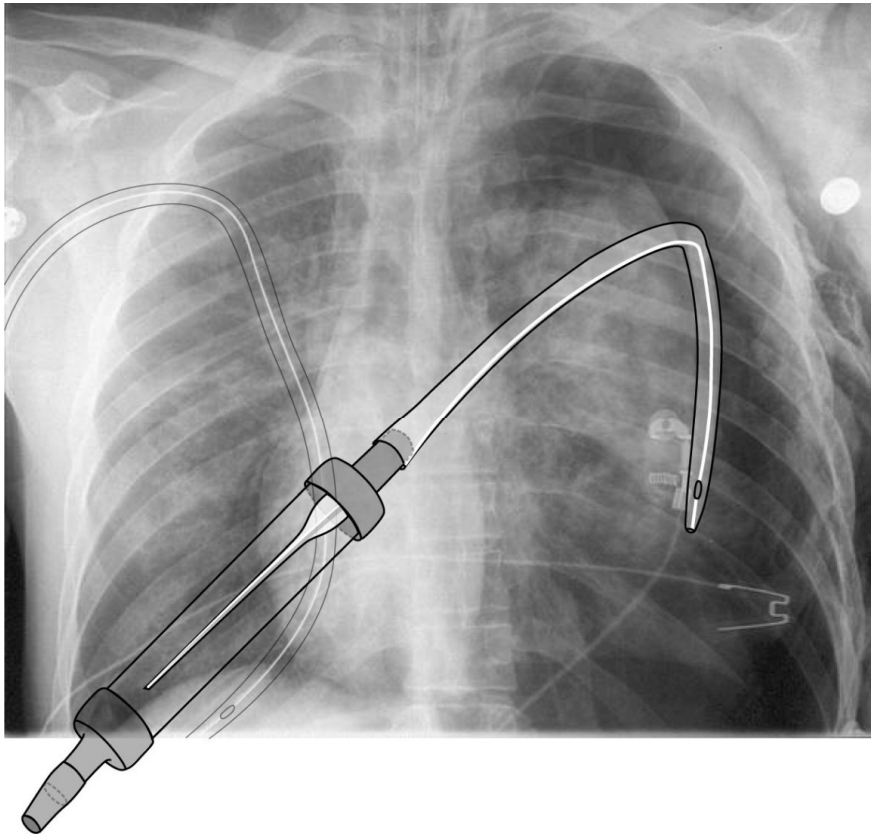
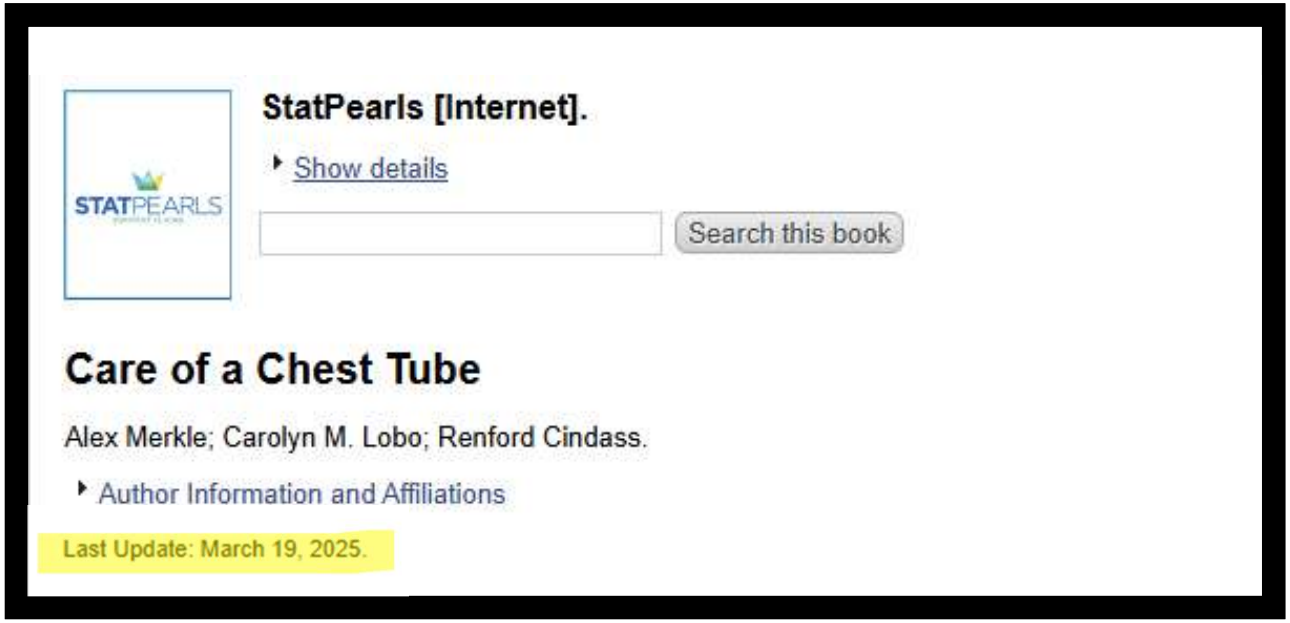
Chest drain management



Nazanin zibanejad.MD

Pediatric intensivist

Isfahan University of Medical Science



Chest or thoracostomy tubes are flexible devices that drain air, fluid, or blood from the pleural space, facilitating lung reexpansion and restoring normal intrathoracic pressure dynamics.

Chest tubes are a critical intervention for managing pleural space pathologies, including pneumothorax, hemothorax, empyema, and postoperative drainage.

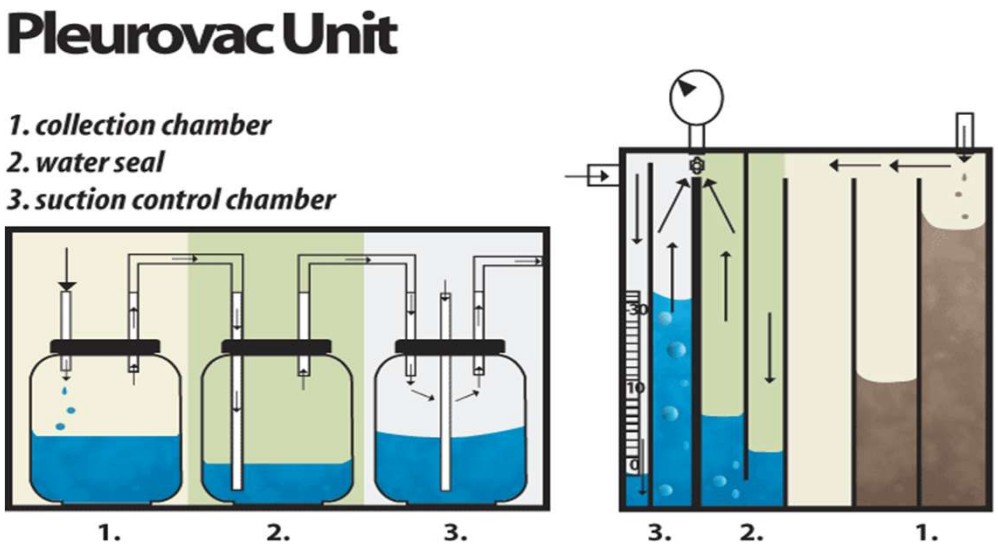
- Typically constructed from polyvinyl chloride or silicone, chest tubes range in size from ۶ to ۴۰ Fr and are fenestrated along the insertion end, often with a radiopaque stripe to enhance visibility during imaging.

