PLEURAL DRAINAGE

Introduction

- Objective of pleural drainage is to collect pleural fluid or to allow safe evacuation of air
- Can consist of simple collection bag, a bottle system or a single-use water column or valve-controlled disposable, commercial apparatus
- All chest tubes must be connected to a drainage apparatus
- If suction not required, a simple drainage bag might suffice, use gravity drainage alone
- In the absence of fluid, a one-way valve which allows expulsion of air from the pleural space may suffice eg Heimlich valve

Indications

- Pneumothorax – closed, open
- Tension pneumothorax - may require urgent needle thoracostomy
- Haemothorax
- Large symptomatic pleural effusion
- Empyema

Equipment

Chest Tubes

- Proper size depends on the indication for insertion, the severity of the condition and the patient's size. In general, use a larger size eg 28F. Smaller size tube tends to kink, occlude and best avoided in adults
- Pneumothoraces – 24-32F
- Haemothoraces or empyemas – 36F; small adult – 32F

Drainage and collection systems *(note: diagrams not included - can be easily found in standard textbooks)*

Heimlich Valve

- Limited use in ICU setting. Its use is mainly in patients with pneumothorax who are going to be managed in outpatient
- Chest tube attached to a plastic one-way flutter valve using a five-in-one connecter
- As inspiration occurs, the thin flexible rubber tubing within the plastic container of the Heimlich valve collapses. During expiration, rubber tubing is kept open, allowing air to escape from the pleural cavity, thru' the container and into the atmosphere
- Attach a valve to a bag collection system if there are small amounts of fluid draining from their chest

One Bottle System

- Bottle served as both a collection container and as underwater seal
- Prevent air from entering the pleural space on inspiration. Water is drawn up into tube on inspiration – the height equals the negative pressure in

chest in cm. Swinging with each breath = *respiratory tidal*. As air leak seals, there will be negative pressure thru'out the respiratory cycle ie water level rises, swinging decreases

- Sterile saline/water to keep tip of rigid cannula 2-3 cm below surface
- Exhalation – air in pleural space flow into bottle and evacuated thru' "water seal", then out the bottle thru' a stopper which have a hole or vent
- *Disadvantage: when there is also fluid draining out of the chest, harder to drain out air as water level rises*

<u>Two Bottle System</u>

- One bottle as collection for fluid and the other serving as underwater seal chamber
- Fluid accumulates in first bottle, air passes thru' the first bottle into a shorter cannula and into a second bottle which is the water seal chamber
- Suction pump can be applied to second bottle
- Fluctuation in water seal cannula same significance as one-bottle system
- *Disadvantage: amount of negative pressure applied during aspiration not well controlled*

<u>Three Bottle System</u>

- 3rd bottle (suction control bottle) eliminates risk of parenchymal lung injury from over-suction as many units uses wall-suction rather than dedicated pleural suction units
- Suction control bottle has 3 cannula
    1. From the water seal bottle
    2. To wall suction
    3. Passes into the bottle with its tip resting below an adjustable level of water (usually 10-20 cm underwater). Level specified by the physician. This level limits the suction applied to the chest tube.

  (Eg if 15 cm saline is placed in the bottle, negative pressure will be 15 cm regardless of the amount of wall suction applied. Any wall negative pressure > 15 cm will draw air in thru' the open cannula. ***The 3rd bottle should always be bubbling***; otherwise less than the specified amount of suction is being applied from the wall)

<u>Commercial Units</u>

- 3-bottle system in one plastic enclosure
- Advantages: compact, non-breakable, convenient, disposable
- **Water seal chamber** - air leak, pleural pressure level and respiratory tidal can be followed just as in the bottle systems. 2 cm of coloured fluid. Can apply negative suction from 0 to -40 cm H_2O. Bubbling = continuous leak. Water height during inspiration = pleural pressure. Check patency of chest tube by observing for respiratory tidal after turning off suction
- Suction control chamber must always be bubbling

