Trouble with the lungs: Pneumothorax and hemothorax

By understanding the conditions, causes, identification, and treatment of pneumothorax and hemothorax, nurses can help to save a life.

By Amanda Perkins, DNP, RN

Every nurse knows the importance of oxygenation and ventilation. It's taught in nursing school and reinforced in practice. A variety of conditions can impair a patient's ability to breathe effectively and maintain their airway. Two of these conditions are pneumothorax and hemothorax. Both can be problematic for patients because they can impair ventilation and oxygenation, increasing the risk of respiratory complications if not identified and treated appropriately.[1]

Many nurses will care for patients with these conditions and should understand their causes, diagnosis, and treatment. This article will provide an overview of both conditions including detailed information about the nurse's role in managing them.

A brief overview of the lungs

Let's start by briefly discussing the lungs. Located in the thoracic cavity on either side of the heart, the lungs are surrounded by the ribs, which offer protection. The lungs extend from the clavicle to the diaphragm, and each one has a visceral and parietal pleural membrane between which there is a thin layer of fluid.[2] Approximately 50 mL of pleural fluid is found between the pleural membranes; this fluid provides lubrication and reduces friction during the movement associated with inspiration and expiration.[3] When a patient breathes in, the diaphragm moves downward and creates negative pressure in the thorax.[2] Think of the negative pressure as a vacuum, pulling air inward. Certain conditions, such as a pneumothorax, can impair the negative pressure in the lungs, decreasing or halting the body's ability to pull air inside.

An in-depth look at pneumothorax

A pneumothorax is when there is air in the pleural space. This air collects between the parietal and visceral pleura, causing pressure that can lead to a collapsed lung.[4] Let's break this down. When a patient has an opening between the two pleura, air enters the pleural space instead of the lungs.[2] This causes a loss in negative pressure.[2] Recall, the negative pressure acts like a vacuum, pulling

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What's a catamenial pneumothorax?

A rare type of pneumothorax is the catamenial pneumothorax.[1] This condition is seen in women and is associated with menstrual periods.[1] It's thought to be the result of endometriosis in the pleura.[1]

air in and keeping the lungs inflated. When this negative pressure is lost, with each breath more air is inspired but may not be able to escape; consequently, the lung will collapse.[2] When caring for a patient with a pneumothorax, the nurse should always remember that more air in the pleural space correlates with less lung volume.[4]

The three main categories of pneumothorax are spontaneous, traumatic, and iatrogenic.[1] A spontaneous pneumothorax develops without an identifiable cause. This type can be further broken down into primary and secondary spontaneous pneumothorax. A primary spontaneous pneumothorax is associated with smoking, a tall and thin body habitus, pregnancy, Marfan syndrome, and a family history of pneumothorax.[4] This condition is seen most in individuals between ages 20 and 30.[4]

Secondary spontaneous pneumothorax is associated with underlying lung disease such as chronic obstructive pulmonary disease (COPD), asthma, pneumonia, tuberculosis, sarcoidosis, cystic fibrosis, acute respiratory distress syndrome, inhalational drug use, and thoracic endometriosis.[2,4] This type of pneumothorax is most common in patients ages 60 to 65.[4] It's also more common in patients assigned male sex at birth, with a 3:1 ratio.[4] This condition is 102 times more likely to develop in individuals who smoke.[4]

Iatrogenic pneumothorax is caused by trauma to the lungs resulting from healthcare provider (HCP) intervention, such as central line insertion, pleural biopsy, lung biopsy, central venous catheter insertion, tracheostomy, intercostal nerve block, and positive pressure ventilation.[1,4] (See *Open and tension pneumothorax*) The key to differentiating this type of pneumothorax from other types caused by trauma, is that with iatrogenic pneumothorax the trauma is caused by a healthcare intervention.

