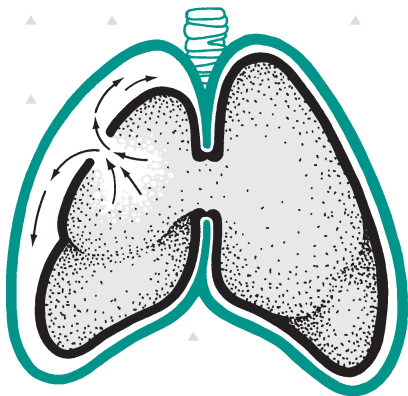


a personal guide to

M A N A G I N G

Dry Suction Water Seal Chest Drainage



ATRIUM

MAQUET GETINGE GROUP

Table of Contents

Your personal guide to *Managing Dry Suction Chest Drainage* is a quick and easy reference to help extend your understanding of dry suction chest tube drainage and to help answer questions which may come up from time to time. It is provided as an educational service of Atrium, the leading producer of water seal chest drainage systems. 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.

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Introduction

■ Making It Simple To Understand

To restore the chest to its normal condition, all air and fluid must be removed, and the source of an air leak must be closed. 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 water seal chest drainage techniques are relatively simple, sometimes the chest drain and its accompanying terminology may appear complex. However, dry suction water 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 Atrium's easy-to-use dry suction water seal operation system.

■ Customer Service

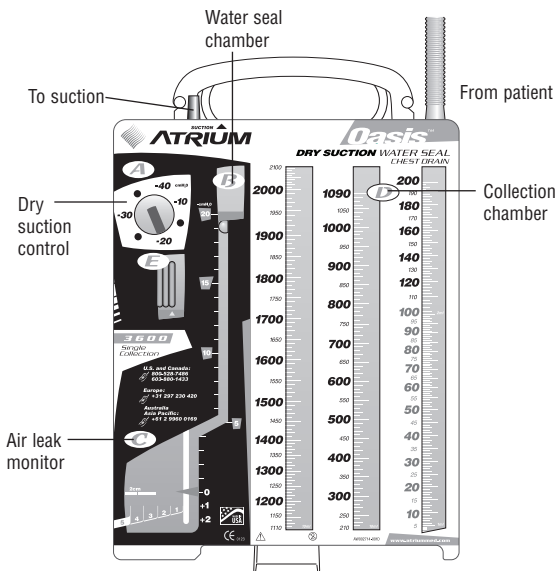
If a question or need arises for customer service, product information, or to request inservice educational material, we invite you to call or FAX Atrium's hotline anytime.

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How Dry Suction Water Seal CDUs Function

■ The Basic Operating System

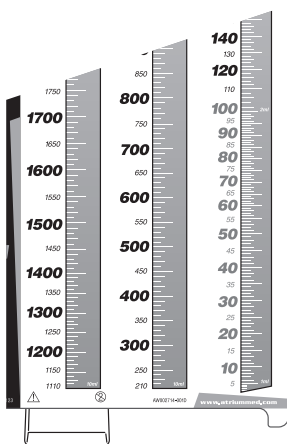
Today's water seal drainage systems are comprised of a one-piece, 3-chamber set up, which separates the functions of *fluid collection*, *water seal* (which serves as a simple one-way valve), and *suction control*. An easy way to describe the *one-way* action of a water seal is to refer to a cup of water and a straw. If one were to blow air into a submerged straw, air would bubble out through the water. Now if you wanted to draw the air back through the straw, you would only draw water. Hence, when chest drainage came into light many years ago, the one-way action of a water seal (water bottle and straw concept) provided a simple but ideal means for evacuating air and not allowing it to return to the patient.



Recently, advances in engineering have enabled dry suction technology to be incorporated into familiar water seal operating systems. Consequently, today's dry suction water seal operating systems not only provide a simple and convenient method to maintain a required amount of vacuum in a patient's chest, but now provide faster set up 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 suction water 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 one of the most important features for any new chest drainage system.



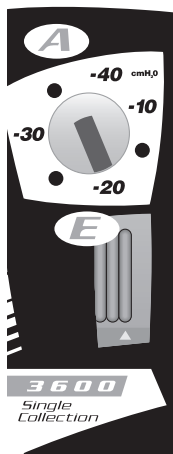
■ Water Seal

The *water seal chamber*, which is connected in series to the collection chamber, allows air to pass down through a straw or narrow channel and bubble out through the bottom of the water seal. Since air must not return to the patient, a water seal is considered one of the safest and most cost effective means for protecting the patient, in addition to being a very useful diagnostic tool. The water seal column is calibrated and acts as a water manometer for measuring intrathoracic pressure. As changes in intrathoracic pressure occur, fluctuation in the water level can be observed in the calibrated col-

umn. Such fluctuations provide the clinician an indication of how the patient is progressing. With the addition of an advanced float valve at the top of the water seal, a patient can also be protected from the dangers of accumulating high vacuum pressures or high negativity, which can be induced from chest tube stripping or milking. Today's more sophisticated systems provide 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. In similar fashion to how a traditional calibrated water chamber controls suction, Atrium's precision dry suction control regulator



works by **continuously balancing** the forces of suction and atmosphere. Atrium'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 $-10\text{cmH}_2\text{O}$ and $-40\text{cmH}_2\text{O}$ by simply adjusting the rotary dry suction control dial. Expansion of the highly visible bellows across the suction monitor window will readily confirm that suction is operating.



