EMERGENCY CARE
Achieving a good outcome for patients that have experienced a traumatic pneumothorax lies not only in the clinician's diagnostic ability but also in excellent nursing care.

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EMERGENCY MEDICINE/CRITICAL CARE

Nursing a Patient With a Traumatic Pneumothorax

MEET THE AUTHOR

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A *pneumothorax* is an emergent condition caused by air leaking into the pleural space, thereby restricting lung expansion and eventually causing lung collapse. Although there are several potential etiologies of air accumulation in the pleural space, the most common is accidental blunt or penetrating trauma.[1] When a pneumothorax is related to trauma, it is categorized as a traumatic pneumothorax. Veterinary nurses and technicians play an important role in the nursing management of traumatic pneumothorax patients by performing patient assessments, performing diagnostic tests (e.g., laboratory analysis, imaging), recognizing changes in patient condition, and providing general nursing care.

INCIDENCE OF TRAUMATIC PNEUMOTHORAX

Studies have looked at causes of trauma, frequency of injuries to anatomic regions (**TABLE 1**),[2] and the type of injuries specific to an anatomic region in dogs and cats. One study of 267 dogs involved in motor vehicle accidents determined that 104 (39%) had thoracic trauma; of those, 52 (50%) had a pneumothorax.[3] Another study of severe blunt trauma in 235 dogs determined that 91.1% of the dogs were involved in a motor vehicle accident.[4] In this study, 72.3% and 20.4% of the dogs suffered chest and abdomen/chest trauma, respectively. Chest injuries included pneumothorax in 47% of all patients.

ANATOMY

The pleural space is the narrow space between the membranes that surround and protect the lungs, known as the visceral (adjacent to the lung) and parietal (adjacent to the thoracic wall) pleura. The function of the pleura and the pleural space is to assist in breathing by helping maintain the relationship between the lungs and the thoracic wall during inspiration and expiration, as well as eliminating friction that would otherwise be created against the surface of the lungs. Normally, the pleural space contains only a small amount of lubricating fluid and is sealed off from the rest of the thoracic cavity to maintain a subatmospheric pressure. If air is introduced into the pleural space, this pressure is lost and the pleura separate, impairing ventilation and, subsequently, oxygenation.

PATHOGENESIS

Air can enter the pleural space as a result of an internal rupture (of the lung, trachea, or pulmonary parenchyma bleb) or an open wound or puncture in the chest wall. Pneumothoraxes resulting from internal tears are categorized as *closed*; those due to penetration and disruption of the integrity of the chest wall are considered *open*. A traumatic pneumothorax may be closed or open.

Open pneumothoraxes are caused by external trauma (e.g., gunshot, bite wound). There are several potential mechanisms for the development of a closed pneumothorax in trauma patients:

- Compression of the thorax in the face of a closed glottis that causes an increase in airway pressure, resulting in barotrauma and rupture of the conducting airways and/or alveoli
- Fractured ribs piercing or lacerating the lung parenchyma, resulting in a leak into the pleural space
- Rapid acceleration/deceleration of the body—such as that caused by a motor vehicle accident or falling from a high place—that creates forces resulting in tearing of the conducting airways and pulmonary parenchyma

TABLE 1 Thoracic Injuries by Specific Cause in 1099 Dogs and 191 Cats[2,a]

	DOGS	CATS
Motor vehicle accident	97	7
Unknown cause	8	7
Animal encounter	22	3
Sharp object	3	1
Fall	5	5
Crushing injury	2	0
Weapon	7	2
Burn	1	2

[a]*These results are combined from those obtained by the two veterinary teaching hospitals involved in the study, the University of Pennsylvania and the University of Georgia. The original study, which also counted injuries to other anatomic areas, displayed them separately.*

BOX 1

Common Comorbidities in Traumatic Pneumothorax Patients

- Rib fractures
- Hemothorax
- Pulmonary/myocardial contusions
- Torn trachea/esophagus
- Diaphragmatic rupture

Ultimately, the breathing pattern of the patient, the size of the defect leaking air, the airflow through the defect (unidirectional or bidirectional), and the volume of air in the pleural space all play a role in the progression and severity of the pneumothorax. A *tension pneumothorax* develops when a tear in the lung acts as a one-way valve, allowing air to continually leak into the pleural space and thereby progressively collapsing the lung(s). This can be an acute, life-threatening situation with implications for not only oxygenation or the lack of it, but also circulation.

