Chest Drain: FAQ

1. What are the indications for chest drain (chest tube) insertion?
   - Chest drain is inserted into the pleural space for drainage of:
     - Air in pneumothorax.
     - Blood in hemothorax.
     - Fluid in pleural effusion, particularly in malignant effusion.
     - Pus in empyema.
     - Postoperatively in thoracotomy or cardiac surgery.

2. What qualification and experience should one acquire before attempting to insert a chest drain in a patient?
   - According to the Cardiothoracic Surgery Student Handbook, 2nd edition, Chinese University of Hong Kong, May 2001: “Housemen (interns) should never attempt insertion unless supervised by an experienced senior.” “Students should be familiar with the drain suction systems.”
   - According to the British Thoracic Society Guidelines: “All personnel involved with insertion of chest drains should be adequately trained and supervised.” “This is part of the Senior House Officer (called MO or resident in Hong Kong) core curriculum training . . .”
   - According to the American College of Chest Physicians’ Guidelines: “Dedicated operators performing this procedure should have ample experience, excellent knowledge of pleural and thoracic anatomy, mature judgment in interpreting radiographic images related to pleural disease, and sufficient surgical skill.” “Trainees should perform at least 10 procedures in a supervised setting to establish basic competence. To maintain competency, dedicated operators should perform at least five procedures per year.”
   - In inexperienced hands this procedure can cause serious, even fatal, complications. As a student, houseman, or intern, you should not allow yourself to be coerced into doing it unsupervised. But knowledge of the perioperative management of chest drain insertion can make you a more competent assistant.

3. What to do if you are the only doctor at the scene of a patient who has collapsed with a tension pneumothorax and yet you are not qualified to insert a chest drain unsupervised?
   - In such a dire emergency the safest approach is to inset a 14G IV cannula into the pleural space of the affected side via the 2nd intercostal space at the mid-clavicular line. A hissing sound can be heard once the pleural space is entered. Advance the plastic cannula further into the space at that point and remove the inner metal cannula. Ask for experienced help to insert a formal drain after the emergency is over.
4. What to watch out for in the assessment of a patient requiring a formal chest drain?

- Obtain a medical history and perform a physical examination to rule out bleeding diathesis on clinical grounds. A coagulation screen is not necessary unless it is clinically indicated. Risk of hemorrhage is not a contraindication to chest drain insertion but increased vigilance should be practised in such a patient.
- Be vigilant in differentiating a giant lung bulla from pneumothorax (both will appear as an air-filled space) and lung collapse from pleural effusion (both will appear as a unilateral “whiteout”).
- Lung adhesion to the chest wall throughout the entire hemithorax is an absolute contraindication to chest drain insertion.
- Be alert to the dilated heart adjacent to the chest wall.
- Chest drain insertion into a post-pneumonectomy space requires expert opinion from a chest physician or chest surgeon.

5. Is consent required for chest drain insertion?

- Full explanation of the procedure to the patient together with reason for doing it and risk of complications is always warranted. Such encounter should be documented in the patient’s records. Whether a written consent signed by the patient is required or not varies among institutions. You should check into local practice.
- If chest drain insertion is life-saving and yet the patient is not in a position to give informed consent, the procedure may be carried out with the sanction of a second opinion.

6. Is it acceptable to insert chest drain in the wards?

- Chest drain insertion need not be restricted to the operating room suite; it can be performed safely in A&E as well as the general wards so long experienced staff is available to give assistance and strict aseptic technique is followed.

7. Should prophylactic antibiotics be given for chest drain insertion?

- Infection is not a common complication of chest drain insertion. There is no indication that prophylactic antibiotic is required in chest tube drainage of spontaneous pneumothorax or pleural effusion.
- There is weak evidence that prophylactic antibiotics can reduce the risk of empyema following chest drain insertion for chest trauma. A cephalosporin or clindamycin may be considered in these cases.

8. Is it necessary to sedate the patient?

- Chest drain insertion is painful; administration of a benzodiazepine sedative (e.g., midazolam) together with a narcotic analgesic (e.g., morphine) to the patient is advisable. Be aware that many patients who require chest tube insertion have chronic lung disease that makes them more sensitive to the respiratory depressant effect of both
benzodiazepines and narcotic analgesics. Giving these drugs in small increments by the IV route and titrate the dose to effect is more effective and safer than giving a relatively large dose of these drugs by the IM route. If necessary flumazenil can be given to counteract the side-effect of midazolam and naloxone to counteract that of morphine.