10.6 Chest Tube Drainage Systems

- A **chest tube drainage system** is a sterile, disposable system that consists of a compartment system that has a one-way valve, with one or multiple chambers, to remove air or fluid and prevent return of the air or fluid back into the pleura

patient Bauman & Handley, ٢٠١١; Rajan, ٢٠١٣

Traditional chest tube drainage system will have these three chambers



□. Collection chamber :

The chest tube connects directly to the collection chamber, which collects drainage from the pleural cavity.

The chamber is calibrated to measure the drainage. The outer surface of the chamber has a “write-on” surface to document the date, time, and amount of fluid. This chamber is typically on the far right side of the system .

□/ Water-seal chamber :

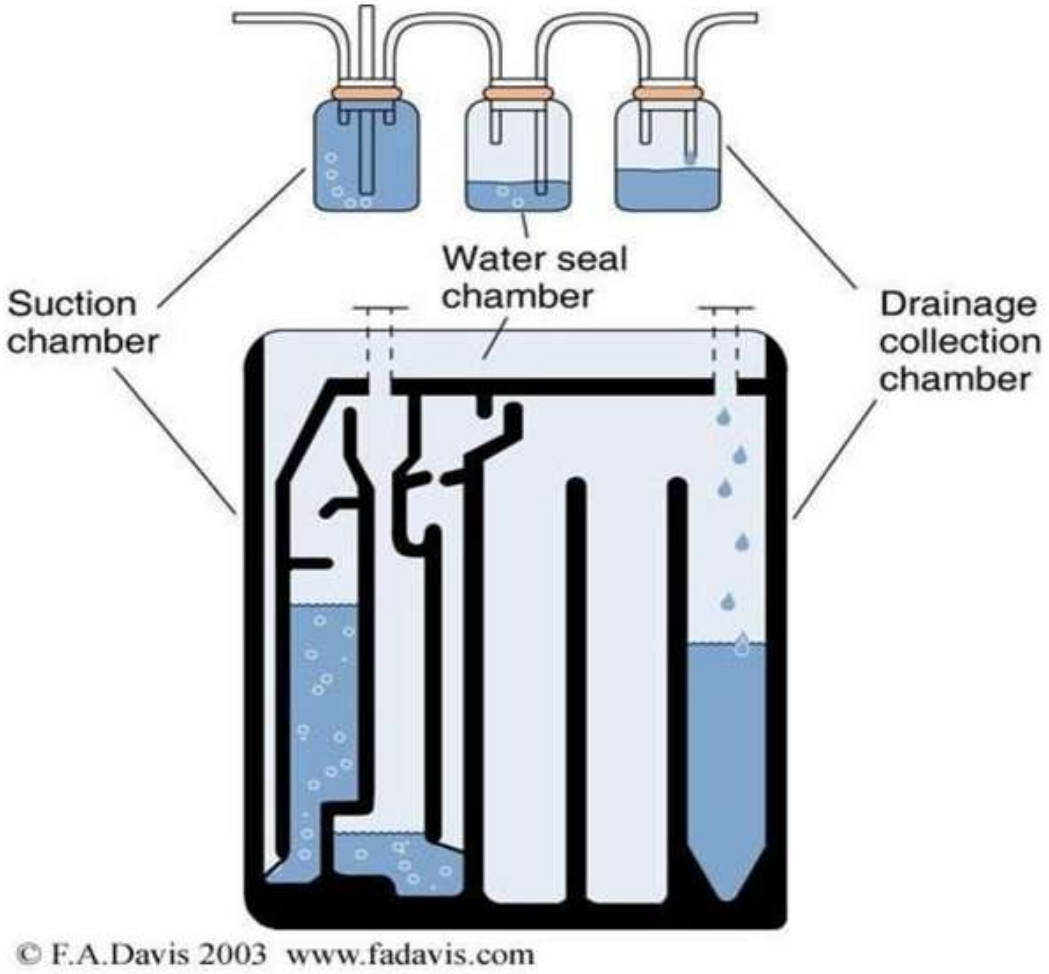
This chamber has a one-way valve that allows air to exit the pleural cavity during exhalation but does not allow it to re-enter during inhalation due to the pressure in the chamber. The water-seal chamber must be filled with sterile water and maintained at the ٢ cm mark to ensure proper operation, and should be checked regularly.

Fill with additional sterile water as required.

The water in the water-seal chamber should rise with inhalation and fall with exhalation (this is called *tidaling*), which demonstrates that the chest tube is patent.

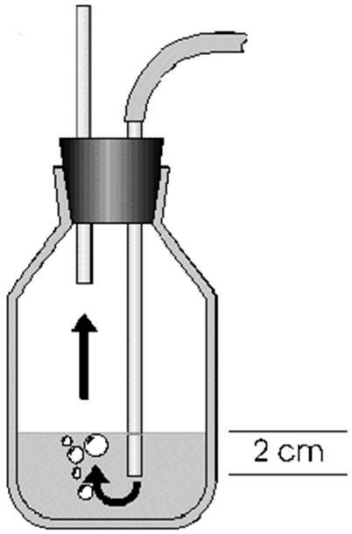
Continuous bubbling may indicate an air leak, and newer systems have a measurement system for leaks — the higher the number, the greater the air leak.

The water-seal chamber can also monitor intrathoracic pressure



سیستم یک بطری:

انتهای لوله درناژ که از سینه بیمار خارج می شود، در آب شناور قرار داده می شود و هوا و مایع از فضای جنب درناژ می گردد؛ اما امکان برگشتن هوا به عقب و به طرف سینه وجود ندارد. از نظر عملی درناژ بستگی به قدرت جاذبه و مکانیک تنفس دارد.

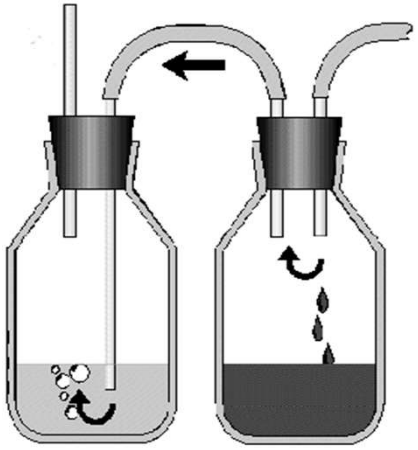


با افزایش سطح مایع در بطری، خروج هوا و مایع از قفسه سینه، دشوارتر خواهد شد

سیستم دو بطری:

این سیستم مشابه سیستم یک بطری، شامل همان محفظه آبی است؛ علاوه بر آن، یک بطری برای جمع آوری مایع نیز وجود دارد. تفاوت این سیستم با سیستم یک بطری تنها در این است که افزایش حجم درناژ، بر روی خروج هوا و مایع از سینه تاثیری نمی گذارد.

