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Needle Thoracostomy

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Overview

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A tension pneumothorax is a life-threatening situation in which excess air is introduced into the pleural space surrounding the lung, either through trauma to the chest cavity or as a spontaneous leak of air from the lung itself. Air trapped within the pleural space causes separation of the lung from the chest wall, disrupting normal breathing mechanisms. Pneumothorax may be small without conversion to tension, but when there is a significant and expanding amount of air trapped in the pleural cavity, the increasing pressure from this abnormal air causes the lung to shrink and collapse, leading to respiratory distress. This pressure also pushes the mediastinum (including the heart and great vessels) away from its central position, causing inability of blood to return to the heart and diminishing the cardiac output. Tension pneumothoraces cause chest pain, extreme shortness of breath, respiratory failure, hypoxia, tachycardia, and hypotension. They need to be relieved emergently when a patient is in extremis.

Tension pneumothoraces are definitively managed by procedures that allow removal of trapped air, such as insertion of a chest tube. However, materials for chest tube placement are typically not available outside of the hospital setting. Temporizing measures are needed in deteriorating patients prior to hospital arrival or while chest tube materials are being gathered. In these situations, urgent needle thoracostomy (also called "needle decompression") is performed. Simply, it is the insertion of a large-bore needle or cannula through the chest wall and into the pleural space to allow air within the pleural cavity to escape. If a catheter or cannula is not immediately available, the procedure may be performed with a long, large-bore needle attached to a syringe. Air can be aspirated out of the pleural space with the syringe. A metal needle cannot stay in the pleural cavity, as the sharp tip may cause further damage; thus, it would need to be removed from the chest wall once air is aspirated.

Procedure

1. Assessment of the patient

1. Place the patient on a monitor and review for tachycardia, tachypnea, hypoxia or hypotension.
2. Perform general inspection, observing patients for tachypnea, shallow respirations, and inability to speak full sentences. Note tracheal deviation, distension of neck veins, or cyanosis, which are later findings heralding tension pneumothorax that will deteriorate into cardiorespiratory arrest.
3. Auscultate both lungs to discriminate decreased or absent breath sounds on the affected side from the normal breath sounds of the non-affected side. Note that the chest wall may fail to rise appropriately compared to the normal lung, and may be hyperresonant on percussion.
4. Stabilize the airway, breathing, and circulation of a rapidly deteriorating patient by performing critical interventions, like intubation or vasopressor support prior to (or simultaneously with) needle decompression and chest tube placement.

2. Needle decompression

Equipment: chlorhexadine or betadine solution; at least a 2-inch-long 14- or 16-gauge catheter or angiocatheter; tape

1. Administer supplemental oxygen with nasal cannula or a non-rebreather mask
2. Place the patient in a supine flat position or (if possible) seated with the head of bed elevated to 45˚ angle, dependent on patient comfort.
3. Identify the second intercostal space on the affected side (the second rib corresponds with the angle of Louis formed by the junction of the manubrium and the sternum). Follow the second rib to the mid-clavicular line.
4. Sterilize the second intercostal space in the mid-clavicular line using alcohol, chlorhexadine, or betadine solution.
5. Place the long large-bore cannula (or angiocatheter) onto a sterile field and don sterile gloves.
6. Perform the needle decompression. Insert the long large-bore cannula (or angiocatheter) at a 90˚ angle to the chest wall in the mid-clavicular line, second intercostal space above the third rib, to avoid damaging neurovascular structures that lie immediately below each rib. The placement of the cannula bevel does not matter.
7. To reach adequate depth, insert the cannula to nearly its hub. Insertion should be done in one motion and may require forceful entry. A "pop" will be felt when the needle penetrates the pleura, and a rush or "hissing" of air through the needle will be audible.

3. Needle decompression with a cannula attached to a 10 mL syringe.

Needle decompression may also be performed using a 10 mL syringe, which can offer better grip when puncturing the chest wall and pleural. There are two methods to do this:

1. Using an empty syringe:
    1. Attach an empty syringe to the cannula and puncture the pleura as described above.
    2. Remove the syringe when the air escaping the pneumothorax pushes the syringe's plunger up, and air is easily aspirated-confirming appropriate depth.
2. Using a syringe half-filled with fluid

1. Attach a 10 mL syringe half-filled with saline or water to the cannula.
2. Leave about 1 mL of air between the fluid and the syringe's plunger.
3. Perform needle decompression, and when the pleura is punctured, the pneumothorax will cause the water in the syringe to bubble.

3. Remove the syringe and the metal needle of the cannula so that only the plastic catheter remains.
4. Secure the catheter with tape.
5. Reassess the patient for clinical improvement. This is signified by patient appearance of less discomfort or agitation, fuller respirations taken, ability to speak more complete sentences, less tachypnea or tachycardia, improvement in hypoxia, resolving tracheal deviation, and improvement in blood pressure.
6. If the patient's condition does not improve, repeat needle decompression by inserting another long large-bore cannula adjacent to the first one. Alternatively, you can move straight to chest tube placement.
7. The above procedure may also be performed in the anterior axillary or mid-axillary line at the level of the fourth or fifth intercostal space. The nipple designates the approximate level of the fifth intercostal space.
    1. Sterilize the anterior to mid-axillary skin lateral to and above the nipple using chlorhexadine or betadine. Make the area of sterilization a wide field.
    2. Place the patient with head and chest elevation to 45˚, which will lower the diaphragm and decrease risk of abdominal injury.
    3. Plunge the cannula into the chest cavity between the anterior to mid-axillary lines above the fifth or sixth rib. Avoid penetration into the abdominal cavity by choosing a more superior insertion site.
    4. Insertion will generate a "pop" when pleura is punctured, followed by an audible rush of air.

8. Prepare for definitive chest tube placement

Summary

Needle thoracostomy is a relatively easy procedure to temporize a patient in extremis from a tension pneumothorax before a chest tube can be placed. Penetration of the chest wall muscle, subcutaneous tissue, and pleura may require significant force, so a stabbing motion of needle entry may be necessary. The most common reason for failure of this procedure is that the needle length is not sufficient enough to reach the pleura. Some patients have significant chest wall thicknesses that standard needles may not penetrate. Because of this, some suggest a lateral approach in the fourth or fifth intercostal space, in the anterior axillary or mid-axillary lines.

Risks include damage to the internal thoracic artery and intercostal nerves, which run underneath each rib. Bleeding may be significant, and may lead to hemothorax. This is the reason for performing the procedure above the third rib in the second intercostal space. Inappropriate positioning may risk subclavian artery laceration, pulmonary artery laceration, or lung parenchyma injury-all causing post-procedure bleeding. It may also cause iatrogenic creation of simple pneumothorax. As the catheter is a foreign body, pneumonia, empyema or local skin infections may develop.

Relative contraindications include prior thoracotomy, pneumonectomy, or pleurodesis, and these conditions may cause false alarm, as breath sounds are often absent after these conditions. Also, care must be taken with those in coagulation disorders, as bleeding complications may arise post-procedure. However, a tension pneumothorax is life threatening, and emergent treatment takes priority.