9. Is it necessary to give the patient a vagolytic drug as premedication?

- There are case reports of vasovagal reactions resulting in death during chest drain insertion. Some practitioners advocate atropine prophylactically as a premedication.

10. What is a safe drain insertion site?

- The British Thoracic Society Guidelines recommends that a drain inserted through a closed chest be sited through the safe triangle defined by the anterior border of the latissimus dorsi, the lateral border of the pectoralis major and a horizontal line through the anatomical position of the ipsilateral nipple.
- The most common insertion site is the mid-axillary line within this triangle. A more anterior site increases the risk of going through breast tissue in a female patient and increases the discomfort associated with arm movement. A more posterior site increases patient discomfort and risks kinking the drain tube associated with the supine position.
- A common mistake is choosing a drain site that is too low. A low drain insertion site risks damaging the diaphragm, entering the abdomen, and injuring the liver or spleen.
- Low thoracic drains may be placed under image guidance by radiologists. Do not use these sites if drain insertion is performed blindly.

11. How should the patient be monitored during the procedure?

- Patient should be monitored according to his physical condition and concurrent illness. As a minimum, the patient should be monitored by pulse oximetry and noninvasive blood pressure (NIBP) monitor.
- Oxygen supplement by nasal cannula or facemask should be given to the patient. A patent IV should be in situ.
12. Is local anesthesia necessary?
   - The drain site should be infiltrated with local anesthetic through the entire thickness of the chest wall. Attempt to aspirate for air or fluid (whatever the case may be that culminates in the decision to insert a chest drain) from the pleural space with the same needle is recommended practice. The decision to insert a chest drain should be reviewed if free air or fluid cannot be aspirated through the needle.

13. What size drain tube should be used?
   - Conventionally 28 to 32 F tubes are used. This still applies if the fluid to be drained is blood or pus. Smaller drain tubes cause less discomfort to the patient. Nowadays most physicians advocate 10 to 14 F tubes if the content to be drained is air.

14. How is a drain tube inserted?
   - Review the section on who is qualified to perform chest drain insertion.
   - Introducing a drain into the closed chest using a trocar can bayonet organs within the chest or abdomen. Such practice is dangerous and is discouraged.
   - The safest method of introducing a chest drain is by blunt dissection. A step by step approach is described on pages 195 to 201 in Roberts: Clinical Procedure in Emergency Medicine, 4th edition; 2004, Elsevier. This book is available electronically at <mdconsult.com> via the Li Ping Library.

15. How should the drainage system of a chest tube be managed?
   - After insertion, the chest tube should be connected to an underwater seal drainage system. Three types of underwater seal drainage systems are available: the 1-bottle, the 2-bottle, and the 3-bottle system.
     - In the 1-bottle system the chest drain is connected by collecting tubing to a tube approximately 3 cm under water (the seal) in the underwater-seal bottle while another vent tube is open to atmosphere. In this system pleural pressure greater than 3 cm water will force air or fluid from the pleural space into the bottle while negative pressure in the pleural space will suck fluid up the tube. As long as the underwater-seal bottle is well below the patient (e.g., on the floor beside the patient), the hydrostatic pressure of the fluid column in the tube will counterbalance the negative pleural pressure and prevent water from being sucked into the pleural space. It should be remembered that hydrostatic pressure is proportional to the height of the fluid.
column. As the level of the underwater-seal bottle is raised, it will become easier for fluid to be sucked into the pleural space. Therefore it is mandatory that the bottle be kept well below the patient at all times. A disadvantage of this single bottle system is that, as liquid contents (blood, pus, effusion fluid) is expelled from the pleural space and collects in the underwater-seal bottle, the seal tube becomes immersed deeper under water and the pressure required to force more contents into the bottle increases. A 2-bottle system can alleviate this problem.

- The working principle of the 2-bottle system is the same as the 1-bottle system except a trap bottle is interposed between the drain tube and the underwater-seal bottle.
- In both the 1-bottle and the 2-bottle system, the vent tube may be connected to a high-volume/low-pressure suction system (e.g., the Vernon-Thompson pump) set at a level of -10 to -20 cm H2O. A low-volume pump (e.g., the Roberts pump) is inappropriate.

- In a 3-bottle system a third bottle, called the manometer bottle, is added after the underwater-seal bottle. This manometer bottle has a vent tube under water to regulate the negative pressure generated by suction. The maximum negative pressure (in cm H2O) generated by suction equals to the distance (in cm) this vent tube is below the water line.
• Many single-use composite 3-bottle drainage systems made of plastic are available commercially. The Pleuravac and the Aqua-Seal Dual Drainage systems are just 2 examples. A diagram of the Pleuravac appears on the right. You should consult the users’ manual of these systems before use.