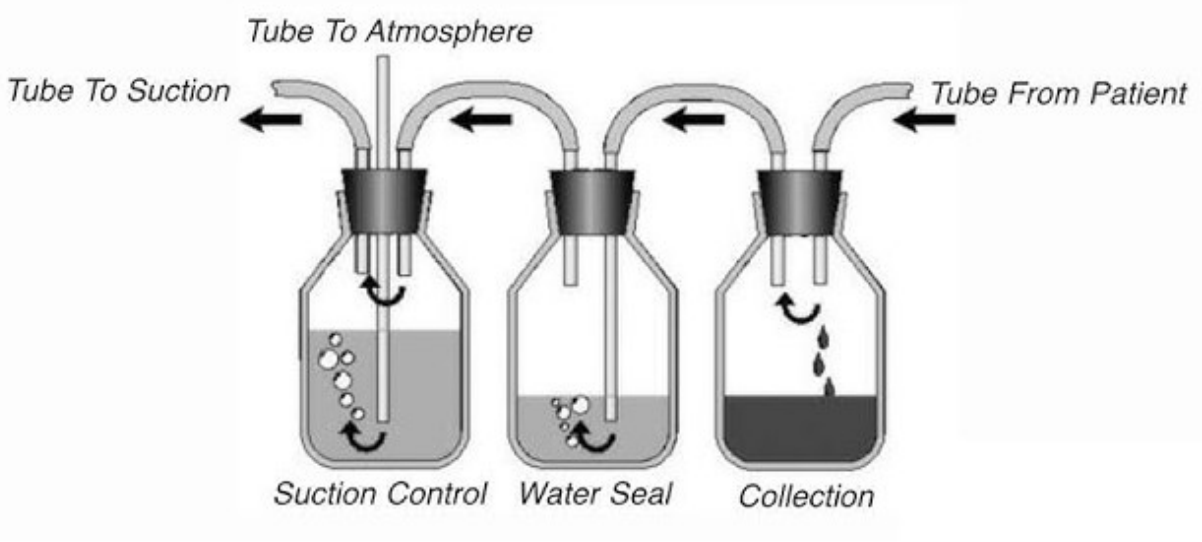
درناژ موثر بستگی به قدرت جاذبه و ساکشن دارد که به سیستم اضافه می شود.



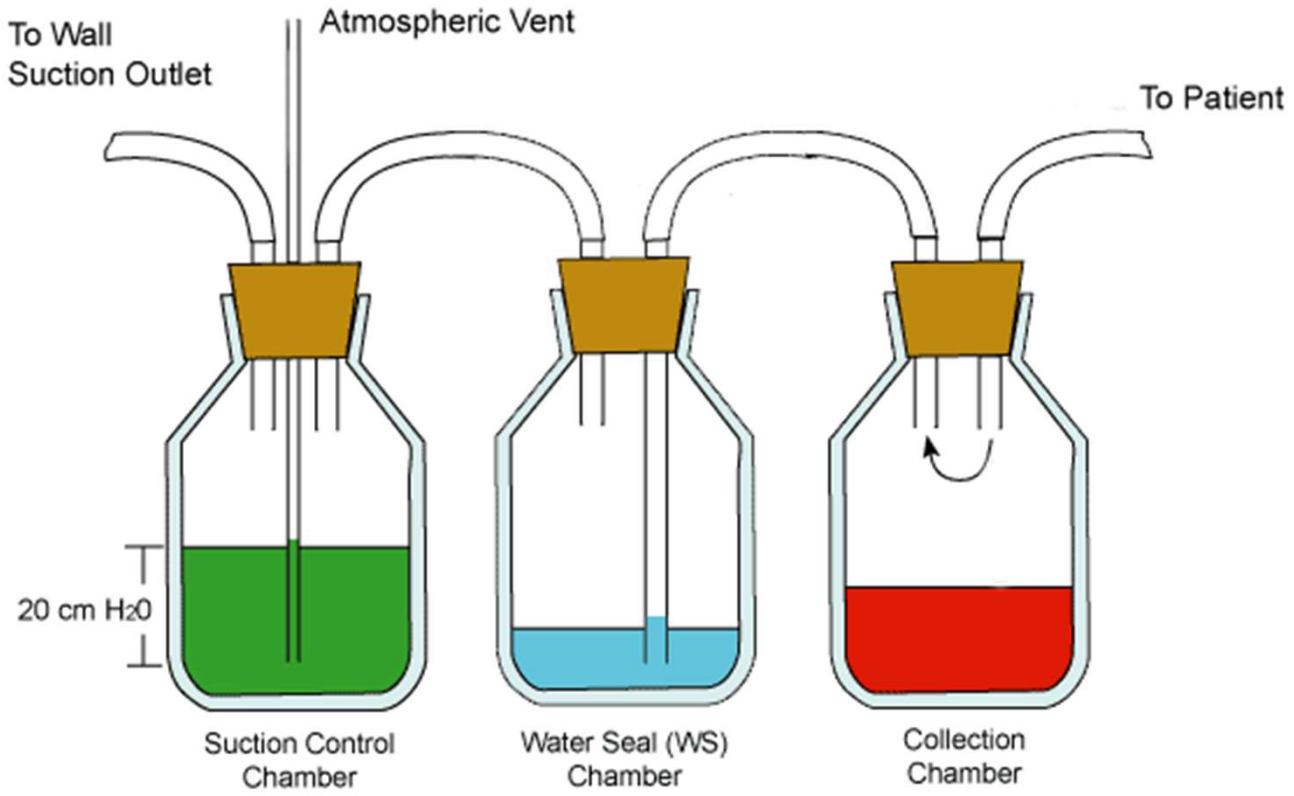
سیستم سه بطری:

این سیستم مشابه سیستم دو بطری است با این تفاوت که در این سیستم برای کنترل حجم ساکشن، یک بطری دیگر نیز به مجموعه اضافه می شود. مقدار ساکشن، بستگی به عمق قرار گرفتن لوله شیشه ای در مایع شناور دارد.

مقدار ساکشن در این سیستم به وسیله مانومتر کنترل و باعث فشار منفی می شود.



Play ▶

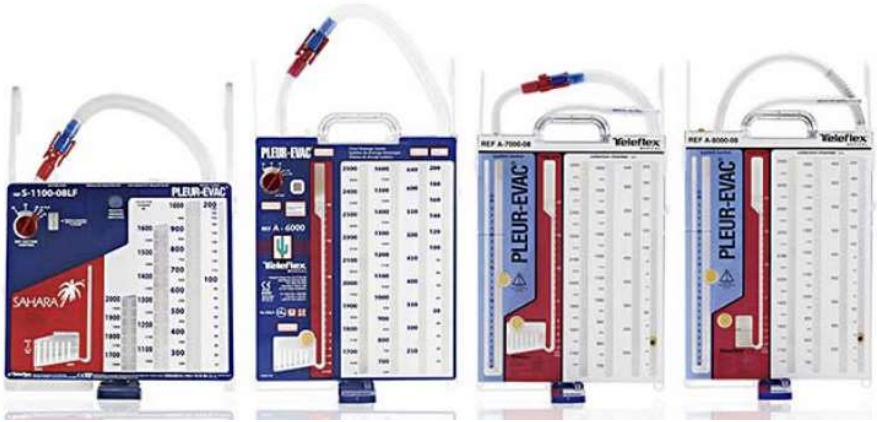

To Wall
Suction Outlet
Atmospheric Vent
To Patient
20 cm H2O
Suction Control
Chamber
Water Seal (WS)
Chamber
Collection
Chamber