Technique of chest tube insertion

a. *Needle thoracostomy* (tension pneumothorax)
   - 16G cannula placed in mid-clavicular line, 2nd intercostal space
   - Always insert a chest drain following this procedure

b. *Pleurocentesis*
   - For pleural effusion
   - It is preferable to get the intervention radiologist to insert a pigtail catheter under ultrasound guidance then connect to an underwater seal. Reasons include - critically ill patients are often coagulopathic, insertion of chest drain may be complicated with underlying lung damage, thus further worsening preexisting condition. Pain from a large bore chest drain may impair weaning
   - Check CXR afterwards
   - Send specimens to microbiology, cytology and biochemistry

c. *Intercostal catheter with underwater seal drainage*
   - You may need to involve the thoracic surgeons if patient is under the thoracic team or if expected difficult chest drain insertion (eg previous pleurodesis, pleural scarring)
   - Local anaesthesia in awake patients
   - Strict aseptic technique at insertion: full gown/glove/mask ± cap; chlorhexidine/alcohol skin preparation
   - Confirm side from CXR before proceeding
   - Site – midaxillary line, 3rd or 4th intercostals space, ***superior border*** in order to avoid the neurovascular bundle
   - Size of drains – refer to section on *Chest Tubes*
   - ***Remove trocar from catheter*** before insertion of tube
   - 2-3 cm skin incision parallel to the ribs
   - Blunt dissection to and through intercostals space with artery forceps and index finger until within pleural space
   - Insert finger into pleural space to enlarge hole and insert tube directly, may need aid from forceps
   - Connect underwater seal apparatus
   - Insert 2 purse string sutures (one to fasten tube, the other untied to close incision on removal)
   - Check CXR

Clamping of chest tubes

- Clamping offers no benefit to the patient, and may be dangerous with ongoing leak – develop tension
- No need to clamp during transport – ensure proper underwater seal
- The few exceptions when chest tube could be clamped include
  - When the drainage system has to be lifted above the patient
  - During evaluation in preparation for chest tube removal

Technique of chest tube removal

- For pneumothorax. Steps:-
  1. Stop suction when lung fully expanded on CXR, no air leak whilst on suction
  2. Chest drain is removed when
     - Lung fully expanded on CXR 24 hours off suction or If not on any suction, lung remains fully expanded CXR 24 hours after the last detectable air leak
     - When there is no detectable air leak when suction is turned off, or when patient coughs, or perform a Valsalva
- For pleural effusion - effusion is completely evacuated or when drainage is < 100 mls/day for consecutive days
- In spontaneously breathing patients, tube withdrawn at end-expiration (or in centres, during forced expiration) to prevent air entry into chest
- In patients on mechanical ventilation, remove tube during positive pressure inspiration
- Secure suture ± pursestring stitch
- Check CXR

Complications

- Haemorrhage
  - Injury to intercostals vessel or lung. Indicated for surgery if continuous arterial haemorrhage - >100-200 ml/h for 4 hours
- Injury to the lung and other intrathoracic structures
  - Prevented by avoiding old thoracostomy and thoracotomy sites and by using finger thoracotomy to free adhesions before inserting tube
- Extrapleural position of the tube
  - Confirm intrapleural position of tube by evacuation of air, blood, effusion; palpation of lung during finger thoracotomy; “fogging” of the tube after insertion before suction applied; post-insertion CXR
- Subcutaneous emphysema
  - Occurs if size of tract > diameter of the tube inserted
  - Last hole of the tube is outside the pleural cavity
  - A large leak from a bronchus or pulmonary rupture
- Failure to drain a pneumothorax
  - Large air leak from a bronchus (see chapter on Bronchopleural fistula) – insert extra chest tube *after* bronchoscopy to rule out bronchial rupture
  - Mucous plug in the chest tube
- Persistent air leak
  - Presence of last hole of chest tube outside pleural cavity
  - Loose connection in the drainage system outside the chest
- Pneumothorax after removal of the tube
  - Premature removal of chest tube

- Infection
  - Blunt trauma > penetrating trauma
  - Delay between injury and insertion of chest tube
  - Unsterile technique
  - Nosocomial factors – role of prophylactic antibiotics

Pleural drainage systems