

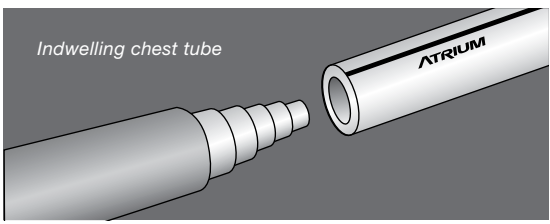
Swing floor stand open for set up. For models equipped with an in-line connector, move the patient tube clamp closer to the chest drain (next to the in-line connector) for set up convenience and patient safety. Follow steps 1-4 and refer to each model's operating instructions for additional details concerning system set up, operation, indications for use, and warnings and cautions.



Step 1

Connect chest drain to patient

Remove patient tube connector cap and insert stepped patient connector into patient's catheter(s). Remove or cut off stepped connector for "Y" connector insertion. If desired, use of nylon bands around catheter and patient tube connections will assure an air-tight connection. Connect chest drain to patient prior to initiating suction.



Step 2

Connect chest drain to suction

Attach suction line to suction port on top of chest drain.

Suction source

The suction source should provide a minimum vacuum pressure of -80 mmHg at 20 liters of air flow per minute for chest drain operating efficiency at a suction control setting of -20 cmH_2O. The suction source vacuum should be greater than -80 mmHg when multiple chest drains are connected to a single suction source.

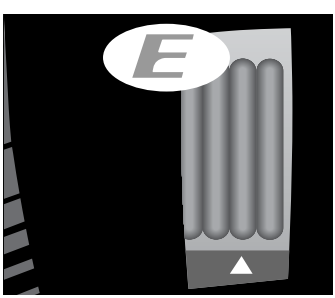
Step 3

Turn suction source On

Increase suction source vacuum to -80 mmHg or higher. The suction monitor bellows must be expanded to the ▲ mark or beyond for a -20 cmH_2O or higher regulator setting. The regulator control dial, located on the side of the drain, can be adjusted to any suction setting between -10 cmH_2O and -40 cmH_2O. **Dial down to lower** the suction setting and **dial up to increase.**

Suction monitor bellows

When the suction control regulator is set at -20 cmH_2O or higher, the bellows must be expanded to the ▲ mark or beyond when suction is operating. If the bellows is observed to be expanded, but less than the ▲ mark, the suction source vacuum pressure must be increased to -80 mmHg or higher. For a regulator setting less than -20 cmH_2O suction (-10 cmH_2O), any observed bellows expansion across the monitor window will confirm suction operation. The bellows need not be expanded to the ▲ mark for pressures less than -20 cmH_2O, just visibly expanded to confirm suction operation.

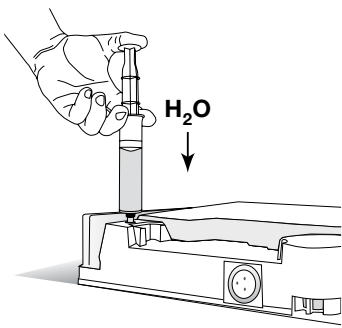


Turn suction source to -80 mmHg or higher. Bellows must be expanded to ▲ mark or beyond for -20 cmH_2O or higher regulator setting.

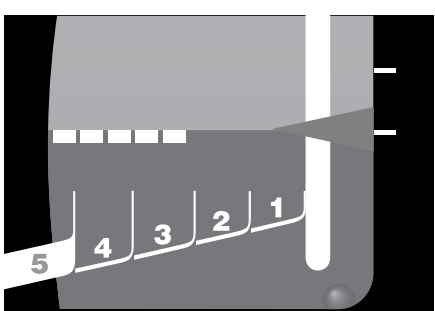
Step 4

Fill air leak monitor Ⓒ to fill line

Fill air leak monitor to the fill line by syringe (no needle) with 30 ml of sterile water or sterile saline via the needleless injection port located on the back of the drain. For models available with sterile fluid, twist top off syringe and insert tip into needleless luer port. Depress syringe plunger into luer port and squeeze contents into air leak monitor until fluid reaches fill line.



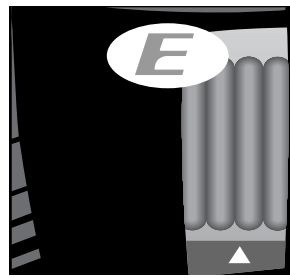
Once filled, water becomes tinted blue for visibility of air leaks.