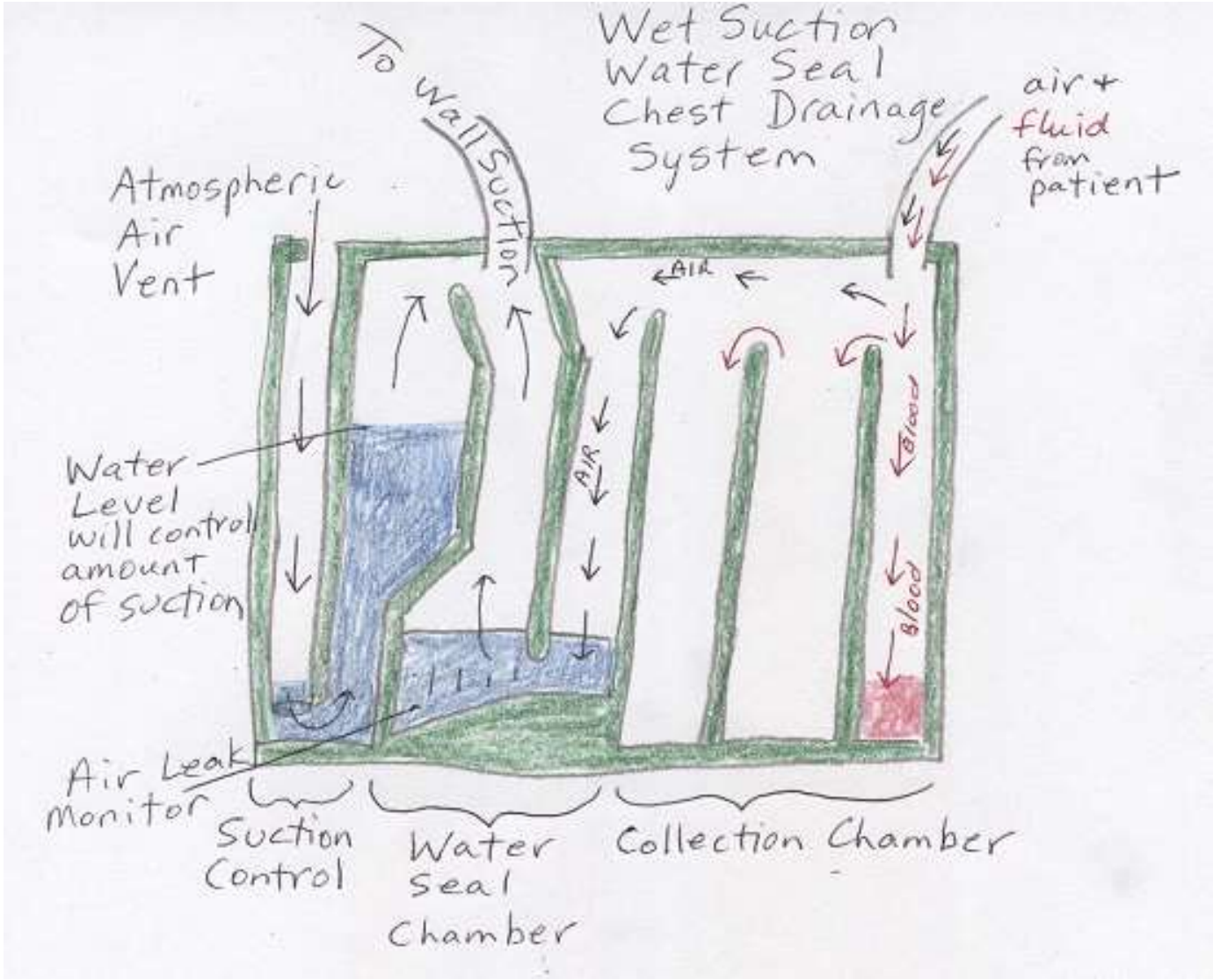
Clinical Education Resources

Pleur-evac™ Chest Drainage System Clinical Education Portal

The Pleur-evac™ Chest Drainage System—the premier chest drainage solution for thoracic, cardiovascular, trauma and critical care—uses the most advanced fluid management technology available. We at Teleflex are dedicated to providing our customers with exceptional product training and support. Below you will find training resources geared toward furthering your chest drainage understanding. Whether you are converting to the Pleur-evac™ System, or continuing your education, we hope to help you improve patient outcomes.

**Note: As of December 2019, Teleflex no longer offers Autotransfusion or Rapid Transfer blood bags. Any mention of ATS on this site or within existing collateral is for instructional purposes only.*




Wet Suction
Water Seal
Chest Drainage
System
To Wall Suction
air + fluid from patient
Atmospheric Air Vent
AIR
AIR
Blood
Blood
Water Level will control amount of suction
Air Leak Monitor
Suction Control
Water Seal Chamber
Collection Chamber

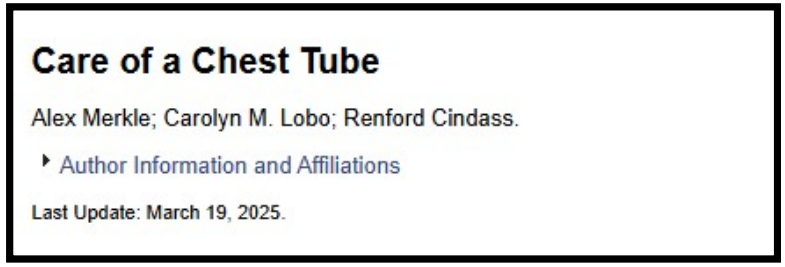
❑ چست تیوب ساده با خط رادیواپاک سوپا

۱۲۴٬۵۰۰ تومان-۵۹٬۹۵۰ تومان به بالا

❑دستگاه‌های تخلیه قفسه سینه برند Pleur-evac، تولید شرکت Teleflex، از جمله مدل‌های (Cactus) A-۶۰۰۰ و (MINI Sahara) S-۰۵۰۰، در بازارهای بین‌المللی به‌ویژه در آمریکا در دسترس هستند.

در وب‌سایت‌های بین‌المللی، قیمت‌ها به‌صورت زیر است:

بین ۵۵٫۹۹ تا ۵۷٫۹۹ دلار :Pleur-evac Trocar Thoracic Catheter



Care of a Chest Tube

Alex Merkle; Carolyn M. Lobo; Renford Cindass.

▸ Author Information and Affiliations

Last Update: March 19, 2025.

Antibiotics

- Prophylactic antibiotics are recommended before chest tube placement, particularly in those with trauma, to reduce the risk of empyema and pneumonia.
- prolonged antibiotic prophylaxis after tube placement has not been shown to decrease infection rates significantly and is generally not recommended.

Figure 10.7 Heimlich valve

Figure 10.8 Blue end connects to chest tube; other end may be left open to air or attach to a small drainage bag

Flutter valve (e.g. Pneumostat, Heimlich valve):

One way valve system that is small and portable for transport or ambulant patients. Allows air or fluid to drain, but not to backflow into pleural cavity.