The Atrium System

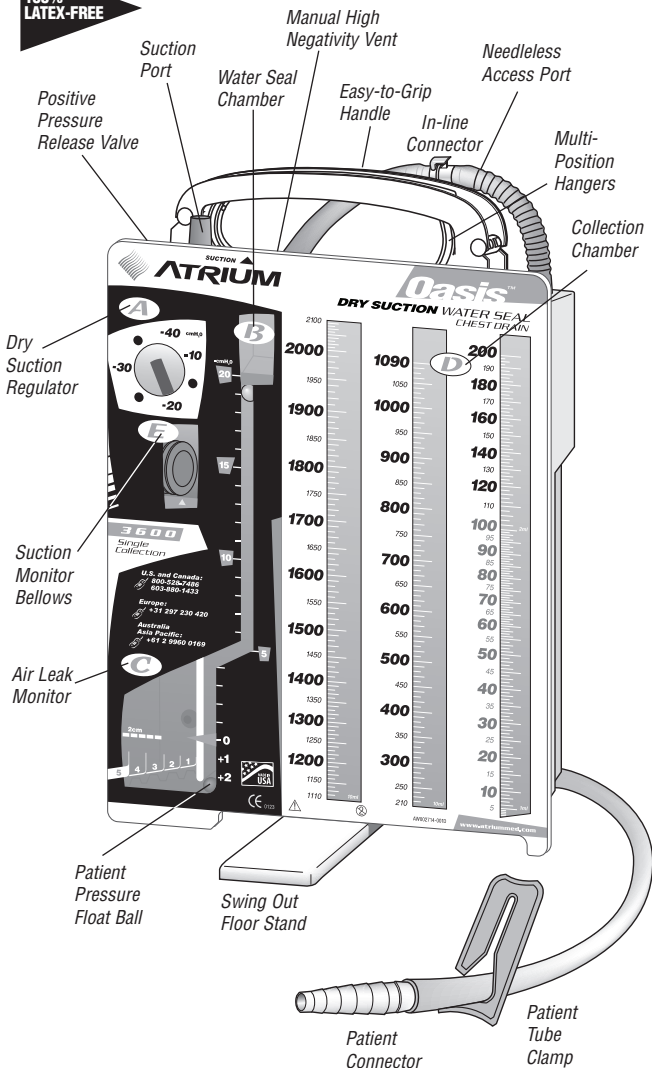
■ All The Water You Need...And Less!

From the beginning, Atrium has pioneered advances in water seal design with compact chest drains that are smaller, user friendly, and cost effective. We've continued our commitment to product innovation with the latest series of Atrium Oasis™ dry suction water seal chest drains, featuring a familiar water seal operating system with the enhanced performance and convenience of dry suction control.

Atrium's complete family of dry suction chest drains has been carefully engineered to provide extraordinary adult and pediatric collection performance and satisfy today's critical need for more cost effective blood management.

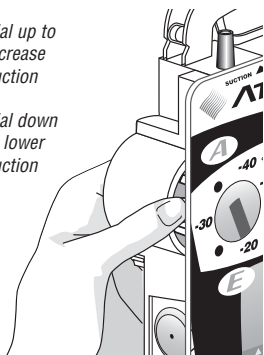
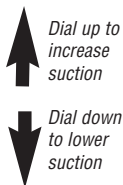
- *With pre-packaged water, system set up is fast and convenient.*
- *Improved knock-over performance.*
- *Finger-tip suction control dial can be easily adjusted to any suction setting between -10cmH₂O and -40cmH₂O for a wide range of chest drainage applications.*
- *Advanced dry suction control regulator continually adjusts to changes in patient air leaks and fluctuations in hospital wall suction, providing the ultimate in safety and reliability.*
- *Highly visible suction monitor bellows readily confirms suction operation.*
- *Large, easy-to-read collection chamber numbers and graduations provide the ultimate in patient drainage assessment.*
- *Advanced controlled release float valve design provides automatic high negative pressure relief.*
- *Filtered manual vent offers an additional method for controlling vacuum pressures when connected to suction.*
- *Blue tint water seal offers enhanced visibility for air leak detection and patient pressure diagnostics.*

**100%
LATEX-FREE**



Continually Adjustable Dry Suction Control

Atrium's precision dry suction control regulator provides accurate, dependable suction for a wide range of chest drainage applications.