What to check during system operation

Verifying suction operation via the suction monitor bellows

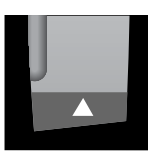
The bellows located in the suction monitor will expand only when suction is operating. The monitor bellows will not expand when suction is not operating or disconnected. The calibrated ▲ mark allows confirmation of vacuum operation over a wide range of adjustable suction control settings.



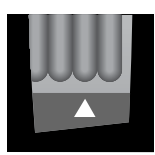
Bellows must be expanded to ▲ mark or beyond for a -20 cmH_2O or higher regulator setting.

Increase vacuum source when bellows is not expanded to ▲ mark

If the bellows is observed to be expanded, but less than the ▲ mark, the vacuum source pressure must be increased to -80 mmHg or higher.



Not enough vacuum for -20 cmH_2O or higher suction control setting.

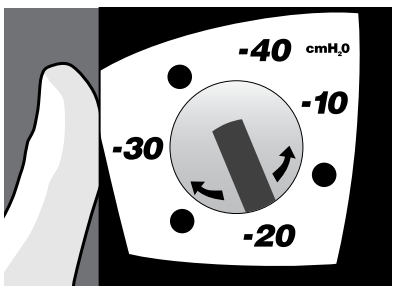


Normal suction operation for -20 cmH_2O or higher.

Increase suction source to -80 mmHg or higher.

Changing suction pressure

Changing suction pressure is accomplished by adjusting the rotary dry suction control dial located on the side of the drain. **Dial down to lower** suction pressure and **dial up to increase** suction pressure.



NOTE: When changing suction pressure from a higher to lower level, use of the manual high negativity vent after regulator adjustment will reduce excess vacuum down to the lower prescribed level.

Recording drainage volume

The collection chamber incorporates a writing surface with easy-to-read fluid level graduations. Please refer to individual product for specific graduation.

Placement of unit

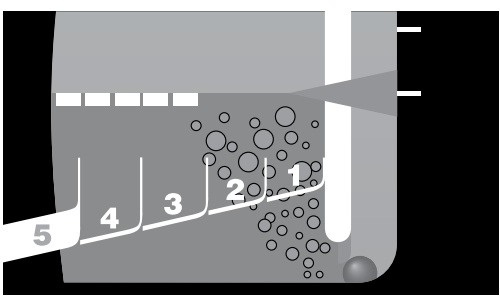
For optimum drainage results, always place chest drain below the level of the patient's chest in an upright position. To avoid accidental knock-over, it is recommended to swing the floor stand open for secure placement on floor or to hang the system bedside with the hangers provided.

Verifying air leak monitor operation

The air leak monitor can be filled and maintained at the fill line to ensure proper operation and should be checked regularly when used for extended periods. As required, additional water may be added by syringe via the luer port located on the back. Fill to the fill line.

Observing air leak monitor for patient air leaks

Atrium Express™ chest drains offer air leak detection with rapid air leak assessment and improved visibility due to the tinted water. A patient air leak is confirmed when air bubbles are observed going from right to left in the air leak monitor.



Continuous bubbling in the bottom of the air leak monitor will confirm a persistent air leak.

Intermittent bubbling with float ball oscillation will confirm the presence of an intermittent air leak.

No bubbling with minimal float ball oscillation at the bottom of the air leak monitor will indicate no air leak is present.

Vacuum indicator

When vacuum is present in the collection chamber, a ✓ symbol will remain visible in the vacuum indicator window. When vacuum is not present (atmospheric pressure) no symbol will appear. All patient tube connections and the vacuum indicator window should be checked regularly for vacuum confirmation.

Graduated air leak monitor

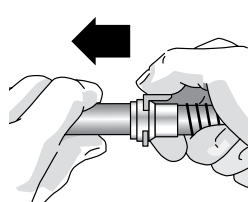
Air leak bubbling can range from 1 (low) to 5 (high). Air bubbles create an easy to follow air leak pattern for monitoring patient air leak trends.