ORIGINAL PAPER

The ANNALS *of* AFRICAN SURGERY | www.annalsofafricansurgery.com

The Heimlich Valve for Pleural Cavity Drainage

Winston Ominde Makanga[1], Andrew Nyaoncha Nyangau[2] , Benjamin Njoga Njihia[3]

1. St Mary's Mission Hospital, Elementaita
2. St Mary's Hospital, Nairobi
3. Aga Khan University Hospital, Nairobi

- One-way valve systems such as the Heimlich valve are small, portable apparatus that allow regulation of fluid flow and require minimal nursing care other than daily charting

Heimlich valve

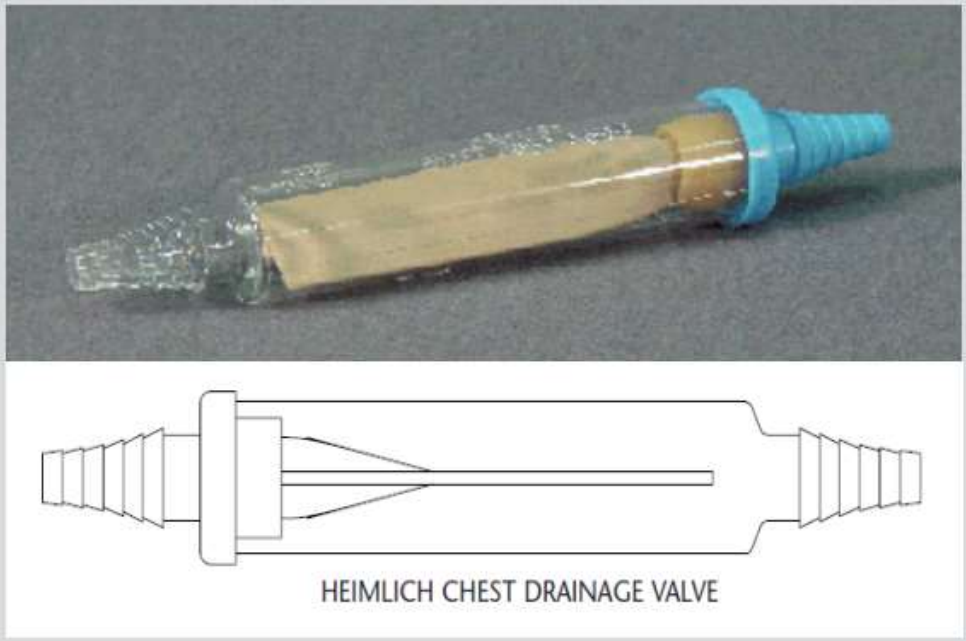
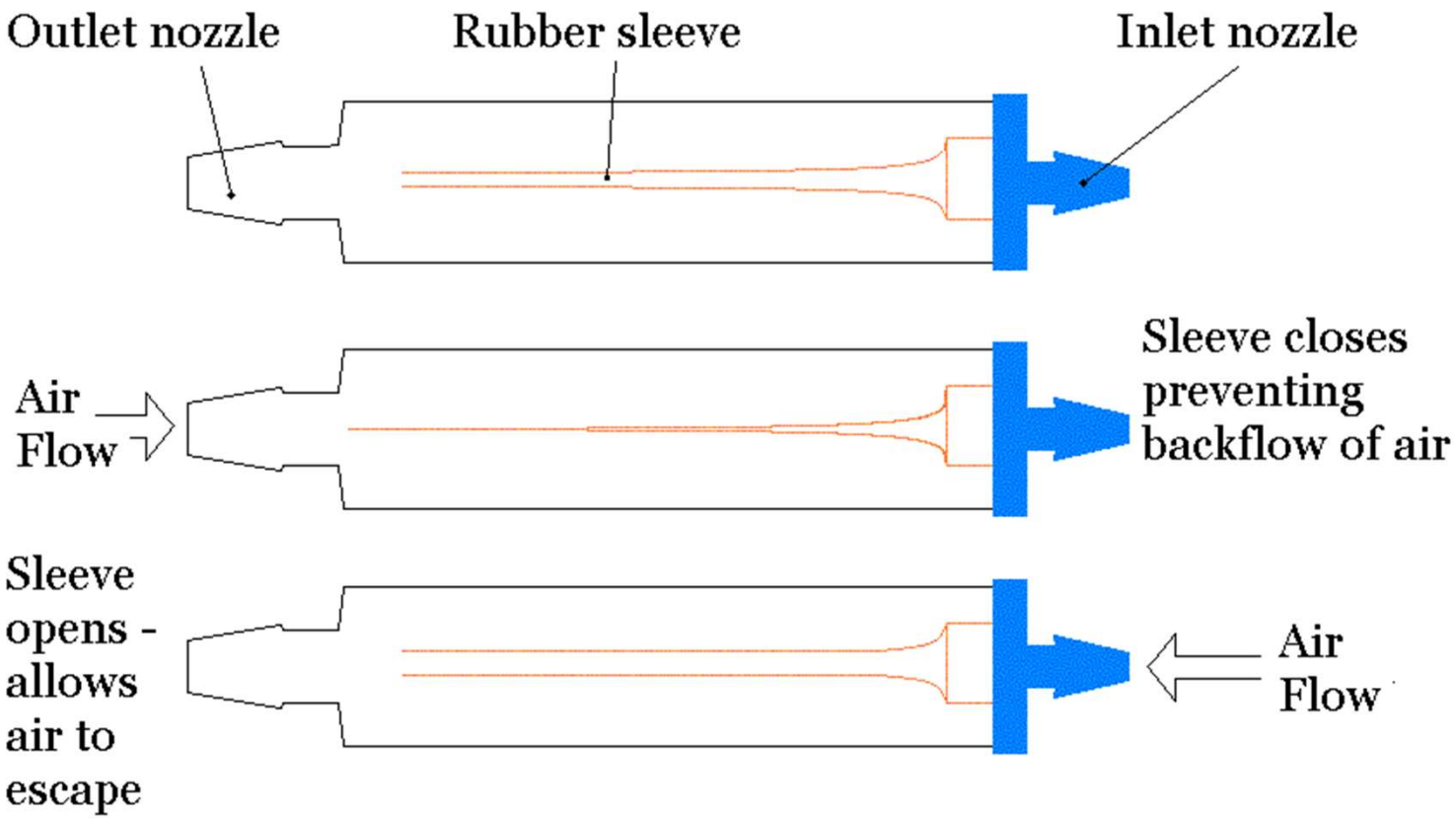


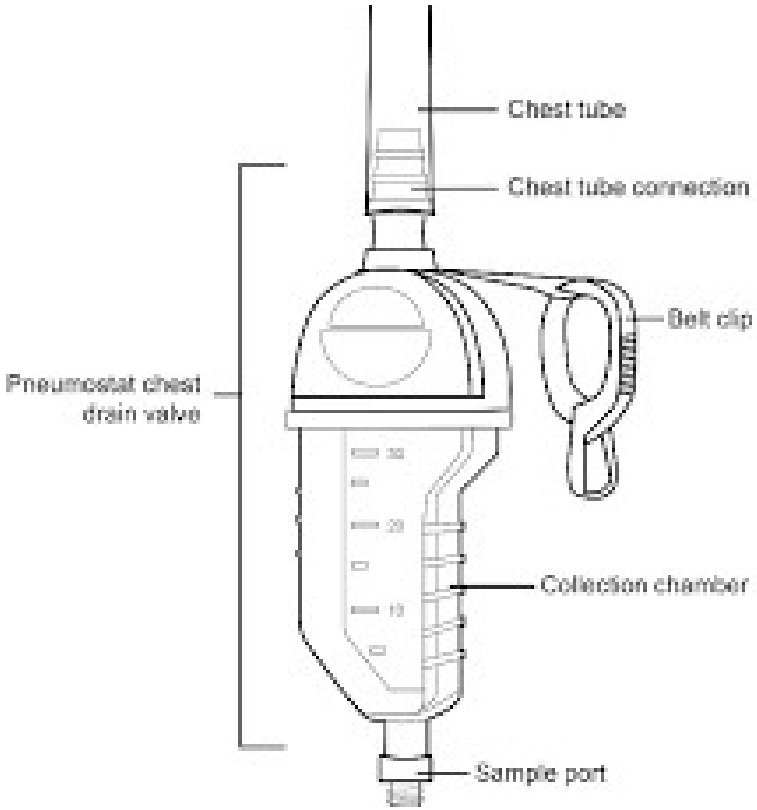
Figure 1: Image and Schematic Diagram of the Heimlich Flutter Valve


