

Pneumothorax

Pneumothorax is a medical condition and potential emergency wherein air or gas is present in the pleural cavity (chest). It may occur spontaneously both in people with chronic lung conditions and those with no other health problems, but many pneumothoraces occur after physical trauma to the chest, blast injury, or as a complication of medical treatment. In the past, creating a pneumothorax was used as a treatment for various lung disorders, such as tuberculosis; this has now been abandoned.

The symptoms of a pneumothorax are determined by the size of the air leak and the speed by which it occurs; they may include chest pain and shortness of breath in most cases, and fainting and rarely cardiac arrest in severe cases ("tension pneumothorax"). The diagnosis can be made by physical examination in severe cases, but usually requires a chest X-ray in milder forms.

Small pneumothoraces typically resolve by themselves and require no treatment. In larger pneumothoraces or when there are severe symptoms, the air may be aspirated with a syringe, or a one-way chest tube is inserted to allow the air to escape. Occasionally, surgical measures are required, especially if tube drainage is unsuccessful.

Pathophysiology

The lungs are located inside the chest cavity, which is a hollow space. Air is drawn into the lungs by the diaphragm. The pleural cavity is the region between the chest wall and the lungs. If air enters the pleural cavity, either from the outside (open pneumothorax) or from the lung (closed pneumothorax), the lung collapses and it becomes mechanically impossible for the injured person to breathe, even with an open airway. If a piece of tissue forms a one-way valve that allows air to enter the pleural cavity from the lung but not to escape, overpressure can build up with every breath; this is known as tension pneumothorax. It may lead to severe shortness of breath as well as circulatory collapse, both life-threatening conditions. This condition requires urgent intervention.

Causes, signs and symptoms

Most spontaneous pneumothoraces result from "blebs", expanded alveoli just under the superficial surface of the lung, that rupture allowing the escape of air into the pleural cavity. Pneumothorax can also occur as part of medical procedures, such as the insertion of a central venous catheter into the subclavian vein. Other causes include mechanical ventilation, endotracheal intubation, laparoscopic surgery, emphysema, and less commonly, bacterial or viral lung diseases.

Pneumothorax presents mainly as a sudden shortness of breath, dry coughs, cyanosis (turning blue) and pain felt in the chest, back and/or arms. In penetrating chest wounds, the sound of air flowing through the puncture hole may indicate pneumothorax, hence the term "sucking" chest wound. The flopping sound of a punctured lung is also occasionally heard. Subcutaneous emphysema is another symptom.

If untreated, hypoxia may lead to hypercapnia, respiratory acidosis, and loss of consciousness. In a tension pneumothorax, shifting of the mediastinum away from the site of the injury can obstruct the superior and inferior vena cava resulting in reduced venous return. This in turn decreases cardiac preload and cardiac output (the amount of blood pumped by the heart in a minute).

Diagnosis

The absence of audible breath sounds through a stethoscope can indicate that the lung is not unfolded in the pleural cavity. This, accompanied by hyper resonance (higher pitched sounds than normal) to percussion of the chest wall, is suggestive of the diagnosis. The "coin test" may be positive. Two coins when tapped on the affected side produce a tinkling resonant sound which is audible on auscultation.

If the signs and symptoms are doubtful, an X-ray of the chest can be performed, but in severe hypoxia or evidence of tension pneumothorax, emergency treatment has to be administered first.

The collapse of the lung will be seen in the x-ray as extra black space around the lung, indicating the presence of air. The lung shrivels up away from the affected side and the mediastinum (trachea and other components) will shift towards the unaffected side.

Management

Many paramedics can perform needle thoracocentesis to relieve intrathoracic pressure. Intubation may be required, even in a conscious patient, if the situation deteriorates. Advanced medical care and immediate evacuation are strongly indicated. An untreated pneumothorax is an absolute contraindication of evacuation or transportation by flight.

Small pneumothoraces are often managed conservatively as they will resolve on their own: just repeat observation via chest X-rays and administer oxygen. Pneumothoraces which are too small to require tube thoracostomy and too large to leave untreated, may be aspirated with a small catheter.

Large pneumothoraces may require tube thoracostomy, also known as chest tube placement. If a thorough anesthetizing of the parietal pleura and the intercostal muscles is performed, the only major pain experienced should be either the injury that caused the pneumothorax or the re-expanding of the lung. Proper anesthetizing will come about by the following procedure: the needle should be inserted into the chest cavity and a negative pressure created in the syringe. While air bubbles rise into the syringe, the needle should be slowly pulled out of the cavity until the bubbles cease. The tip of the syringe that contains the anesthetic is now in the intercostal muscles, just next to the parietal pleura. A proper and sizable injection should ensue (5 to 10 ml). This will allow the patient to be fairly comfortable despite a hemostat or finger being inserted into the chest cavity. A tube is then inserted through the chest wall into the pleural space and air is extracted using a simple one way valve or vacuum and a water valve device. This allows the lung to re-expand within the chest cavity. The rate of re-expansion will vary widely. It is important not to connect the chest tube to suction right away, as rapid expansion may lead to pulmonary edema. The pneumothorax is followed up with repeated X-rays. If the pneumothorax has resolved and there is no further air leak, the chest tube is removed. If, during the time that the tube is still in the chest, the lung manages to sustain the re-expansion, but then collapses once suction is turned off; a Heimlich valve may be used. This flutter valve allows air and fluid in the pleural cavity to escape the pleura into a drainage bag while not letting any air or fluid back in. This method was developed by the military in order to get soldiers with lung injuries stable and out of the battlefield faster. It is a rarely used medical device in the treatment of patients these days, but may be used in order to allow the patient to leave the hospital.

It is critical that the chest tube be managed in such a way that it does not become kinked or occluded with clot or other fibrinous material. Chest tube clogging can result in buildup of air in the pleural space. At the very least, this will lead to a recurrent pneumothorax. In the worse case, the patient can have a tension pneumothorax if the air builds up under pressure and impairs venous return to the heart. This can be fatal. The tubes have a tendency to form clot from blood and other fibrinous material that can occlude them. To keep them open, they must be stripped, milked or even replaced if they totally occlude. Smaller tubes are less traumatic, but more prone to clogging, although this can also occur with larger tubes. One sign the chest tube is clogged is subcutaneous emphysema. Another is a loss of respiratory variation in the fluid level at the water seal valve in the drainage canister.

In the situation that the chest tube is not sufficient for healing the lung (for example, a continued air leak despite chest tube drainage), or if a computerized axial tomography (CT scan) shows the presence of large "bullae" on the surface of the lung, thoracoscopic surgery or video assisted thorascopic surgery (VATS) may be done in order to staple the leak shut and to irritate the pleura to promote adhesions between the lung and pleura (pleurodesis). Two or three small incisions are made in the side of the chest and back, one for a small camera and the other (s) for tools used to seal the lung and abrade or remove the pleura. When finished, the wound is covered with a sterile strip and bandaged up. In case of penetrating wounds, these require attention, but generally only after the airway has been secured and a chest drain inserted. Supportive therapy may include mechanical ventilation.