PATHOPHYSIOLOGY

In addition to lung collapse, patients with a pneumothorax experience a decrease in tidal volume and an increase in thoracic volume (secondary to the separation of the parietal and visceral pleura). Hypoxemia ensues due to ventilation-perfusion mismatch (i.e., lungs are perfused but poorly ventilated or not ventilated) and pulmonary shunting. Venous return may decrease owing to the loss of negative pleural pressure. To compensate, respiratory rate increases while expiratory muscular activity decreases in an effort to maintain or increase alveolar ventilation despite decreasing tidal volume.

In patients with a tension pneumothorax, the ongoing influx of air leads to the development of supra-atmospheric pressure in the pleural space. As a result, these patients have severe lung compression and profound hypoxemia. Initially, tachycardia maintains cardiac output, but over time decompensation, worsening venous return, and decreased cardiac output can develop. The rapid progression of a tension pneumothorax is life-threatening owing to cardiovascular collapse.

PATIENT ASSESSMENT

Physical Examination

The derangements seen in patients with traumatic pneumothorax depend on not only the severity of the pneumothorax but also the presence of comorbidities (**BOX 1**) and other concurrent injuries. A routine primary survey should be undertaken to assess all major body systems and treat any life-threatening problems as they are identified.

Airway patency and adequacy of breathing efforts should be assessed via visualization, auscultation, and palpation. Visible signs that an animal is having difficulty breathing include tachypnea, absent chest wall motion, exaggerated ventilatory effort, flaring of the nares, open-mouth breathing, and paradoxical breathing. Some animals with respiratory distress may assume a posture with the head and neck extended and abducted elbows. Cyanosis indicates hypoxemia. Signs consistent with a pneumothorax include absent or diminished breath sounds and a rapid, shallow (restrictive) breathing pattern. These signs are also suggestive of other conditions affecting the pleural space (e.g., hemothorax, pyothorax, chylothorax, diaphragmatic hernia).

Courtesy Kate Hopper, BVSc, PhD, DACVECC

FIGURE 1. This radiograph demonstrates the classic lateral view of a pneumothorax. Note the elevation of the heart off the sternum. The elevation is not due to air elevating the heart but is an illusion created by the collapse of the lung(s).

BOX 2

Radiographic Signs of Pneumothorax

- Elevation of the heart from the sternum in the lateral projection
- Retraction of the lung margins that are outlined by air in the dorsal ventral projection
- Collapsed lung lobe(s) that are small, opaque, and leaflike
- Flattened diaphragm
- Hyperlucent thorax
- Mediastinal shift (tension pneumothorax)
- Overexpanded, hyperlucent thorax (tension pneumothorax)

Chest wall motion should be observed, and the chest wall may be palpated to assess its integrity. Crepitus about the body may be due to subcutaneous emphysema, which can be caused by tracheal tears or chest wall defects.

Thoracentesis

If a patient presents with diminished to absent breath sounds and a rapid shallow or restrictive breathing pattern and is in obvious distress, thoracentesis should be considered. Thoracentesis is a diagnostic and therapeutic procedure that removes air or fluid from the pleural space and is less stressful than radiography, making it preferable in unstable, respiratory-compromised patients. This procedure is outlined under **THERAPY**.

Imaging

Radiography

Radiographs are the primary modality for diagnosis of pleural space defects such as pneumothorax, and radiographic diagnosis is straightforward (**BOX 2** and **FIGURE 1**). The problem is that the necessary restraint

On ultrasound images, pneumothorax can be diagnosed by the absence of a glide sign.

and positioning are very stressful for respiratory-compromised patients and put them at risk for cardiopulmonary arrest. If radiographs are to be taken, oxygen supplementation and sedation should be provided.