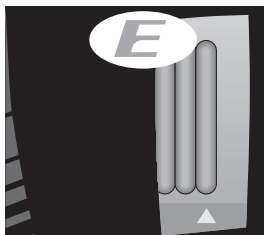


The state-of-the-art regulator design *continually and automatically* adjusts to changes in patient air leaks and/or fluctuations in hospital wall suction to help maintain a more consistent vacuum level to the patient. Suction pressure can be set to any

desired pressure level between $-10\text{cmH}_2\text{O}$ and up to a maximum of $-40\text{cmH}_2\text{O}$. Changing the suction pressure is easily accomplished by adjusting the rotary dry suction control dial located on the side of the drain. Simply **dial down to lower** the suction setting and **dial up to increase** the suction pressure setting.

Suction Monitor Bellows

Atrium's *suction monitor bellows* allows quick and 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.

■ Advanced Water Seal Technology

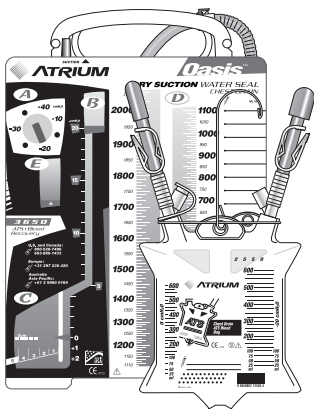
At the heart of every Atrium Oasis™ dry suction water seal chest drain is an advanced water seal design. Patient air leak assessment and system integrity are enhanced with Atrium's blue tint water seal and superior knock-over protection. The fully calibrated water seal and patient pressure float ball also make it easier to monitor changes in intrathoracic pressures. Together with our automatic high negative pressure relief and an easy-to-use filtered manual vent, patients now have the ultimate protection from accumulating high negative pressure.

■ Proven Float Valve Design

Atrium's high negativity float valve, with its unique controlled release action, enables any thoracic patient to draw as much intrathoracic pressure as is required during each respiratory cycle. During prolonged episodes of extreme negative pressure (as with chest tube stripping), Atrium's controlled release system will automatically relieve excessive high negative pressure to a lower level.

■ Convenient System Disconnection And Options For Autotransfusion

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



■ Atrium Product Feature Summary

Feature	Benefit	Function
■ Compact, Lightweight Chest Drain Design	■ Easier to store, handle, and transport. Less packaging.	■ More environmentally responsible. Less waste is more cost savings for the hospital.
■ Continually 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 -10cmH ₂ O and -40cmH ₂ O. Provides accurate, reliable suction control for a wide range of chest drainage applications.
■ Suction Monitor Bellows	■ Quick and easy confirmation of suction operation.	■ Large, brightly colored bellows expands across suction monitor window when suction is operating.
■ *Pre-Packaged Water	■ With only the water seal to fill, system set-up is fast and convenient.	■ No more overfilled or underfilled water seals. The ultimate in time and cost savings.
■ Blue Tint Water Seal	■ More efficient air leak detection and convenient monitoring of patient pressure.	■ Water seal turns blue when filled. Improves visibility.
■ 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.
■ High Negativity Float Valve	■ Advanced design provides maximum patient protection during deep inspiration and gravity drainage.	■ Allows the thoracic patient to draw as much intrathoracic pressure as required to complete respiration while maintaining the integrity of the water seal.
■ Filtered Manual Vent	■ Preferred ergonomic design is easy-to-use and offers maximum filter protection.	■ Provides effective manual vent control when lowering height of water seal column.
■ High Negative Pressure Protection	■ Advanced float valve automatically vents high vacuum.	■ Unique valve design offers a controlled release during episodes of prolonged high negative pressure.

*patented

Feature	Benefit	Function
■ Positive Pressure Protection	■ Tamper resistant positive pressure relief valve automatically protects patient from accumulating positive pressure.	■ Integral to the system, this valve automatically prevents <i>tension pneumothorax</i> during accidental suction line occlusion.
■ Autotransfusion Capabilities	■ Atrium 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 convenient system disconnection or fast in-line ATS bag attachment.
■ Collection Chamber Graduations	■ Improved collection chamber design is easier to read.	■ Large collection window graduations provide fast and accurate volume assessment.
■ Maximum Knock-over Protection	■ Fully recoverable water seal offers maximum patient protection.	■ Water seal integrity is preserved during transport and accidental knock-over, even when connected to suction.
■ Easy-to-Grip Handle	■ Comfortable design facilitates hand-off.	■ Makes patient ambulation and patient transport safer and more practical than before.
■ 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 conveniently swings out for maximum stability, closes for transport.
■ Complete Product Line	■ Atrium produces a complete family of dry suction chest drain models for hospital-wide standardization, including dual collection, pediatric, and ATS models.	■ Atrium offers maximum cost efficiency with superior quality and options for ATS, all with a familiar water seal operating system.
■ Needleless Access Sampling Port	■ In-line fluid removal. No needle necessary.	■ Connects to any standard luer-lock syringe.