Outlet nozzle
Rubber sleeve
Inlet nozzle
Air
Flow
Sleeve closes
preventing
backflow of air
Sleeve
opens -
allows
air to
escape
Air
Flow

Conclusion

The Heimlich valve is a feasible and cheap alternative method of chest tube drainage with high rates of success and very low morbidity. It is especially useful in a setting of high patient to nursing staff ratio. We propose it for adoption in local institutions over the underwater seal for chest drainage as well as trials that will offer greater insight as to patient perspective and cost comparison.

Pneumostat


Chest tube
Chest tube connection
Belt clip
Pneumostat chest drain valve
Collection chamber
Sample port

Chest tube sizes:

- Adults and teenage boys: ٢٨-٣٢ fr
- Adults and teenage girls: ٢٨ fr
- Children: ١٨ fr
- Neonate: ١٢- ١٤ fr

The location of the chest tube depends on what is being drained from the pleural cavity.

- If air is in the pleural space, the chest tube will be inserted above the second intercostal space at the mid-clavical line.
- If there is fluid in the pleural space, the chest tube is inserted at the fourth to fifth intercostal space, at the mid-axillary line.

- A chest tube may also be inserted to drain the pericardial sac after open heart surgery, and may be placed directly under the sternum

- A chest tube drainage system must always be placed below the drainage site and secured in an upright position (attached to the floor or an IV pole to prevent it from being knocked over.

- Safety/emergency equipment must always be at the patient's bedside and with the patient at all times during transportation to other departments.

- Safety equipment includes:
  - Two guarded clamps
  - Sterile water
  - Vaseline gauze (Jelonet)
  - ٤ x ٤ sterile dressing
  - Waterproof tape

- *Never* clamp a chest tube without a doctor's order or valid reason.

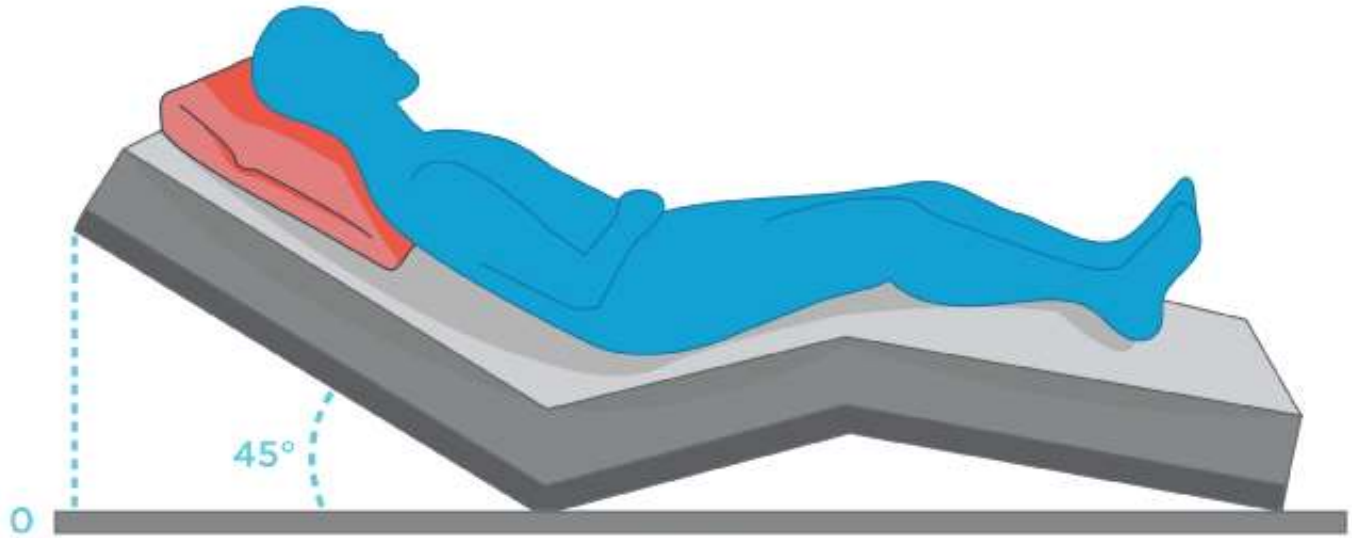
- The tube must remain unobscured and unclamped to drain air or fluid from the pleural space.

- Chest tube drainage systems are replaced only when the collection chamber is full or the system is contaminated.

- Complete respiratory assessment, ensure patient has minimal pain, and measure vital signs. Place patient in *semi-Fowler's position* for easier breathing.

- Semi-Fowler, or low Fowler, position is a supine position in which an individual lies on their back on a bed, with the head of the bed elevated between ٣٠-٤٥ degrees, and the legs of the patient can be either straight or bent at the knees. A pillow can also be placed under the calves for support and comfort

semi-Fowler’s position

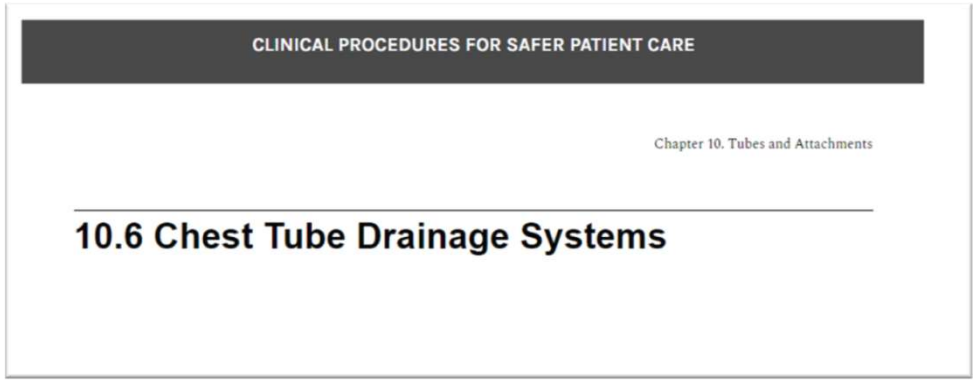


Semi-Fowler’s: Head of the bed raised 30-45 degrees

Chest drain management

https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Chest_drain_management/

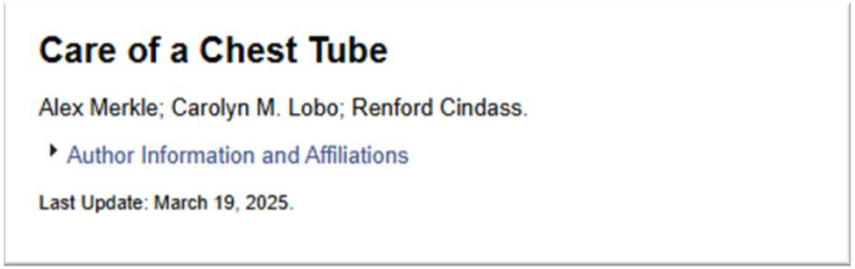
The Royal Children's Hospital Melbourne



Patient Assessment :

- Vital signs
  - PICU and NICU patients should be on continuous monitoring
  - HR, SpO٢, BP, RR
  - Routine observations:
- For ward areas:
  - On insertion of chest drain monitor patient observations of HR, SpO٢, BP, RR:
    - ١٥ minutely for ١ hour
    - ١ hourly for ٤ hours
  - Includes HR, SpO٢, BP, RR, Respiratory Effort and temperature
  - ١-٤ hourly as indicated by patient condition

Chest tube care



Care of a Chest Tube

Alex Merkle; Carolyn M. Lobo; Renford Cindass.