Sampling patient drainage

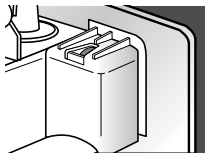
Sampling of patient drainage must be in accordance with approved hospital infection control standards. Selected models include a needleless luer port on the patient tube connector for sampling patient drainage. Alcohol swab the luer port prior to syringe attachment (no needle). Fluid samples can also be taken directly from the patient tube by forming a temporary dependent loop and inserting a 20 gauge needle at an oblique angle. Alcohol swab the patient tube prior to inserting syringe at a shallow angle. **Do not puncture patient tube with an 18 gauge or larger needle.**

In-line patient tube connector

The locking in-line patient tube connector provides system replacement, simple disconnection after use, and rapid in-line ATS blood bag attachment when required. The in-line connector must remain securely connected at all times during operation and patient connection. **Do not separate in-line connector prior to clamping off patient tube clamp.**



Positive pressure protection

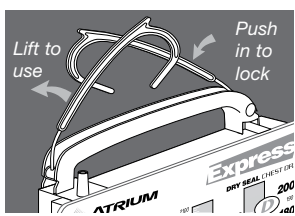


Maquet's positive pressure release valve, located on top of drain, opens instantly to release accumulated positive pressure. Integral to the system, this valve design is tamper-resistant. Do not obstruct the positive pressure valve.

Swing out floor stand

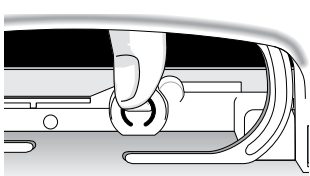
Maquet's floor stand swings open for convenient system set up and secure placement on floor. It is recommended that the floor stand be closed during patient transit or when unit is hung on bed.

Multi-position hangers



The multi-position hangers are easily lifted from inside the handle. Press hangers into handle when not in use. The flexible hangers allow the drain to be hung bedside from a single point.

Manual high negativity vent



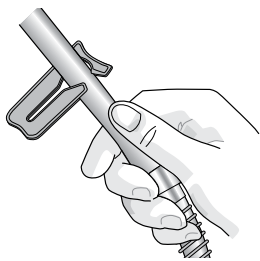
Do not use when suction is not operating.

To manually lower the height of the water column or to lower patient pressure when connected to suction, temporarily depress the filtered manual vent located on top of the drain until the water column lowers to the desired level. **Do not use manual vent to lower water column when suction is not operating or when the patient is on gravity drainage**.

Patient tube clamp

The removable patient tube slide clamp provided with in-line connector models must remain open at all times during system operation. It is recommended to move the patient tube clamp next to the in-line connector (closer to the chest drain) for set up convenience and routine visual check. **Do not keep patient tube clamp closed when system is connected to patient. Tube clamp must be closed prior to in-line connector separation.**

Move clamp closer to drain, next to in-line connector



CAUTION: *Keep clamp open at all times when system is connected to patient*

Gravity drainage

For gravity drainage applications, the drain should be placed below the patient's chest in an upright position. Disconnect the suction source vacuum line from the suction line port.

System disconnection

For models equipped with an in-line connector, close the patient tube slide clamp prior to disconnecting the chest drain patient tube from patient. Clamp off all indwelling thoracic catheters prior to disconnecting chest drain from patient.

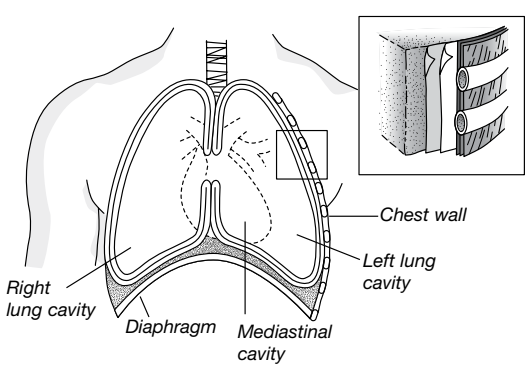
Anatomy and physiology review

Anatomy of the chest

The chest wall is composed of the ribs, sternum, and thoracic vertebrae and are all interlaced and covered with intercostal muscle to form a semi-rigid structure. The lower boundary or floor of the thoracic cavity is known as the diaphragm, which is also composed of muscle.

Although the thoracic cavity contains two passageways which are open to the outside environment, the esophagus and trachea, the cavity itself is an enclosed structure. The interior of the thoracic cavity can be divided into three distinct areas: the mediastinum and two separate chambers for each lung. The superior mediastinum consists of soft tissue which encloses the esophagus, trachea, heart, aorta, and other major vessels. The mediastinum acts as a flexible partition which extends from the front-to-back and top-to-bottom of the central portion of the chest.