Ultrasonography

Ultrasonography can be used to diagnose pneumothorax and has been described in the veterinary literature.[5-7] It is not as straightforward as radiography or computed tomography (CT), but it has the benefit of potentially being less stressful for the patient. On ultrasound images, pneumothorax can be diagnosed by the absence of a glide sign. In the normal thorax, the glide sign is the movement of the parietal and visceral pleura (2 hyperechoic lines) sliding past each other during normal respiration. One study may call into question the utility of a specific ultrasonography examination protocol (thoracic-focused assessment with sonography for trauma) to diagnose pneumothorax in veterinary patients.[8]

Computed Tomography

CT is the gold standard for diagnostic imaging in human trauma medicine. It has its pros and cons in veterinary medicine. It is more sensitive for diagnosing pneumothorax than ultrasonography or radiography. One study concluded that thoracic radiography had a low sensitivity (relative to CT) for detecting lesions related to blunt thoracic trauma caused by motor vehicle accidents and supported the use of CT as an additional diagnostic imaging modality in dogs.[9]

It has been reported that with newer and faster CT units, it is possible to obtain whole-body CT images in the average awake or minimally sedated veterinary patient.[8] Unfortunately, CT is not widely available in practice and is expensive, and even sedated patients may be uncooperative.

Arterial pH and Blood Gases

Arterial blood gases are the gold standard for assessing ventilation and oxygenation. The amount of carbon dioxide in the arterial blood (measured as the arterial partial pressure of carbon dioxide, or $PaCO_2$) is an indicator of the patient's ventilating ability. A $PaCO_2$ <35 mm Hg or >45 mm Hg indicates hyperventilation (hypocapnia) or hypoventilation (hypercapnia), respectively. The amount of oxygen in the arterial blood (arterial partial pressure of oxygen, or PaO_2) is an indicator of the patient's oxygenating ability. A patient with a PaO_2 <80 mm Hg is considered hypoxemic. Patients with a pneumothorax may be hypoxemic and, in severe cases, hypercapnic. If arterial blood gases cannot be measured, pulse oximetry is a reasonable alternative to assess oxygenation status. Pulse oximetry is a noninvasive technique that continuously measures arterial oxygen saturation of the blood (SpO_2). Venous partial pressure of oxygen (PO_2) cannot be used to evaluate the oxygenation status of the patient. Venous PO_2 reflects tissue PO_2 and bears no correlation to arterial PO_2.

THERAPY

Supplemental Oxygen

Oxygen support is indicated when the patient has demonstrated low oxygen levels (either a PaO_2 <80 mm Hg or SpO_2 <95%). It is also indicated in patients with suspected hypoxemia, respiratory distress, or cardiovascular compromise. There are many ways to administer oxygen; all have advantages and disadvantages.

Face masks are readily available and easy to use but are only good for short-term use. High inspired oxygen concentrations can be obtained with a properly fitted face mask. Unfortunately, patients often fight the face mask (unless obtunded), thereby increasing oxygen consumption and canceling the effects of the oxygen therapy.

An oxygen bag (or hood) is an alternative to the face mask. A transparent plastic bag is placed over the patient's head, and a hose from an oxygen source is placed near the animal's nose. The bag should be large enough to accommodate the patient's head without collapsing as the patient breathes. The bag remains open along the animal's neck to allow the gas to escape. A flow rate of 5 to 8 L/min is used. Animals seem to tolerate the bag/hood when they resist the face mask.

Oxygen cages are well tolerated by patients. An oxygen cage must:

- Have a system for eliminating carbon dioxide
- Deliver a known amount of oxygen in a concentration beneficial to the patient (40% to 50%)
- Have a mechanism to maintain temperature at 70°F (21.1°C) and humidity at 50%

The disadvantages of an oxygen cage are that it is expensive to operate, gives minimal access to the patient, and may not accommodate large patients.