Author Information and Affiliations

Last Update: March 19, 2025.

- **Site management**: To reduce the risk of infection, the insertion site must be kept clean and dry, and a sterile dressing must be applied. The dressing should be changed regularly, and the site should be inspected for signs of infection, such as redness, swelling, or drainage.

- **Tube patency** :Regular checks are needed to ensure the tube is not kinked or obstructed. If the chest tube becomes clogged, gentle milking or flushing with sterile saline (under physician guidance) may be used, though this should be done cautiously to avoid increasing pleural pressure.
- **Drainage system:** The drainage system, often a water-seal or dry-seal device, should be positioned below the chest level to prevent fluid or air backflow (see **Image.** Chest Tube Drainage System). Clinicians should regularly monitor the drainage for fluid volume, color, or consistency changes. Sudden changes, such as increased drainage or a shift from serous to bloody fluid, may signal complications.
- **Pain management:** Chest tubes can be uncomfortable, so appropriate pain management is important. Early mobilization and deep breathing exercises can also help prevent complications like atelectasis.

Pain

- Chest tubes are painful as the parietal pleura is very sensitive. Patients require regular pain relief for comfort, and to allow them to complete **physiotherapy or mobilis**

- Ensure patient has adequate pain relief, especially prior to repositioning, sitting, or ambulation.

Review Article on Prolonged Air Leak after Lung Surgery: Prediction, Prevention and Management

Enhanced recovery after surgery and chest tube management

Tim J. P. Batchelor^

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Journal of Thoracic Disease, Vol 15, No 2 February 2023

- They are painful and can limit mobility. Pain is both musculoskeletal and neuropathic in nature.

- Immobility and its deleterious effects may be the result of “drain pain” and/or the side effects of the analgesics required to control the pain.

- Intercostal nerve injury appears to be the most important factor in its pathogenesis
- Indwelling chest tubes may cause ongoing irritation of the pleura or intercostal bundles.

❖ Pain relief pathways should include multimodal enteral and parenteral analgesia with regional analgesia or local anesthetic techniques while attempting to avoid opioids and their side effects.

❖ Recommendations following lung cancer surgery include regional anesthesia (preferably without thoracic epidural), acetaminophen in combination with non-steroidal anti-inflammatory drugs, glucocorticoids and ketamine

- Assess chest tube insertion site to ensure sterile dressing is dry and intact.
- Check insertion site for subcutaneous emphysema.

- Dressing is generally changed ٢٤ hours post-insertion, then every ٤٨ hours. Chest tubes are generally sutured in place.

- There should be no fluid leaking from around the site or sounds of air leaks from insertion site.

- Ensure suction control dial is set to ordered level (usually ٢٠ cm)

- Measure date and time, and the amount of drainage, and mark on the outside of the chamber.

- Record amount and characteristics of the drainage on the fluid balance sheet and patient chart

- Encourage **frequent position changes** as well as **deep-breathing** and coughing exercises

The following should be documented and assessed according to agency policy:

- Presence of air leaks
- Fluctuation of water in water-seal chamber
- Amount of suction
- Amount of drainage and type
- Presence of crepitus (subcutaneous emphysema)
- Breath sounds
- Patient comfort level or pain level
- Appearance of insertion site and/or dressing

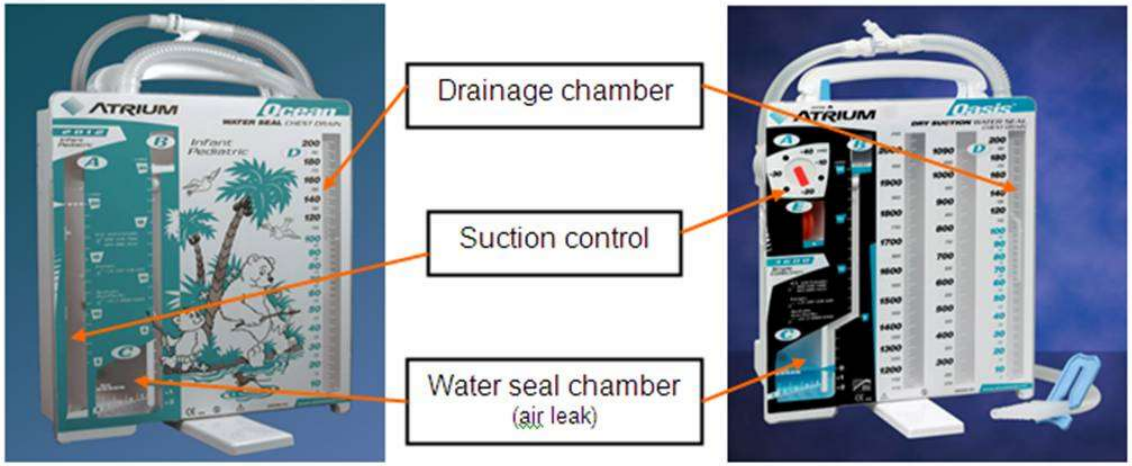
Drain insertion site

- Observe for signs of infection and inflammation
- Check dressing is clean and intact
- Observe **sutures** remain intact and secure (particularly long term drains where sutures may erode over time)

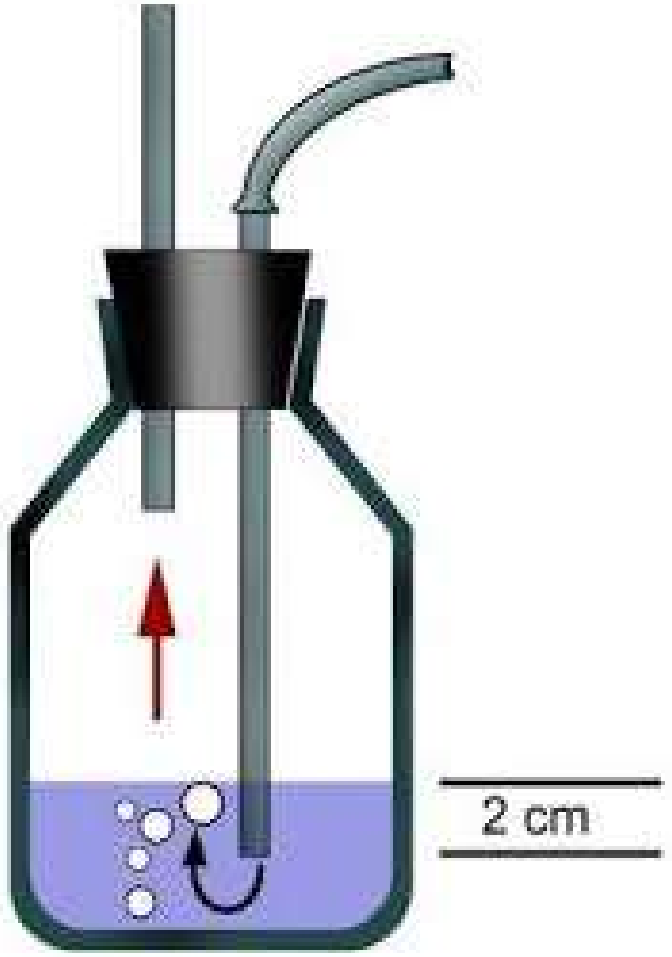
- **Assessment of chest tube** and **system tubing** should occur at the beginning of the shift and every hour throughout the shift