System Set Up

■ Open Package

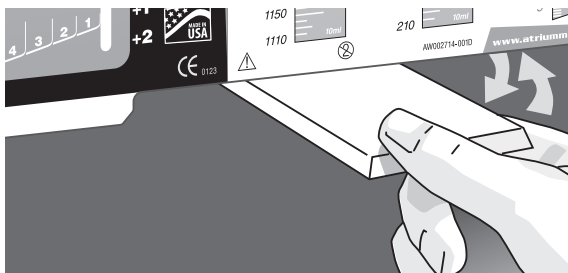
Remove non-sterile outer protective bag. Atrium chest drains are wrapped in two layers of CSR wrap and should be opened following hospital approved sterile technique.

■ Requirements For Set Up

A maximum of 50ml 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.

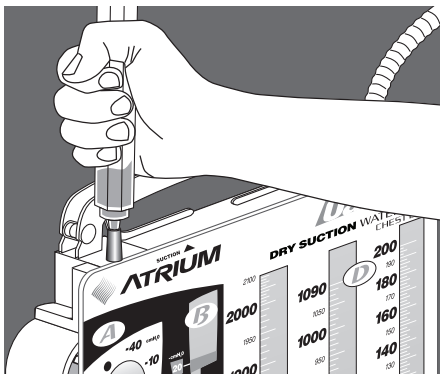


■ Step 1

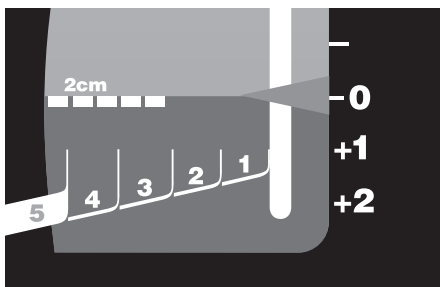
Fill Water Seal (B) To 2cm Line

Add 45ml of sterile water or sterile saline via the suction port located on top of the drain. For models available with sterile fluid, twist top off bottle and insert tip into suction port.

Squeeze contents into water seal until fluid reaches 2cm fill line.



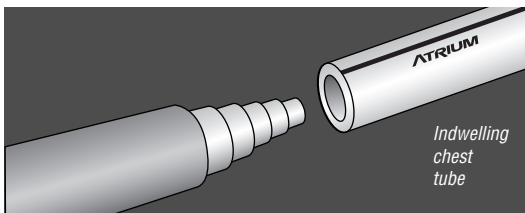
Once filled, water becomes tinted blue for improved visibility of air leaks and convenient monitoring of patient pressures.



■ Step 2

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 3

Connect Chest Drain To Suction

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

Suction Source

The suction source should provide a *minimum vacuum pressure of -80mmHg* at 20 liters of air flow per minute for chest drain operating efficiency at a suction control setting of -20cmH₂O. The suction source vacuum should be greater than -80mmHg when multiple chest drains are connected to a single suction source.

■ Step 4

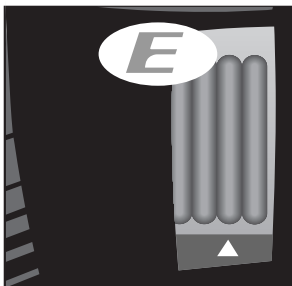
Turn Suction Source On

Increase suction source vacuum to -80mmHg or higher. The suction monitor bellows must be expanded to the ▲ mark or beyond for a -20cmH₂O or higher regulator setting. The regulator control dial, located on the side of the drain, can be adjusted to any suction setting between -10cmH₂O and -40cmH₂O. **Dial down to lower** the suction setting and **dial up to increase**.

Suction Monitor Bellows

When the suction control regulator is set at -20cmH₂O 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 -80mmHg or higher. For a regulator setting less than -20cmH₂O suction (-10cmH₂O), **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 -20cmH₂O, just visibly expanded to confirm suction operation.

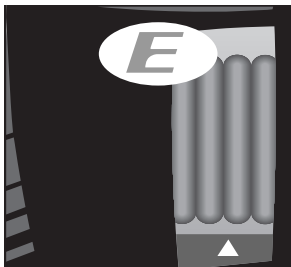


Turn suction source to -80mmHg or higher. Bellows must be expanded to ▲ mark or beyond for -20cmH₂O or higher regulator setting.

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 quick and easy confirmation of vacuum operation over a wide range of continuously adjustable suction control settings.



Bellows must be expanded to ▲ mark or beyond for a $-20\text{cmH}_2\text{O}$ or higher regulator setting.