In addition to these broad categorizations, pneumothorax can also be classified based on its physiology.[1] In these instances, it's classified as simple, open, or tension pneumothorax.[4] With a simple pneumothorax, the air in the pleural space doesn't communicate with the outside atmosphere and there will be no mediastinal shift, or deviation of the mediastinal structures.[1,4]

An open pneumothorax, also called a communicating pneumothorax or sucking chest wound, develops as the result of an open wound in the chest wall.[4] This defect in the chest wall allows for open communication with the atmosphere.[1] For example, a patient who has been in a motor vehicle collision resulting in a shard of glass entering the chest wall has a communicating pneumothorax. This can lead to air being pulled or sucked inward and collapsing the lung.

With a tension pneumothorax, the accumulation of air in the pleural cavity causes a mediastinal shift.[1] A tension pneumothorax may be caused by penetrating or blunt trauma, barotrauma resulting from positive pressure ventilation, or a percutaneous tracheostomy.[4] With this condition, air enters the pleural cavity and can't escape. This trapped air causes pressure that leads to a mediastinal shift. This shift occurs on the opposite side of the pneumothorax and is life-threatening because it compresses the vena cava as well as other great vessels, decreasing blood return to the heart, which in turn decreases cardiac output.[1,2]

An in-depth look at hemothorax

A hemothorax is a collection of blood between the chest wall and the pleural cavity. Causes may include chest trauma, blood clotting disorders, chest surgery, heart surgery, pulmonary infarction, lung

cancer, and tuberculosis.[5] Of these, chest trauma makes up most cases of hemothorax.[5] The trauma that causes a hemothorax can be blunt, penetrating, or both.[6] In the US, up to 80% of blunt chest traumas are the result of motor vehicle collisions.[6] Although most cases of hemothorax are caused by a trauma, nontraumatic causes may include healthcare procedures (iatrogenic), lung sequestration, vascular abnormalities, tumors, bleeding disorders, and infectious processes.[6]

A large hemothorax can lead to a tension hemothorax, as described previously. A tension hemothorax can lead to hemodynamic instability, cardiovascular collapse, and death. When a pneumothorax and hemothorax occur at the same time, this is referred to as a hemopneumothorax.[2]

Signs and symptoms

The signs and symptoms associated with pneumothorax and hemothorax may overlap. For instance, if a patient has a hemopneumothorax, symptoms of both conditions will be present. This section separates the two conditions to enhance learning and understanding of the signs and symptoms associated with each.

Pneumothorax

The patient with a pneumothorax may have no signs or symptoms present. When symptoms are present, they often develop suddenly.[1] The most common symptoms associated with a pneumothorax are shortness of breath and chest pain.[1,4] Patients will often describe the chest pain as severe, sharp, and stabbing.[1] They may also report chest pain that radiates to the shoulder and arm.[1] If the patient has an open wound, the nurse may hear air entering and exiting it.[2]

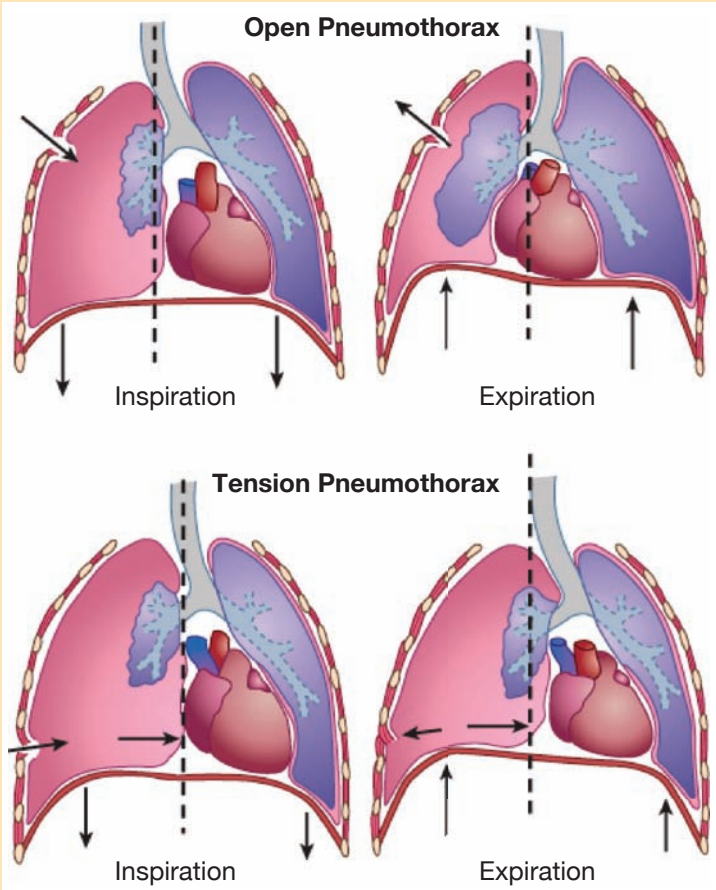
Additional signs and symptoms include anxiety, cough, tachypnea, tachycardia, and restlessness.[1,2] Anxiety experienced by the patient with a pneumothorax may be due to the difficulty associated with breathing. Asymmetrical chest expansion may also be noted on inspiration.[2] If a patient has a primary spontaneous pneumothorax, symptoms may start to improve after 24 hours because of the gradual resolution of the pneumothorax.[1]