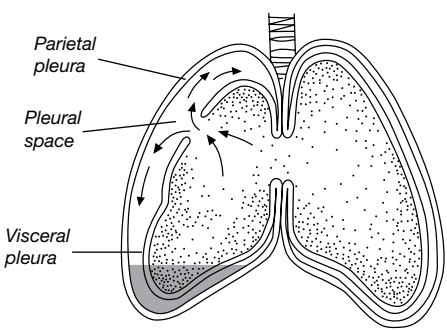
The inside of the rib cage is lined by a membrane called the parietal pleura while the lungs are covered by another membrane called the pulmonary or visceral



pleura. Under normal conditions, these two pleural surfaces slide against each other allowing the lungs to expand and contract. These two surfaces are closely held to one another, being separated only by a very thin film of lubricating fluid secreted by the pleura, called pleural fluid.

Why the lungs are expanded

A principal factor which keeps the visceral and parietal pleurae together and not separating is vacuum, commonly referred to as negative pressure. This negative pressure, or vacuum, is present during normal respiration with the membranes closely intact under normal conditions. The presence of negative pressure between these two membranes is what helps hold the visceral pleura in close contact with the parietal pleura at all times. Hence, negative pressure or vacuum around the outside of the elastic lung is what keeps the lung in a fully expanded position, counteracting the lung's normal tendency to shrink in size.

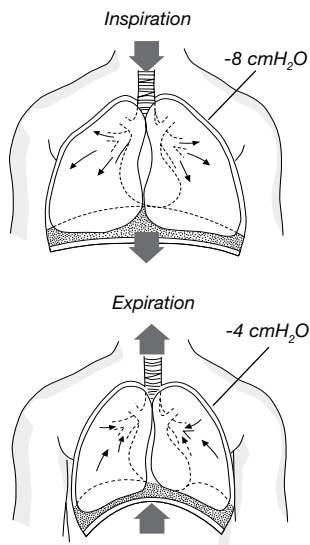


If air, fluid, or blood were to enter the space between these two membranes, the space created is known as a pleural space and is an abnormal occurrence. When this occurs, the lungs can no longer fully expand with each inspiration and intense pain results, inhibiting the voluntary effort of breathing.

The mechanics of breathing

Respiration is the cycle of inspiration and expiration in which air moves in and out of the lungs due to changes in pressure. When the diaphragm is stimulated by the phrenic nerve, it contracts and moves downward. With the help of the external intercostal muscles, the rib cage moves up and out. The lung itself expands because of the movement of the diaphragm and the chest wall. The surface tension of the pleural fluid together with the naturally occurring vacuum pressure induced by the pulling action of the diaphragm is what actually holds the pleural membranes together, thus keeping the lungs fully expanded.

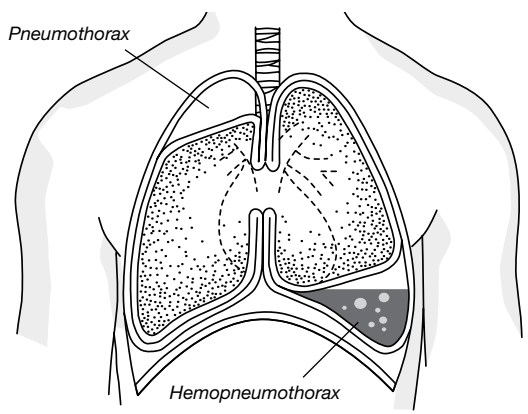
Under normal conditions, there is always negative pressure in the pleural cavity. The degree of negativity, however, changes during respiration. During normal inspiration, intrapleural vacuum pressure is approximately -8 cmH_2O, while during expiration the vacuum pressure falls to -4 cmH_2O. With deep inspiration, intrapleural pressures can be even more negative.