■ Increase Vacuum Source When Bellows Is Not Expanded To ▲ Mark

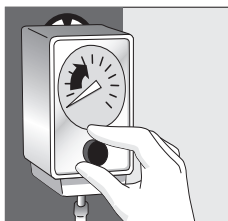
If the bellows is observed to be expanded, but less than the ▲ mark, the vacuum source pressure must be increased to -80mmHg or higher.



Not enough vacuum for $-20\text{cmH}_2\text{O}$ or higher suction control setting.



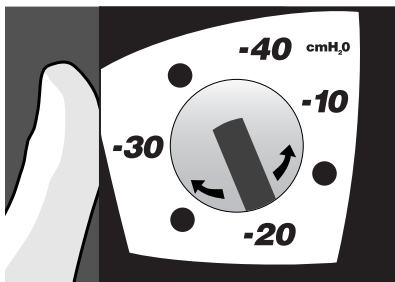
Normal suction operation for $-20\text{cmH}_2\text{O}$ or higher.



Increase suction source to -80mmHg or higher.

■ Changing Suction Pressure

Changing suction pressure is easily 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 calibrations.

■ Placement Of Unit

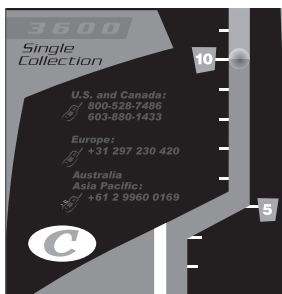
For optimum drainage results, always place chest drain *below* the level of the patient's chest in an upright position. To avoid accidental knock-over, it is recommended to swing the floor stand open for secure placement on floor or to hang the system bedside with the hangers provided. Atrium's unique water seal design provides maximum knock-over protection against inter-chamber siphoning events, accidental spillover, and does not allow unrestricted atmospheric air back to the patient when kept in an upright position.

■ Verifying Water Seal Operation

The water seal must be filled and maintained at the 2cm level 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 grommet located on the back. Fill to the 2cm line.

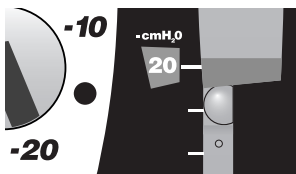
■ Observing Changes In Patient Pressure

Patient pressure can be determined by observing the level of the blue water and small float ball in the calibrated water seal column. With suction operating, patient pressure will equal the suction control setting plus the calibrated water seal column level. For gravity drainage (no suction) patient pressure will equal the calibrated water seal column level only.



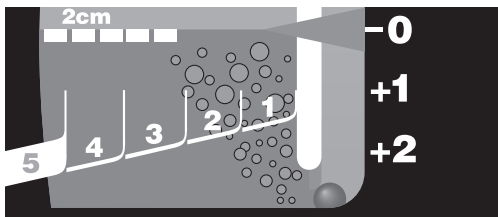
■ High Negativity Float Valve

Atrium's high negativity float valve, with its controlled release action, enables any thoracic patient to draw as much intrathoracic pressure as is required during each respiratory cycle. During prolonged episodes of extreme negative pressure, Atrium's controlled release system will **automatically** relieve excess vacuum to a lower, more desirable pressure level.



■ Observing Water Seal For Patient Air Leaks

Atrium Oasis™ chest drains offer superior 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 water seal air leak monitor will confirm a persistent air leak.

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

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

■ Graduated Air Leak Monitor

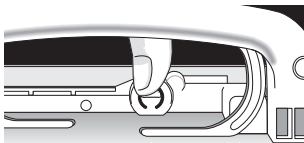
For those models with a graduated air leak monitor, air leak bubbling can range from 1 (low) to 5 (high). Air bubbles create an easy to follow air leak pattern for monitoring patient air leak trends.

■ 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.**

■ Manual High Negativity Vent

To manually lower the height of the water seal column or to lower patient pressure when connected to suction, *temporarily depress* the filtered manual vent



Do not use when suction is not operating.

located on top of the drain until the float valve releases and the water column lowers to the desired level. ***Do not use manual vent to lower water seal column when suction is not operating or when the patient is on gravity drainage.***

■ Positive Pressure Protection

Atrium's positive pressure release valve, located on top of drain, opens instantly to release accumulated positive pressure. Integral to the system, this advanced valve design is tamper-resistant and offers maximum air flow. ***Do not obstruct the positive pressure valve.***

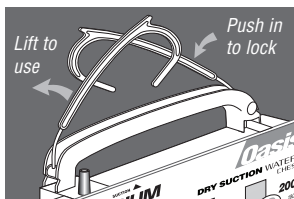


■ Swing Out Floor Stand

Atrium'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

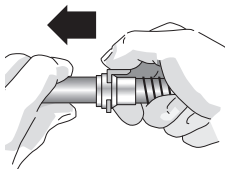
The multi-position hangers are easily lifted from inside the handle. Press hangers into handle when not in use.