• The Heimlich Flutter Valve is a one-way valve that can be used in place of the underwater seal bottle to drain air from a pneumothorax. Its use allows the patient to ambulate and be managed even at home as an outpatient. Care should be exercised to identify the end to be connected to the chest drain. The other end can be connected to a drainage bag to collect pleural fluid (usually only a small amount) that comes with pneumothorax. When in operation the Valve honks and makes duck-like quacks with respiration. This is normal.

16. How should a patient be managed after insertion of a chest drain?
• All connections should be secured with adhesive tapes to prevent inadvertent disconnection.
• A chest x-ray should be obtained after insertion of a chest drain to ascertain its position. Ideally the tip of the drain should point toward the apex of the pleural space when draining air from a pneumothorax and toward the base when draining liquid contents from the pleural space. Previous concern of a drain lodged in a pulmonary fissure is unfounded.
• Patient should be managed in a ward with nursing staff familiar with management of chest drains.
• Regular assessment of the amount of bubbling (when it is gas) and drainage (when it is liquid) should be made.
• There have been reports of re-expansion pulmonary edema after rapid drainage of large pleural effusion, which can be fatal. Early signs of re-expansion pulmonary edema
include onset of cough and shortness of breath. It is suggested that no more than 1 liter of effusion fluid should be drained at any one time or continuous drainage should be limited to about half a liter per hour.

17. Is it acceptable to clamp a chest drain?

- In general a bubbling chest drain should not be clamped. In rare occasions this may be necessary as when the drainage bottles have to be changed. In this instance the clamps should be released as soon as possible.
- If the chest tube is inserted to drain liquid contents and is not bubbling, it is not unreasonable to clamp the drain during procedures related to care of the patient. Again, the clamps should be released as soon as possible.
- After successful drainage of a pneumothorax confirmed by chest x-ray, some physicians will clamp a non-bubbling drain for several hours before obtaining another chest x-ray to check for small leaks. In this instance the patient should be confined for observation in the ward. Development of shortness of breath or subcutaneous emphysema demands immediate unclamping of the drain. (Opinion is equally divided among experts on whether or not chest drain should be clamped to check for small leaks after successful drainage of pneumothorax.)

18. What to do if the drain tube is suspected to be blocked and fails to perform its function?

- Chest drain inserted to drain fluid contents (effusion, blood, pus) has a tendency to become blocked by clots. The cardinal sign of a blocked drain is failure of water within the tube in the underwater-seal bottle to fluctuate with the respiratory cycle or with coughing.
- This block may simply be due to kinking of the drain tube at the site of insertion or the collecting tubings. Un-kink it if that is the case.
- If the drain tube or collecting tubing is blocked by semi-solid contents (e.g., blood clot) within the lumen, it can be unblocked by “milking” or “stripping”.
  - “Milking” is an attempt to undo a block within the pleural space. It is done by clamping the distal collecting tubing and pumping the proximal segment with one’s fingers like milking a cow to create positive pressure to dislodge the block.
  - “Stripping” is an attempt to undo a block in the collecting tubing. It is done by clamping the collecting tubing well proximal to the suspected block and pumping the distal segment with one’s fingers to create positive pressure to dislodge the block.

19. What to do when the underwater-seal bottle under suction suddenly bubbles furiously?

- There are 2 possible causes for this massive “leakage” of air: (1) disconnection of collecting tubings or dislodgement of the drain tube and (2) increased amount of air entering the patient’s pleural space from within the thorax. You should turn your attention first to the patient and check if his vital signs are stable and act accordingly.
• If the patient is not in respiratory distress and his vital signs are stable, you have time in your hand to troubleshoot the problem. If the patient shows signs of respiratory distress, subcutaneous emphysema, and his vital signs are unstable, you have an emergency in your hand and you should:
  - Call for experienced help.
  - Offer the patient 100% oxygen and be prepared to give respiratory support (positive pressure ventilation) if necessary.
  - Support the circulation as required.
  - Monitor his oxygenation by pulse oximetry and his blood pressure by NIBP.
  - Examine the patient’s chest for telltale signs of a worsening pneumothorax or tension pneumothorax.
  - Check the drainage system to see if there has been a disconnection or if the drain tube has been partially dislodged with drain hole(s) exposed.
  - Send for the radiographer to do a chest x-ray at the bedside.