Why dry seal chest drains are used

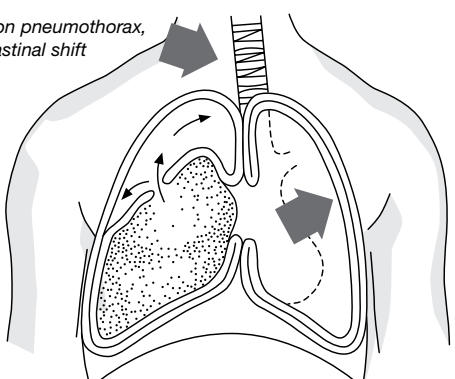
Clinical needs for chest tube drainage

When the chest wall is opened either by surgery or chest injury, the in-rush of air causes the vacuum in the patient's pleural cavity to escape and atmospheric air to enter the intrapleural space. Since the normal negative pressure or vacuum is no longer present, the lungs collapse as they depend upon this negativity or vacuum to stay fully expanded up against the inside of the chest wall. When air enters or becomes trapped inside the chest causing a pleural space, the lungs cannot fully expand, and the patient will experience difficulty in breathing. This condition is known as a *pneumothorax*. This is a frequent occurrence after all thoracic and cardiac surgeries, as well as with most chest wall injuries. Often there is a combination of both air and blood present in this abnormal space, causing a similar effect on breathing. When blood collects in the patient's pleural space, it is known as a *hemothorax* and when there is the combination of both blood and air, it is known as a *hemopneumothorax*.

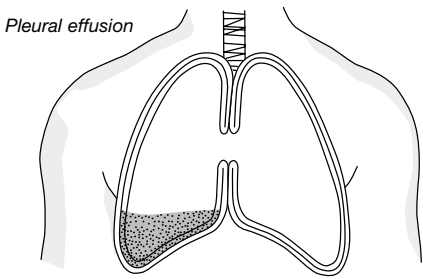


Tension *pneumothorax* is a more serious complication that can develop when air continues to leak from a hole in the lung directly into the pleural space and has no way to escape. As more and more air accumulates in the pleural space, pressure within this space rises significantly. If the pressure builds up enough, it causes a mediastinal shift, which means that the entire mediastinal area, including the heart and other structures, can be pushed toward the unaffected side. This reduces the size of the unaffected lung chamber, making it very difficult to breathe. A *mediastinal shift* can also be significant enough to collapse the unaffected lung to a measurable degree and interfere with normal heart activity. When the compressed lung becomes collapsed as a result of a tension pneumothorax condition, a life-threatening situation develops which requires immediate attention. Early signs of mediastinal shift may include an overexpanded chest, shallow gasping respiration, a shift of the trachea in the suprasternal notch, and changes in arterial pulse. Any one or all of these signs require prompt attention and emergency action by the nurse and/or physician. Normally, this would be accomplished with a procedure known as a thoracostomy.

Tension pneumothorax, mediastinal shift



Other conditions in the pleural cavity that may require chest drainage intervention are pleural effusion and empyema. *Pleural effusion* is the accumulation of fluid within the pleural cavity. The presence of lymph fluid is called chylothorax and is often clear, serous fluid. *Empyema* is a pleural effusion that involves purulent material in the pleural cavity and is often caused by pneumonia, lung abscess, iatrogenic contamination of the pleural cavity, or injury.



Mediastinal drainage is routinely required after all heart surgeries, sometimes including pleural drainage. Mediastinal drainage is required to prevent the accumulation of blood and clots from taking up space in and around the pericardiac sac. If blood were left to accumulate in the mediastinal cavity, it would cause *cardiac tamponade,* resulting in cardiac distress and death.

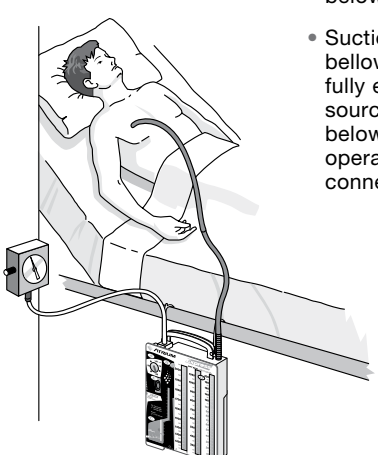
The physician's prescribed treatment for any of these clinical drainage situations are:

- To remove the fluid and air as promptly as possible.
- To prevent evacuated air and fluid from returning into the chest cavity.
- To expand the lungs and restore the negative pressure in the thoracic cavity back to its normal level.