■ In-Line Patient Tube Connector

The locking in-line patient tube connector provides convenient 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.

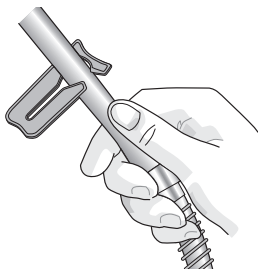


■ Patient Tube Clamp

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

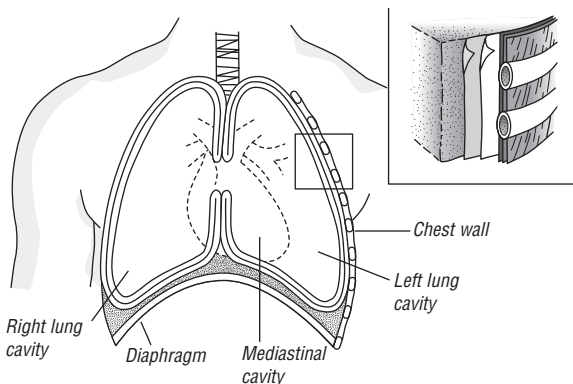
For models equipped with an in-line connector, *close the patient tube slide clamp prior to disconnecting the chest drain patient tube from patient*. For maximum patient protection, clamp off all indwelling thoracic catheters prior to disconnecting chest drain from patient.

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

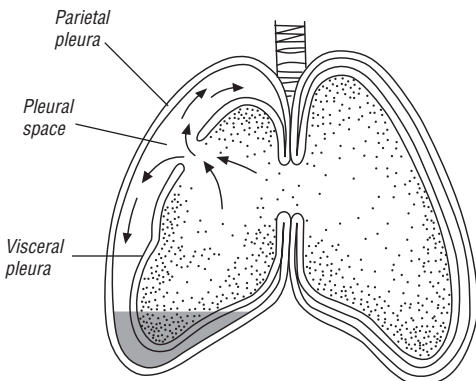


other major vessels. The mediastinum acts as a flexible partition which extends from the front-to-back and top-to-bottom of the central portion of the chest.

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 always 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.

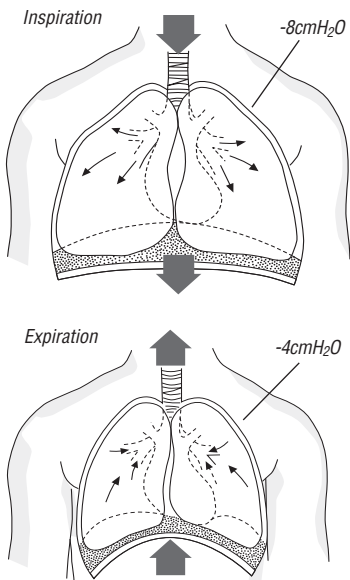


If air, fluid, or blood were to enter the space between these two membranes, the space created is known as a pleural space and is an abnormal occurrence. When this occurs, the lungs can no longer fully expand with each inspiration and intense pain results, inhibiting the voluntary effort of breathing.

■ 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.

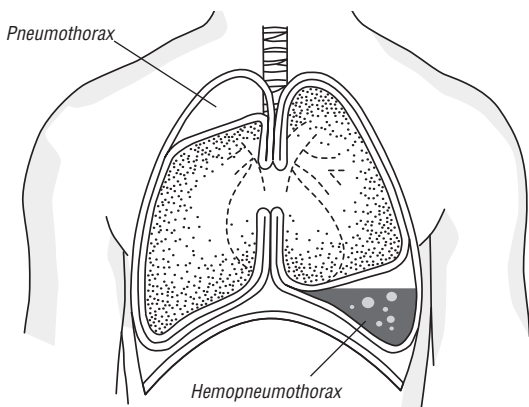
Under normal conditions, there is always negative pressure in the pleural cavity. The degree of negativity, however, changes during respiration. During normal inspiration, intrapleural vacuum pressure is approximately $-8\text{cmH}_2\text{O}$, while during expiration the vacuum pressure falls to $-4\text{cmH}_2\text{O}$. With deep inspiration, intrapleural pressures can be even more negative.



Why Water Seal CDUs Are Used

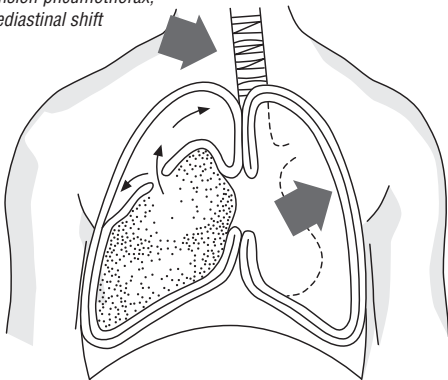
■ Clinical Needs For Chest Tube Drainage

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. Very 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.