Nasal oxygen is an excellent way to provide oxygen. It does not require an expensive cage, uses readily available supplies, is well tolerated by patients, and the veterinary nurse/technician always has direct access to the patient. Nasal prongs (**FIGURE 2**) or nasal oxygen catheters may be used for oxygen administration.

To place a nasal oxygen catheter, assemble the supplies listed in **BOX 3**. Place a few drops of 1% lidocaine in the patient's nostril and tilt the head back so that the lidocaine runs down the nostril. Wait a few seconds and repeat. Measure the catheter from the tip of the nose to the second premolar or the medial canthus of the eye; mark this length on the catheter. Brace a hand against the animal's snout and insert the lubricated catheter into the anesthetized nostril. In dogs, the catheter should be directed dorsomedially for 1 to 2 cm and then ventromedially. In cats, the tube is initially inserted in a ventral-medial direction. Insert the catheter a few millimeters at a time, releasing it between each movement, until the mark is reached or the catheter exits the nostril at the alar notch. Suture or staple the catheter as it exits the alar notch and alongside the face, or bring it up and over the forehead between the eyes and secure it again. Attach the catheter to a humidified oxygen source. A flow rate of 50 to 150 mL/kg/min should be effective in increasing tracheal O_2 concentration to ≥30% in most patients.[10]

FIGURE 2. Patient with nasal prongs in place.

BOX 3

Nasal Oxygen Catheter Insertion Supplies

- Nasal oxygen catheter, red rubber urinary catheter, or infant feeding tube (5-Fr, cats/small dogs; 8-Fr, large dogs)
- Lubricating jelly
- 2% lidocaine (dilute to 1%)
- ½-inch tape
- Suture material or surgical staple gun
- Bubble humidifier
- IV extension set
- Oxygen source

High-flow nasal oxygen systems (Vapotherm, vapotherm.com) also deliver oxygen via nasal prongs but allow adjustment of the gas temperature and inspired oxygen concentration (21% to 100%). Advantages of this system include better patient comfort and potential avoidance of intubation. Disadvantages include expense of the equipment and the potential for oxygen toxicity.

Adhesive Dressings

If a patient presents with an open chest wound, the wound should be sealed immediately with a sterile adhesive dressing. Often, a sterile water-based lubricating jelly is used to help achieve the seal. Once the bandage is in place, thoracentesis is performed to remove the intrapleural air. This is a temporary measure until definitive care can be performed.

There has been concern that if the temporary bandage is left in place too long, the patient is at risk for the development of a tension pneumothorax.[11,12] Vented chest seal dressings are available (HyFin Chest Seal [North American Rescue, narescue.com]; Sentinel Chest Seal [Combat Medical, combatmedical.com]). These products seal the open chest wound while serving as a one-way valve to prevent tension pneumothorax. Studies in swine have demonstrated their effectiveness.[11,12]

Thoracentesis

Thoracentesis can be used to diagnose or treat pleural space defects such as pneumothorax or pleural effusion by removing air or fluid from the pleural space. If a pneumothorax or pleural effusion is suspected in an unstable patient, thoracentesis should be performed before radiography. **BOX 4** lists the equipment necessary for a thoracentesis.

To perform a thoracentesis, clip and surgically prepare the area where the catheter or needle is to be inserted (more dorsally, about a third of the way down the chest in the eighth or ninth intercostal space). Use lidocaine to perform a local block at the insertion site.

After putting on sterile surgeon's gloves, assemble the aspiration equipment (**FIGURE 3**). Palpate the anterior edge of the rib (seventh to ninth intercostal space), avoiding the intercostal vessels and nerve that lie on the posterior edge of the adjacent rib. Position the over-the-needle catheter or needle perpendicular to the rib and advance it through the chest wall. Once in the pleural space, change the angle of the catheter or needle so that it is parallel to the long axis of the rib. If using a catheter, thread it off the needle. If using a needle, direct the bevel away from the rib. Using gentle pressure, aspirate the syringe. Place fluid samples in the lab tubes. Continue to aspirate until you achieve a slight negative pressure.