What to check for during drain use

Potential problems can usually be avoided by routinely checking the patient, tube connectors and drainage system at regularly scheduled intervals. Listed below are many of those common problems that can be easily corrected:

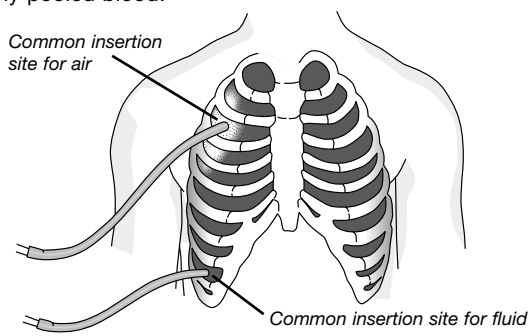
- Clot in chest tube inside patient
- Clot in the patient tube
- Dependent loop in patient tube with fluid
- Kink in patient tube from bed rail or patient position
- Partial dislodgement of catheter from patient
- Partial disconnection of patient tube from chest tube connector
- Overfilled (air leak monitor above the fill line)
- In-line connectors not properly secured
- Patient tube clamp may be closed
- Floor stand is not fully opened
- Chest drain is not upright
- Chest drain is not positioned sufficiently below patient's chest
- Suction monitor bellows does not fully expand because source suction falls below the minimum operating range or poor connection



Chest tube placement

Chest tube insertion

To facilitate air and fluid evacuation post surgically, the surgeon will insert a catheter or thoracotomy chest tube so that the chest tube eyelets are located inside the chest wall. The surgeon will usually suture the catheter loosely in place to facilitate removal later on. Frequently two catheters are inserted, in which case one is placed near the apex to remove air while the other is placed in the lower part of the chest to remove any pooled blood.



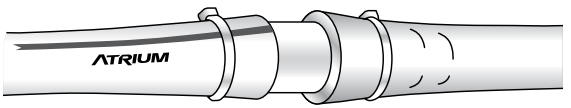
Thoracotomy chest tubes are normally flexible, kink resistant, clear catheters which are inserted through the chest wall via a small incision. A tight intercostal fit is preferred to minimize small bleeders around the catheter and to maintain an air-tight seal. A radiopaque stripe helps the clinician identify catheter placement and location of the “catheter eyes” during x-ray for maximum drainage efficiency.

Typical chest tube sizes:

8Fr-12Fr	Infants, young children
16Fr-20Fr	Children, young adults
24Fr-32Fr	Most popular adult sizes
36Fr-40Fr	Larger adult sizes

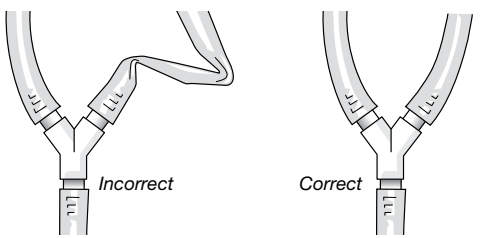
Chest tube nursing responsibilities

After chest tube insertion, the connector end of the catheter is cut to length and the chest drain stepped connector is inserted. Such connections can be secured with tape or bands for added security and to assure an airtight tubing connection.



Bands for added security

When two or more indwelling chest tubes are attached to a single chest drain via a "Y" connector set up, it is important to ensure that all indwelling catheters are properly tailored so as to not kink.

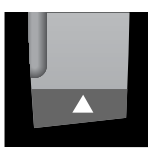


It is important to check the chest tube connections for signs of air leaks, such as "hissing" sounds or bubbling in the air leak monitor. Also check the chest tube dressings and condition of the tube itself, such as position or clotting in the tube. If a tube accidentally pulls out, the insertion site should be quickly sealed with a petroleum gauze dressing to prevent air from entering the pleural cavity. The physician should be notified to assess the patient's condition and to determine whether or not a new tube will need to be inserted bedside.

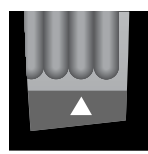
Troubleshooting guide

Q What should I do when the suction monitor bellows is not expanded to the ▲ mark when the regulator is set at -20 cmH_2O or higher?

A The position of the bellows across the suction monitor window will alert the operator that the suction source has fallen below the minimum operating range for the prescribed suction control setting. Increase the vacuum source to -80 mmHg or higher. The suction monitor bellows must expand to the ▲ mark or beyond for a -20 cmH_2O or higher suction regulator setting.



Not enough vacuum for -20 cmH_2O or higher suction control setting.



Normal suction operation for -20 cmH_2O or higher.

Increase suction source to -80 mmHg or higher.

Q What should I do when the bellows does not fully expand to the ▲ mark after I increase the suction source vacuum?