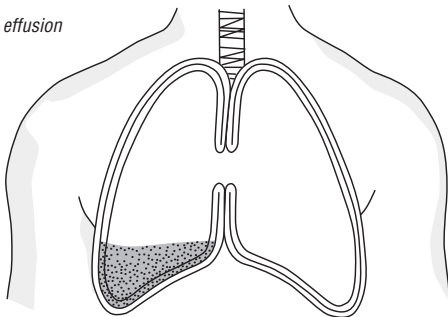
*Tension pneumothorax,
mediastinal shift*



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.

Pleural effusion



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.

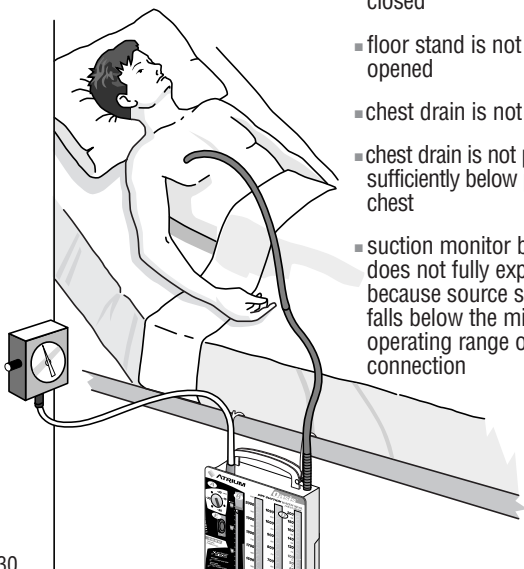
The physician's prescribed treatment for any of these clinical drainage situations are:

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

What To Check For During CDU Use

Very often, 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:

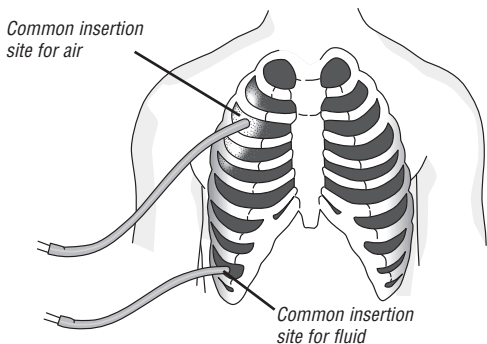
- clot in chest tube *inside* patient
- clot in the patient tube
- dependent loop in patient tube with fluid
- kink in patient tube from bed rail or patient position
- partial dislodgement of catheter from patient
- partial disconnection of patient tube from chest tube connector
- overfilled water seal (water is above 2cm 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.



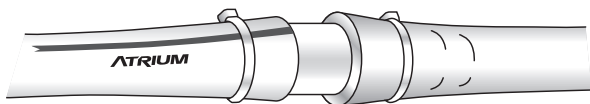
Thoracotomy chest tubes are normally flexible, kink resistant, clear catheters which are inserted through the chest wall via a small incision. A tight intercostal fit is preferred to minimize small bleeders around the catheter and to maintain an air-tight seal. A radiopaque stripe helps the clinician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

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

Typical Chest Tube Sizes

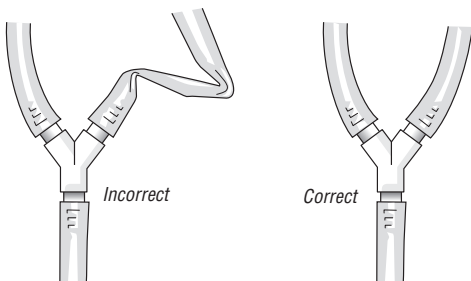
■ Chest Tube Nursing Responsibilities

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



Bands for added security

Since two or more indwelling chest tubes are frequently 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 water seal. 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 $-20\text{cmH}_2\text{O}$ or higher?

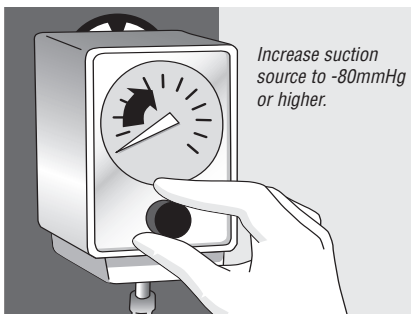
A The position of the bellows across the suction monitor window will alert the operator that the suction source has fallen below the minimum operating range for the prescribed suction control setting. Simply increase the vacuum source to -80mmHg or higher. The suction monitor bellows must expand to the ▲ mark or beyond for a $-20\text{cmH}_2\text{O}$ or higher suction regulator setting.



Not enough vacuum for $-20\text{cmH}_2\text{O}$ or higher suction control setting.



Normal suction operation for $-20\text{cmH}_2\text{O}$ or higher.