• If the cause is due to disconnection in the collecting tubings, air is sucked through the underwater-seal bottle from the atmosphere leading to the furious bubbling; air is also sucked into the pleural space during the negative phase of the respiratory cycle, enlarging the pneumothorax. You should:
  - Ensure the patient is stable and continue to monitor him appropriately.
  - Re-connect the disconnected tubings and tape them together securely.
  - Ask the patient to cough to expel any air that may have entered the pleural space during disconnection.
  - Perform a chest x-ray with the patient in the sitting position to check the size of the residual pneumothorax.
  - Continue to monitor the patient and the bubbling of air in the underwater-seal bottle until you are confident the crisis is corrected.

• If the drain tube is partially dislodged with drain hole(s) exposed, the situation is similar to the disconnection of collecting tubings. In this instance the drain tube should be re-introduced with aseptic precautions:
  - Ensure the patient is stable and continue to monitor him appropriately.
  - Send for an experienced assistant and prep the drain site, including a generous portion of the exposed drain tube, with Betadine and square drape the area.
  - Stop the suction, cut the stay suture, and re-introduce the drain tube until the exposed hole(s) is well inside the pleural space. (NB: You must stop the suction before re-introducing the drain tube. If you do not, the negative pressure from suction will suck the surrounding tissue into the drain hole as soon as it disappears beneath the skin, preventing it from being sited properly in the pleural space.)
  - Have your assistant holding the drain tube in place and re-insert a new stay suture under local anesthesia.
  - Secure the re-inserted drain tube in place with the stay suture and tapes.
  - Ask the patient to cough to expel any air that may have entered the pleural space when the drain hole was exposed.
  - Order a bedside chest x-ray to confirm the position of the drain tube and the size of the residual pneumothorax.
  - Consider ordering prophylactic antibiotic. (Although antisepsis is practised by sponging the exposed drain tube with Betadine, this is not the equivalent of inserting a sterile tube.)
• Continue to monitor the patient and the bubbling in the underwater seal bottle until you are confident the crisis is corrected.

• If the problem is due to increased air leak within the patient’s thorax, definitive treatment depends on the nature of the problem. Surgical closure of the leak may be necessary.

20. What to do if a sudden gush of blood appears in the drain bottle?

• The all important factor here is the patient’s vital signs. If he is tachypneic, tachycardic, and hypotensive, these are signs the bleeding is fresh and large in amount and demands immediate action.
  o Call for experienced help.
  o Offer the patient 100% oxygen.
  o Support the circulation: replace volume with crystalloid, colloid, or blood; administration of vasopressor may be indicated.
  o Order a bedside chest x-ray if time permits.
  o Emergency thoracotomy to locate and stop the bleeding may be indicated.

• If the patient’s vital signs are stable, there is time to look into the matter. The bleeding may still be new but just not large enough to cause any change in vital signs. In this instance it is reasonable to treat the incidence expectantly:
  o Offer the patient 100% oxygen and monitor his vital signs frequently.
  o Check the drain bottle for new bleeding as frequently as you would check vital signs.
  o Replace volume loss as necessary.
  o Order a chest x-ray to check if there is accumulation of blood within the hemithorax.
  o Be prepared to act accordingly if fresh bleeding is continuous and is affecting the patient’s vital signs.

• In some instances a gush of blood appears after a period of low drainage from a partially blocked tube. The gush appears when the tube becomes unblocked by itself. If this is suspected, check the patency of the drain tube and unblock the tube as described in the answer to Question 18.

21. What are the criteria for chest drain removal?

• The criteria for chest drain removal vary according to the reason why the chest drain was inserted in the first place:
  o No air leak in the last 24 hours in pneumothorax.
  o No fresh bleeding in the last 24 hours in hemothorax.
  o Fluid loss is < 200 ml/day in effusion.
  o Clinical and radiological evidence of resolution of the infection in empyema.

22. How to remove chest drain safely?

• Always have an assistant skillful in tying surgical knots present.
• Prepare and drape the insertion site and follow aseptic technique.
• Put a purse string suture around the drain tube if it has not been done during insertion.
• Infiltrate the area with local anesthetic only if you have to put in the suture. Otherwise drain removal itself does not require local anesthesia.
• Unwound and cut the suture holding the drain to the skin.
• Have your gloved assistant form a knot with the purse string suture without pulling it tight.
• Ask the patient to take a deep breath and perform a mild Valsalva maneuver.
• Pull the drain tube out in one quick motion while the patient is still holding his breath. Your assistant should pull the purse string knot tight as soon as the tube is out.
• Cover the site with an occlusive dressing.
• Continue to observe the patient and order a chest x-ray in 4 to 6 hours.
• Any deterioration in the patient’s condition in the meantime demands immediate assessment and possible re-insertion of the chest drain.