A Dry suction chest drains require higher levels of vacuum pressure and air flow from the suction source to operate properly at each suction control setting as compared to traditional water controlled operating systems. The suction source should provide a minimum vacuum pressure of -80 mmHg at 20 liters of air flow per minute for chest drain operating efficiency at a suction control setting of -20 cmH_2O. The suction source should be greater than -80 mmHg when multiple chest drains are connected to a single suction source.

If the bellows does not fully expand to the s mark, it may be that the suction source is not functioning to its full potential to provide the minimum vacuum pressure or air flow required to “drive” the suction control regulator. Additionally, conditions may exist that can reduce, or “restrict” air flow from the suction source. A restrictive clamp, connector, or kink in the suction line tubing can potentially “starve” the chest drain of air flow. A leak in a connection or wall canister, along with extensive lengths of suction tubing can also reduce air flow to the unit.

To troubleshoot this situation, first check to be sure that all connections are air-tight. Inspect the suction tubing and connections for possible cracks, leaks, kinks, or occlusions. You may need to bypass a “leaky” wall canister. Try connecting the chest drain to a different suction source on a wall regulator. When multiple chest drains are “Y” connected to a single suction source, if possible, reconnect the drains to separate suction sources. Finally, replace the chest drain if you suspect the unit is cracked or damaged.

Q Does the bellows need to expand beyond the ▲ mark for a -10 cmH_2O regulator setting?

A No. For a regulator setting less than -20 cmH_2O suction (-10 cmH_2O), **any** observed bellows expansion across the monitor window will confirm suction operation. The bellows need not be expanded to the ▲ mark for suction pressures less than -20 cmH_2O, just visibly expanded to confirm suction operation.

Q Is it required to fill the air leak monitor?

A It is not required to fill the air leak monitor for seal protection. However, the air leak monitor should be filled for confirmation and detection of air leaks.

Q How do I confirm my patient has an air leak when there is no bubbling in the air leak monitor?

A If there are no air bubbles observed going from right to left in the air leak monitor, there is no patient air leak.

Q How do I confirm my patient has an air leak when there is bubbling present in the air leak monitor?

A Whenever constant or intermittent bubbling is present in the air leak monitor, this will confirm an air leak is present. Oscillation of the patient pressure float ball at the bottom of the air leak monitor without bubbling will indicate no apparent air leak. To determine the source of the air leak (patient or catheter connection), momentarily clamp the patient tube close to the chest drain and observe the air leak monitor. If bubbling stops, the air leak may be from the catheter connections or the patient's chest. Check the catheter connectors and patient dressing for a partially withdrawn catheter. If bubbling continues after temporarily clamping the patient tube, this will indicate a system air leak requiring system replacement.

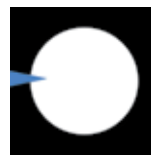
Q What does it mean when the small float ball is located at the bottom of the air leak monitor?

A If the small float ball is located and oscillating at the bottom of the air leak monitor with no bubbling, there is no apparent patient air leak. However, the air leak monitor should be carefully monitored for the presence of an occasional or intermittent air leak.

Q What does it mean when the vacuum indicator is visible?

A When vacuum is present in the collection chamber, a symbol will remain visible in the vacuum indicator window. When vacuum is not present (atmospheric pressure) no symbol will appear. All patient tube connections and the vacuum indicator window should be checked regularly for vacuum confirmation.

Vacuum is present



Vacuum is not present

Q When will I see a rise in the air leak monitor column?

A A rise in the air leak monitor column will only be seen if there is an increase in negative pressure on the patient side. When changing suction pressure from a higher to lower level, depress the manual high negativity vent to reduce excess vacuum to the lower prescribed level.

Q Should the manual vent be used during gravity drainage?

A No. It is not recommended to depress the manual vent during gravity (no suction) drainage.

Q What should I do if the chest drain gets knocked over?

A We recommend that the drain be placed immediately back into the upright position, however it will continue operating if knocked over. After the drain is set upright, check the fluid level in the air leak monitor. Maquet provides a convenient needleless luer port on the back of the drain to adjust the fluid level. Simply use a syringe (no needle) to add or remove fluid, if required.

Q How do I dispose of the system?

A Disposal of system and contents must be in accordance with approved hospital infection control standards.

Notes

Notes

Customer service

If a question or need arises for customer service, product information, or to request inservice educational material, we invite you to call anytime.

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