The patient with a tension pneumothorax may become hypotensive and die if it's not identified and treated appropriately.[4] Additional signs and symptoms could include distended neck veins, tachypnea, dyspnea, tachycardia, cyanosis, respiratory failure, cardiac arrest, and hypoxia.[4] Auscultation may reveal muffled heart sounds.[2]

Hemothorax

Signs and symptoms that may be associated with a hemothorax include

Open and tension pneumothorax



shortness of breath; rapid, shallow breathing; tachypnea; decreased or absent breath sounds on the affected side; dullness to percussion; chest wall asymmetry; chest pain; hypotension; pale, cool, clammy skin; tachycardia; restlessness; anxiety; tracheal deviation; narrow pulse pressure; and hypotension.[5,6] The signs and symptoms seen with a tension pneumothorax could also be seen in the patient with a tension hemothorax (the nurse may hear air entering and leaving the wound). If the patient's superior vena cava is compressed, as would occur with a tension hemothorax, the nurse may observe facial/neck swelling and cyanosis.[6]

Diagnosis

A variety of tests may be used to aid in the diagnosis of both pneumothorax and hemothorax. The following diagnostic tests may be used:

- chest X-ray
- ultrasound
- computed tomography (CT) scan
- thoracentesis
- thoracotomy

The chest X-ray may be used prior to a CT scan or ultrasound and may be the only test needed, particularly for the patient with a pneumothorax.[4] Although the chest X-ray is often the first diagnostic tool used, a point-of-care ultrasound can diagnose the pneumothorax quickly and with better accuracy than the chest X-ray.[1] An added benefit to the use of an ultrasound is that the patient won't be exposed to radiation.[1]

When a patient has an intrathoracic injury that has potentially caused a hemothorax, the CT scan is the preferred diagnostic tool.[6] If a CT scan isn't readily available or if the patient is too unstable for a CT scan, a chest X-ray or ultrasound may be used instead.[6] As is the case with a pneumothorax, point-of-care ultrasound is rapid, reliable, and can be completed at the bedside for the patient with an intrathoracic injury.[6]

Thoracentesis is used for both diagnostic purposes and to treat a pneumothorax or hemothorax.[7] This procedure involves the use of a needle to remove fluid from the pleural space. Complications associated with thoracentesis include bleeding, pain, infection, nerve damage, and reexpansion pulmonary edema.[7] Nerve damage may develop if the needle is placed incorrectly.[7] Reexpansion pulmonary edema may develop if too much fluid is removed or if fluid is removed too quickly from the pleural space.[7] The most common complication associated with this procedure is a pneumothorax.[7] (See *Nursing interventions during thoracentesis*.)

A thoracotomy is the drainage of pleural fluid through a chest tube.[5] In most cases, pleural fluid that's collected will be analyzed in a lab. As is the case with thoracentesis, the thoracotomy can be used for diagnostic purposes and as a treatment. For example, analysis of pleural fluid could provide valuable information about the causative organism and appropriate treatment, if an infection is present. The thoracotomy can also be used to collect tissue samples for analysis in a lab.