- **Never lift drain above chest level**

Chest drain system



Ensure the water seal is **maintained at ٢cm at all times**



Suction

- Suction is **not** always required, and may lead to tissue trauma and prolongation of an air leak in some patients

- Suction on the Drainage unit should be set to the prescribed level
  - **-٥ cmH٢٠** is commonly used for **neonates**
  - **-١٠ cmH٢٠ to -٢٠ cmH٢٠** is usually used by convention for **children**

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View this article at: https://dx.doi.org/10.21037/jtd-22-1373

A number of randomized clinical trials (RCTs) have been conducted comparing suction versus **no** suction in the postoperative period.

Several systematic reviews have subsequently addressed whether external suction or its absence has a beneficial effect on clinical outcomes .

The evidence is conflicting.

- There does not appear to be an advantage to the routine application of external suction (typically −٢٠ cmH٢O) in terms of shortening the duration of air leak, chest drainage or length of stay.
- Since wall suction limits patient mobility, its routine application should therefore be avoided

Milking- stripping : Based on the latest studies and clinical guidelines, the routine use of chest tube "milking" or "stripping" techniques is not recommended

.

١. StatPearls – NCBI Bookshelf (Published: March ٢٠٢٥)

According to this source, in cases of chest tube obstruction, gentle milking or sterile saline flushing under physician supervision may be used. However, these interventions should be performed cautiously to avoid increasing intrathoracic pressure.

٢. Annals of Thoracic Surgery (Published: ١٩٨٦)

A study showed no significant difference in drainage volume or tube blockage between groups with milking, stripping, or no manipulation of chest tubes. Therefore, such interventions are generally unnecessary.

٣. Clearflow (Published: ٢٠١٢)

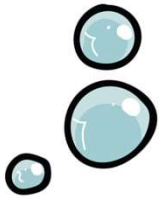
This source notes that stripping techniques can increase negative intrathoracic pressure up to approximately -٤٠٠ cm H_2O, which may cause tissue damage.

Furthermore, these methods have not been proven effective in preventing tube obstructions.

✅ Conclusion:

- Based on current evidence, chest tube milking or stripping is generally not recommended except in specific cases and under medical supervision.
- Instead, the use of active drainage systems and regular monitoring of tube function are considered safer and more effective methods for chest tube management.

Air Leak (bubbling)



- **Continuous bubbling** of this chamber indicates large air leak between the drain and the patient.
- Check drain for disconnection, dislodgement and loose connection, and assess patient condition.

Patient Positioning

- Patients who are **ambulant** post operatively will have fewer complications and shorter lengths of stay.

- Consider converting to a portable flutter valve system such as the pneumostat to facilitate this.
- If a patient is on strict bed rest or is an infant, **regular changes in position** should be encouraged to promote drainage, unless clinical condition prevents doing so

Patient Transport

- If the patient needs to be transferred to another department or is ambulant, the suction *should be disconnected* and left open to air.
- **DO NOT CLAMP THE TUBE**

- Ensure the chamber is **below** the patient's chest level during transport
- Flutter Valve systems (pneumostat, Heimlich) may be used for patient interhospital transfers

Chest Drain Dressings

- Dressings should be **changed** if:

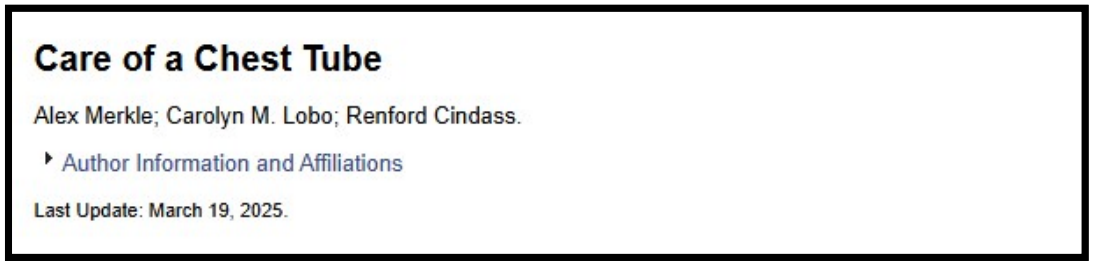
- no longer dry and intact, or signs of infection e.g. redness, swelling, exudate
- Infected drain sites require daily changing, or when wet or soiled

- No evidence for routine dressing change after ٣ or ٧ days

- This procedure is a risk for accidental drain removal so avoid unnecessary dressing changes

Changing the Chamber

- Indications
  - The chest drain chamber needs to be replaced when it is ¾ **full or when the UWSD system sterility has been compromised** eg. Accidental disconnection.



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Author Information and Affiliations

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- A chest tube is typically removed when drainage is <١٠٠ to ٢٠٠ mL in ٢٤ hours. However, enhanced recovery after surgery protocols suggest removal at <٥٠٠ mL if no air leak, chylothorax, pus, or active bleeding is present.

- The timing of removal depends on clinical progress and postoperative protocols. For pneumothorax, removal is generally considered when there has been no air leak for at least ٢٤ hours and imaging confirms lung reexpansion

Guideline

The Society for Translational Medicine: clinical practice guidelines for the postoperative management of chest tube for patients undergoing lobectomy

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Recommendations:

- Chest tubes can be removed safely with daily pleural fluid of up to ۴۵۰ (non-hematic, non-chylous), which may reduce chest tube duration and hospital length of stay.

- Chest tube clearance by milking and stripping offers no advantages in patients after lobectomy

Table 2 Recommendations for chest tube removal following routine lung resection

Chest tube drainage	Recommendation for tube removal
Pleural fluid drainage	<450–500 mL/24 hours
Air leak	No air leak in previous 6–12 hours
Nature of fluid	Serous/hemoserous (no evidence of chyle, pus or active bleeding)

- Routine chest tube suction offers no advantage for patients undergoing lobectomy, and may only be indicated in case of progressive subcutaneous emphysema

- Regulated seal is as effective as regulated suction (−١١ to −٢٠ cmH٢O, depending on the type of lobectomy) when an electronic drainage system to maintain preset intrathoracic pressure is used after lobectomy by thoracotomy

There is no clear evidence indicating when during the respiratory cycle the chest tube should be removed

امام حسین (ع)

نیاز مردم به شما از نعمتهای خدا
بر شماست. از این نعمت
افسرده و بیزار نباشید

(تحف العقول، ص ۸۱)