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Q The Atrium dry suction chest drainage system can be set to -40 cm H_2O. The water-filled suction chambers I have used only go to -20 cm H_2O; I have never seen suction pressures other than -20 cm H_2O ordered. What circumstances warrant a chest drain suction pressure greater than -20 cm H_2O?

A Patricia Carroll, RN,BC, CEN, RRT, MS, replies:

First, it is important to understand how the current state of the art developed with regard to suction pressures used with chest tubes. There are no data to guide an evidence-based decision on the suction limit established with a chest drain system.[1] Chest drainage was originally established by using a 1-, 2-, or 3-bottle system. In one of these glass bottles, a straw submerged under 2 cm of water established a water seal. In some cases, suction was generated by a device called an Emerson pump (J.H. Emerson Co, Cambridge, Mass) attached to either a 1-bottle combination collection bottle/water seal (commonly used in the 1930s to treat empyema associated with tuberculosis before antibiotics were widely available), or to a 2-bottle system in which one bottle collected drainage and the second bottle established a water seal. The dial on the pump was used to set the amount of negative pressure applied through the chest tube and to the pleural space. The Emerson pump's dial ranged from 0 to -60 cm H_2O.

A third bottle was added to limit the amount of negative pressure that could be transmitted to the chest. This was a safety measure; if a third bottle was not added, it was suggested the nurse tape the pump's dial in place to prevent inadvertent changes in pressure.[2] In the suction control bottle, a straw was submerged to a depth of about 20 cm under water (-20 cm H_2O). The size of the bottle limited the suction level by limiting the depth to which the straw could be submerged.

When the first plastic, disposable, all-in-one chest drains were introduced about 30 years ago, they too were limited by size. Today, "wet" suction control chambers are calibrated to -25 cm H_2O. If higher suction levels were desired, the chest drain would have to be taller. This changed with the dry suction drains—they are not limited by size, so "available" pressures could be higher. A chest drain such as the Atrium Oasis has a dry suction control mechanism that can control pressures up to -40 cm H_2O.

The flow rate of air out of the chest is related to, but not the same as, the negative pressure. If all things remain equal, increasing the amount of negative pressure set on the drain should increase the flow of air through and out of the system. Drain suction pressure is increased typically with pleural chest tubes only. An increased negative pressure may be needed in cases in which the lung is noncompliant and stiff, and greater force is needed to expand the lung and approximate the pleurae. If a patient has a large air leak and requires mechanical ventilatory support (usually with positive end-expiratory pressure), the air may not be fully evacuated out of the chest before the next breath is delivered by the ventilator. One option would be to increase the amount of suction set

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on the chest drain to pull air out of the chest more quickly. Another option is to increase the amount of suction set on the vacuum regulator attached to the system. Increasing the vacuum pressure at the source (making it more negative) will not expose the tissues to higher negative pressures, but it will increase the flow rate; that is, the speed at which air is pulled out of the pleural space.[3] Increasing the flow rate can help remove all the air from the pleural space and approximate the visceral and parietal pleura. However, some experts believe that a high flow rate instead allows a pleural air leak to persist because it maintains a continuous flow through the tissue opening, preventing healing.[1]

There is some concern that setting higher suction pressures on the drain can increase the risk of tissue injury. However, case reports by Stahly and Tench[4] found focal lung infarction when lung tissue was pulled into the eyelets of the chest tube at suction limits of -10 to -20 cm H_2O. Rusch and colleagues[5] found that even though increasing the negative pressure on the drain from -20 cm H_2O to -40 cm H_2O should theoretically double the flow rate, in vivo, there was little difference in air flow through chest drainage systems.

Why do dry suction control chest drains such as the Atrium unit offer negative pressure settings up to -40 cm H_2O? One reason is that it is technically easy to do, and another is that thoracic surgeons requested higher levels be available for selected patients. Many experienced surgeons have achieved positive patient outcomes anecdotally by turning up the dial on the Emerson pump. This mindset has been translated to a desire to have higher negative pressure levels available on a disposable chest drain today.

If higher negative pressures are required, and a water-filled suction control chamber is used, it is possible to achieve higher suction levels. Occlude the atmospheric vent on the suction control chamber with nonporous tape or a special cap; this will allow you to bypass (or override) the limits of the suction control chamber, and the negative pressure level dialed in on the source vacuum regulator will be transmitted directly to the chest. Clearly mark which regulator is being used for the chest drain so that the vacuum level is not changed inadvertently. Be aware that most wall vacuum regulators measure pressure in mm Hg; you need to convert this to cm H_2O. Check with your chest drain manufacturer for specific instructions for the device you are using.

Interestingly, the most recent research has not examined increasing suction levels, but rather, has looked at discontinuing suction and switching to simple gravity drainage with a water seal as soon as possible after surgery to make it easier for patients to get out of bed in an effort to reduce length of stay.[6-8] This may well be a foreshadowing of the future of chest drainage.

As always, the key to positive patient outcomes when adjusting the suction level on a chest drainage system is individualized patient assessment. Determine whether the patient has delicate, friable lung tissue that may be more easily damaged by negative pressure, or if the lungs are stiff and noncompliant so that they may not reexpand easily. Regularly assess breath sounds, review results of chest radiographs, and carefully monitor the chest drain to see if the patient has an air leak. Check whether interventions such as changing ventilator settings, altering the suction limit established by the drain, or adjusting the source (wall) vacuum increase or decrease the size of the air leak.

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