Additional tests for the patient with a suspected hemothorax include the ECG, complete blood cell count, basic metabolic panel, troponin, coagulation profile, blood

Nursing interventions during thoracentesis

- Ensure informed consent is signed and in the patient's chart
- Assist with positioning the patient
- Obtain a baseline set of vital signs
- Monitor oxygen saturation throughout the procedure
- Monitor heart rate and BP throughout the procedure
- Monitor for signs of respiratory distress
- Provide support to the patient

type and screen, and lactate levels.[6] Serum lactate can be used as a predictor of mortality in the patient with a chest trauma.[6] When serum lactate levels are above 4 mg/dL, the patient has a higher mortality risk.[6]

Nursing assessment

When caring for a patient with a pneumothorax, hemothorax, or both, patient assessment will provide valuable clues. This includes both the visual assessment and head-to-toe assessment. A key component is auscultation of the lungs. Patients with either of these conditions will have decreased or absent breath sounds on the affected side. The nurse should also obtain vital signs, paying close attention to oxygen saturation. The nurse should monitor for signs associated with difficulty breathing, such as cyanosis or dyspnea.

During assessment, the nurse may find that lung expansion is asymmetrical.[4] To test this, the nurse can place his or her hands on the patient's back in the shape of a "W" with both thumbs touching in the middle and the fingers fanned out. Typically, when asking the patient to take a deep breath, both hands should move out equally. In the patient with a pneumothorax or hemothorax, the nurse may find that one hand moves outward more than the other. The hand with minimal to no movement would correlate to the side with the injury. In the patient with a pneumothorax, percussion will often result in hyper-resonance.[4]

The patient with a suspected chest injury should be asked about chest pain, dyspnea, the mechanism of injury, drug use, alcohol use, comorbidities, surgical history, and anticoagulant or antiplatelet therapies.[6] The nurse should inspect the patient's chest wall for signs of injury, such as bruising or open wounds. If the patient was in a motor vehicle collision, the nurse should monitor for the seatbelt sign, which is associated with a deceleration or vascular injury.[6] During a motor vehicle collision, a seatbelt can cause blunt force trauma to the neck, chest, or abdomen.[8] When this occurs, it's referred to as a seatbelt injury or seatbelt syndrome.[8] Seatbelt sign, first described in 1962, refers to the ecchymosis that develops due to a seatbelt injury.[8] (See *Nursing assessment*.)

Nursing assessment

The nurse caring for the patient with a suspected or confirmed pneumothorax or hemothorax should:

- auscultate the lungs
- obtain vital signs and oxygen saturation
- monitor for signs and symptoms of difficulty breathing
- monitor for asymmetrical lung expansion
- percuss over the lungs
- assess for wounds
- assess for seatbelt sign, if in a motor vehicle collision
- ask about mechanism of injury, if appropriate

Treatment

The treatment of the patient with a pneumothorax is focused on eliminating air from the pleural space, reducing air leakage, promoting reexpansion of the lung, and preventing future pneumothorax.[1] If a patient has an asymptomatic pneumothorax, the best treatment may be rest and oxygen administration.[1,2] These patients are often referred to a pulmonologist.[1] For patients who are symptomatic, treatment may include needle aspiration or small-bore catheter insertion.[1] In these cases, a needle or catheter will be inserted into the pleural space by the HCP to remove trapped air.[2]

The treatment of the patient with a hemothorax is focused on blood removal and reexpansion of the lung. In patients who have a hemothorax with less than 300 mL of blood in the pleural cavity, it may be appropriate to watch and wait, as blood reabsorbs over time, in most cases over several weeks.[6]

A common treatment for both conditions is the insertion of a chest tube. If the chest tube is ineffective for the patient with a hemothorax, the HCP may need to complete a thoracotomy.[5] A thoracotomy is a cut made between the ribs to view the lungs and heart.[9] During this procedure the ribs may need to be cut or removed to enhance visibility or improve accessibility.[9] Throughout this procedure, the anesthesiologist will suspend ventilation in the affected lung.[9] Prior to finishing the procedure, the surgeon will insert a chest tube to drain fluids and allow air to escape.[9]

Complications associated with a thoracotomy include pain, bleeding, and infection, in addition to complications associated with the use of anesthesia. The patient may also develop postthoracotomy pain syndrome, which is when pain persists for a prolonged period after surgery, in some cases months.[9] The nurse should closely monitor the patient for pain, bleeding, and infection and notify the HCP of any abnormal findings.