Increase suction source to -80mmHg 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 efficiently at each suction control setting as compared to traditional water controlled operating systems. The suction source should provide a minimum vacuum pressure of -80mmHg at 20 liters of air flow per minute for chest drain operating efficiency at a suction control setting of -20cmH₂O. The suction source should be greater than -80mmHg when multiple chest drains are connected to a single suction source. If the bellows does not fully expand to the ▲ mark, it may simply 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 simply bypass a “leaky” wall canister. Try connecting the chest drain to a different suction source or 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 -10cmH₂O regulator setting?

A No. For a regulator setting less than -20cmH₂O suction (-10cmH₂O), **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 -20cmH₂O, just visibly expanded to confirm suction operation.

Q How do I confirm my patient has an air leak when there is:

■ **No bubbling in the water seal?**

A *If there are no air bubbles observed going from right to left in the air leak monitor, there is no patient air leak.* In order to confirm that your patient's chest catheter(s) are patent, temporarily turn suction off and check for oscillation of the patient pressure float ball in the water seal column coinciding with patient respiration.

■ **Bubbling present in the water seal?**

A Whenever *constant or intermittent bubbling* is present in the water seal *air leak monitor*, this will *confirm an air leak is present*. Oscillation of the patient pressure float ball at the bottom of the water seal *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 water seal. 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 water seal column?

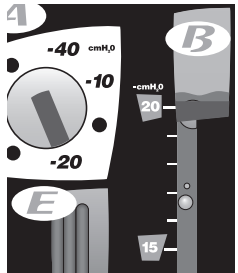
A If the small float ball is located and oscillating at the bottom of the water seal column with *no bubbling*, there is no apparent patient air leak. However, the water seal should be carefully monitored for the presence of an *occasional or intermittent* air leak.

Q**How do I lower the water seal level?****A**

Changes in your patient's intrathoracic pressure will be reflected by the height of the water in the water seal column. These changes are usually due to mechanical means such as milking or stripping patient drainage tubes, or simply by deep inspiration by your patient after all air leaks have subsided. If desired, the height of the water column and patient pressure can be reduced by temporarily depressing the filtered manual vent located on top of the drain, until the float valve releases and the water column lowers to the desired level. ***Do not lower water seal column when suction is not operating, or when patient is on gravity drainage.***

Q**What happens when the water rises to the top of the water seal float valve?****A**

The water seal column is a diagnostic manometer for monitoring your patient's intrathoracic pressure. When intrathoracic pressures increase, causing the water to rise to the top of the water seal float valve, the ball floats up and "seats" up against a valve seat. This valve seat has been carefully engineered to allow a certain amount of water to pass through it during a precise amount of time. When vacuum pressures greater than $-20\text{cmH}_2\text{O}$ on gravity or $-40\text{cmH}_2\text{O}$ on suction occur for an *extended period of time*, water will pass through the valve seat and float valve to allow the water seal to release *automatically*. The benefit of Atrium's *controlled release* design is that during normal or deep inspiration, the float valve will float up and down with each respiratory cycle, not allowing the water seal to release.



This enables thoracic patients to draw as much intrathoracic pressure as they may require during each respiratory cycle.

Q Is it normal for the patient pressure float ball to fluctuate up and down (tidal) near the bottom of the water seal column?

A Yes. Once your patient's air leak is resolved, you will generally observe moderate tidaling in the water seal column. Increases in intrathoracic pressure will cause the water level to rise (the ball rises) during patient inspiration and will lower or decrease (the ball drops) during expiration. This diagnostic tool will help to confirm patency of your patient's catheter(s).

Q How do I determine patient pressure with a dry suction chest drain?

A Whether a traditional wet or dry suction operating system, one cannot overemphasize the importance of the calibrated water seal column when it comes to diagnosing the patient's condition or monitoring normal system operation. Patient pressure can be determined by observing the level of the blue water and small float ball in the calibrated water seal column. With suction operating and the bellows expanded across the suction monitor window, patient pressure will equal the suction control setting (read directly from the regulator dial) *plus* the calibrated water seal column level. For example, when the suction monitor bellows is expanded to the ▲ mark or beyond to confirm a -20cmH₂O suction setting, and the calibrated water seal column reads -15cmH₂O, patient pressure is -35cmH₂O (-20cmH₂O + -15cmH₂O = -35cmH₂O). For gravity drainage (no suction) patient pressure will equal the calibrated water seal column only.

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 If the chest drainage system has been knocked over, can I use it and what should I do?

A After a chest drainage system has been knocked over, set it upright and immediately check the fluid level of the water seal for proper volume. Atrium provides a convenient self-sealing diaphragm for access by a 20 gauge or smaller needle and syringe to adjust the water level in the water seal chamber, if required. Alcohol swab the needle access area and aspirate any overfill that may have occurred. If the water seal has an inadequate fluid level, simply replace the lost volume. If a significant amount of blood has entered the water seal, it may be advisable to change the system for a new one.

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



CUSTOMER SERVICE

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

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