The nurse should know that tension pneumothorax and hemothorax are treated as an emergency because they're life-threatening.

The nurse should know that tension pneumothorax and hemothorax are treated as an emergency because they're life-threatening.[2] In an unstable patient with a pneumothorax or hemothorax, the HCP may perform a needle decompression known as a thoracentesis.[4] This is when a needle is inserted into the pleural space to remove air, blood, or other fluids. If the patient has a tension pneumothorax, needle decompression is typically completed first, followed by chest tube placement.[10] This helps to stabilize the patient before the insertion of the chest tube.[10] During the thoracentesis, the nurse may be responsible for monitoring the patient for signs and symptoms associated with poor oxygenation, in addition to vital sign and oxygen saturation monitoring.

Whereas a chest tube is typically used for a stable patient, thoracotomy is often used for the patient with a traumatic pneumothorax or hemothorax.[1,4] Indications for a thoracotomy would include 1,500 mL of blood drainage over 24 hours, 300 to 500 mL of blood drainage per hour over a period of 2 to 4 hours, great vessel or chest wall injury, and cardiac tamponade.[6] An open pneumothorax is initially treated with a three-sided occlusive dressing.[4]

If a patient has recurrent pneumothoraces, the treatment of choice may be chemical pleurodesis or sclerotherapy with sterile talc or tetracycline.[1,2] The HCP completes this procedure by draining the pleural fluid and instilling a chemical such as talc into the pleural space.[3] A thoracentesis may be conducted to allow for the injection of these medications into the pleural space.[2] This causes irritation, inflammation, fibrosis, and the adhesion of the pleural membranes.[2,3] This procedure is painful, and the patient should be medicated beforehand. After the procedure, instruct the patient to avoid nonsteroidal anti-inflammatory drugs because these medications decrease the necessary inflammatory response.[3] Twenty-four hours after the procedure, a chest X-ray should be

completed to check for pneumothorax or fluid accumulation.[3]

When using talc, a potential complication is systemic inflammation and acute respiratory distress syndrome.[3] Additional risks associated with this procedure are anaphylaxis and infection.[3] The development of a fever after the procedure may be due to the inflammatory response and not an infection.[3]

The patient with a pneumothorax or hemothorax may require high-flow oxygen. The trauma patient should have two large bore I.V.s placed, and they should also have cardiac and continuous oxygen monitoring in place. If a patient has a penetrating chest injury, prophylactic antibiotics may be ordered.[11] Additional interventions may include BiPAP, endotracheal intubation, ventilator, blood transfusion, arterial blood gases, and I.V. fluids.[5] Chest X-rays will be used to track the effectiveness of treatment.

Chest tubes

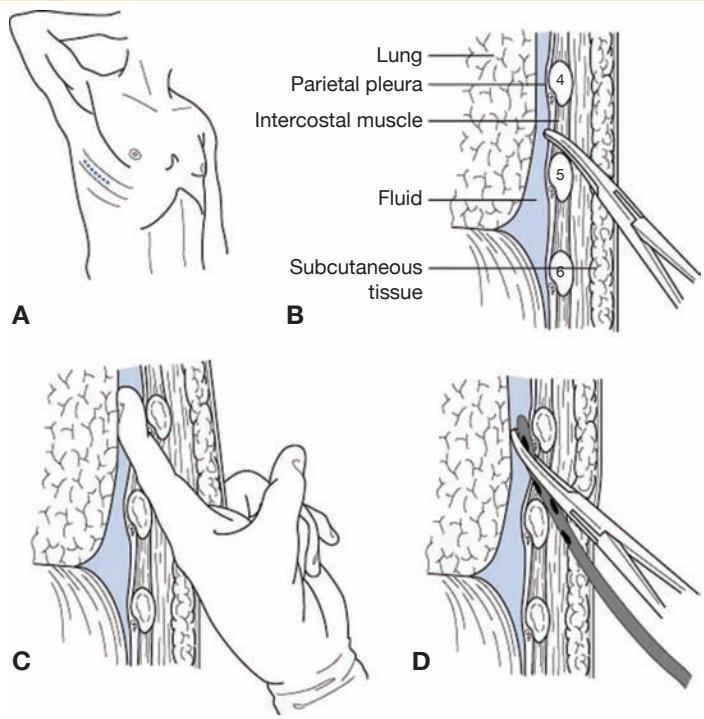
For patients with a pneumothorax or hemothorax, a chest tube may be placed. The nurse will help to position the patient as directed by the healthcare provider. In many cases a good position is sitting on the edge of the bed while leaning forward on a table, but this may not be appropriate or possible with all patients. This procedure is referred to as a thoracostomy.[11] Chest tubes are used to create negative pressure and reinflate the lungs.[10] In most cases, chest tubes can stay in place for up to 2 weeks.[11] As is the case with most indwelling devices, the longer the chest tube stays in place, the higher the risk of infection.[11]

Once the chest tube is placed, the chest drainage system will be connected. A variety of chest drainage systems are available, including the water seal drainage system, a Heimlich valve, and the digital drainage system.

Treatment may include the insertion of a chest tube connected to a water seal drainage system. This procedure can be completed at bedside or in the OR. The insertion point of the chest tube will depend on the problem that the patient has. If a patient has a pneumothorax, the tube is typically placed high, between the second and fourth intercostal space; if the patient has a hemothorax, the tube will be placed lower, between the eighth or ninth intercostal space.[2] To help remember this, think of air floating upward, whereas liquid is pushed down by gravity. If the patient has a hemopneumothorax, there will be two chest tubes inserted, one high and one low, connected via a "Y" connector before connecting to the drainage system.[2]

Once a chest tube is placed, exhalation allows trapped air to exit the plural space.[2] The chest tube system has a water seal chamber that allows the air from the pleural space to exit but not reenter. While the lung is reexpanding, the nurse will observe bubbling in the water seal chamber with

Chest tube insertion



each exhalation.[2] As the pneumothorax starts to resolve, the bubbling will change to "tidaling," which is when the water in the chamber fluctuates with inspiration and expiration. Once the pneumothorax has completely resolved, the "tidaling" will stop.[2] Be aware that constant bubbling indicates a leak in the system. If this happens, check the system for leaks, starting at the patient and moving outward. The nurse should be aware that bubbling in the water-seal chamber, indicating an air leak, will be more pronounced when the patient coughs.[11]

In some cases, suction is used with the chest tube system. This can help to reinflate the lung more quickly.[2] The amount of suction used will be determined by the HCP, although in most cases suction is set to negative 20 cm of water.[2] The nurse should follow HCP orders regarding suction settings and document the amount of suction used. When suction is used, the nurse will observe gentle bubbling in the suction chamber.[2]

In the case of a hemothorax, a third chamber is used to collect fluid. This chamber isn't emptied to measure drainage. Instead, it will have markings that allow the nurse to measure fluid output. At the end of each shift, the nurse should mark the level of drainage with a pen, piece of tape, or other appropriate means and document the output. The nurse should date and time the markings. The nurse should observe the fluid and notify the HCP if the drainage amount increases or if the drainage becomes increasingly bloody or purulent.

Prior to the insertion of a chest tube, the nurse should obtain a set of vital signs and assist with patient positioning. Once the chest tube is inserted, the nurse should tape over each connection site to ensure that air doesn't enter.[2] The insertion site will typically be covered with sterile petroleum jelly gauze and an occlusive dressing to prevent air from entering the pleural space.[2]

Although two padded clamps should be left at bedside for an emergency, such as a disconnected chest tube, the nurse should avoid clamping the chest tube.[2] This can cause a buildup of air in the pleural space leading to a tension pneumothorax.[2] There are instances in which the chest tube may need to be clamped for short periods of time, but the nurse doing this would need special training beyond the scope of this article.

The drainage tube system should always be upright and below the level of the patient's chest. Placing the patient in a semi-Fowler's position will help to make breathing easier. When examining the patient with a chest tube, palpate around the dressing site to check for crepitus.[2] If present, this may indicate air leaking into the tissue.[2] The HCP should be notified if this occurs.

Steroid use, emphysematous lungs, extensive scar tissue, and significant trauma to the lungs increase the risk of an air leak.[10] The following complications may occur as the result of chest tube placement: bleeding, infection, tube dislodgment, clogging of the tube, reexpansion pulmonary edema, and injury to internal organs.[10]

Chest tube complications[1,5]

- Tension pneumothorax
- Tension hemothorax
- Pneumothorax (complication of hemothorax)
- Hypoxic respiratory failure
- Shock
- Respiratory arrest
- Cardiac arrest
- Empyema
- Reexpansion pulmonary edema
- Chest tube induced dysrhythmia
- Pneumomediastinum (air in mediastinum)
- Fibrosis

The following may be indications for chest tube removal: no air leak seen, serosanguineous output, less than 150 to 400 mL output in 24 hours, nonexistent or mild pneumothorax on chest X-ray, and the patient is minimized on positive pressure from the ventilator.[10] When it's time for the chest tube to be removed, the HCP will remove the tube and cover the site with sterile petroleum jelly gauze and an occlusive dressing.[2] The nurse should monitor for crepitus and signs of respiratory difficulty after removal of the chest tube.[2] The HCP should be notified of any abnormal or unexpected findings.

Another drainage system that may be used is the one-way Heimlich valve. This device has a flutter valve that occludes during inspiration and is open during expiration.[11] This allows air to escape during inspiration while preventing air from entering the pleural space.[11] This type of system is used for the patient with a pneumothorax. One advantage is that it allows for increased patient mobility because it's not connected to the large, three-chamber drainage system.[11] In some cases, the patient can go home with a device that allows air to escape the chest but not reenter.

The nurse may also encounter digital drainage systems. Digital drainage devices are becoming more common and have some advantages over other systems.[11] These devices provide a constant digital recording of air leaks, fluid drainage, and intrapleural pressure.[11] They allow for earlier and easier patient ambulation because they're not attached to wall suction.[11] Another benefit is that patients can be discharged from the hospital with these devices in place.[11] (See *Chest tube complications*).

The nurses' role

Understanding that a secondary spontaneous pneumothorax is 102 times more likely to develop in smokers, the nurse can play an important role in prevention by counseling patients about smoking cessation. The nurse should also educate the patients that spontaneous pneumothoraces recur in 20% to 60% of patients within 3 years.[1] Accordingly, educate the patients about signs and symptoms of the disorder and when to seek help from a healthcare professional.

The nurse is responsible for ensuring that informed consent has occurred for any procedures such as a thoracentesis or chest tube placement. The nurse isn't responsible for obtaining the informed consent but should ensure that it's signed and documented in the patient's chart. Additionally, the nurse can witness the informed consent and should speak with the patient to determine their level of understanding prior to any of these procedures.

Finally, the nurse will play an important role in pain control for these patients. Chest tube insertion (as well as other diagnostic tests and treatments) are painful, so the nurse should properly medicate

Nurses play an important role in pain control for patients who undergo chest tube insertion. The procedure is painful, so the nurse should properly medicate the patient beforehand.

the patient beforehand. The nurse should request pain medication when needed and administer medications within HCP orders to maintain the patient's comfort.

Saving lives

Nurses play an essential role in the identification and management of pneumothorax and hemothorax. This is highlighted by the fact that tension pneumothorax signs are often initially identified by the nurse.[1] Understanding these conditions, including their causes, identification, and treatment, can help to save a life. ■

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