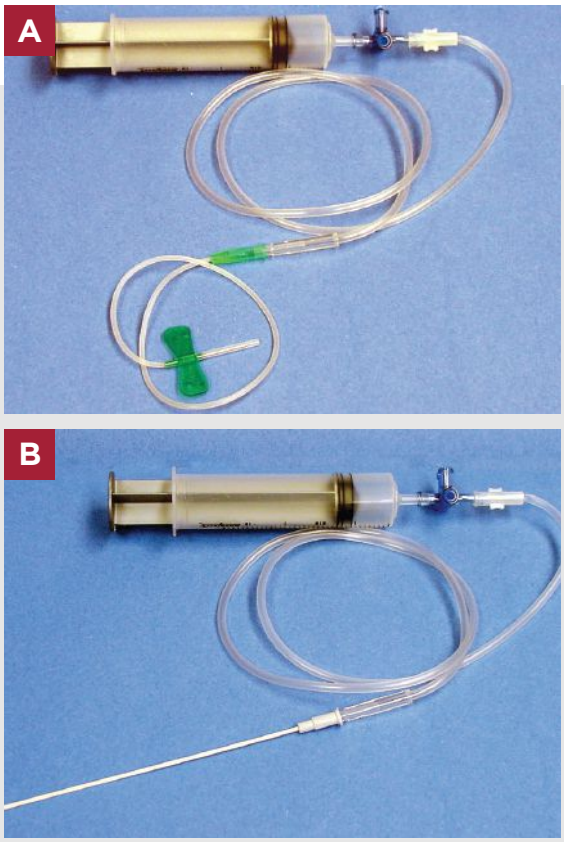

FIGURE 3. Assembled thoracentesis sets. **(A)** Set with a butterfly catheter. **(B)** Set with long over-the-needle catheter.

BOX 4

Thoracentesis Supplies

- Sterile gloves
- Needle or over-the-needle catheter (size appropriate to patient)
- Extension tubing
- Stopcock
- Syringe
- 2% lidocaine
- Laboratory tubes

Complications of this procedure reported in humans and veterinary patients include hemothorax, pneumothorax, hemopneumothorax, shearing of the catheter tip, and infection.[13,14]

Chest Tube Placement

Patients with a rapidly forming pneumothorax requiring repeated thoracentesis (>1/hr) are candidates for chest tube insertion. Commercial chest tubes come in a variety of sizes, with and without trocars (**FIGURE 4**). Tubes measuring 12- to 16-Fr may be used in cats and very small dogs, 18- to 22-Fr tubes are suitable for small dogs, and 22- to 28-Fr for medium to large dogs. If necessary, a red rubber catheter may be

FIGURE 4. Various sizes of trocar chest tubes.

BOX 5

Chest Tube Placement Supplies

- Chest tube
- Surgical prep solution
- Surgical kit
- Suture material
- Carmalt forceps or chest tube clamps
- Sterile gloves and drapes
- Lidocaine
- Syringes
- Bandage/dressing materials

used in a pinch. It may be beneficial to add a few more holes to the chest tube if using a red rubber catheter. **BOX 5** lists the equipment necessary to place a chest tube. A local block along with heavy sedation or anesthesia is also required.

Procedure

The chest wall is clipped and prepared for surgery. An assistant grasps the skin along the entire lateral chest wall just caudal to the elbow and pulls it cranially (**FIGURE 5**). Lidocaine is injected into the intended insertion site. A skin incision the size of the chest tube is made, through which the chest tube is inserted through the chest wall and into the pleural space. The path for the chest tube is made by blunt dissection with hemostat or carmalt forceps. A trocar chest tube can then be guided into the pleural space with minimal force; non-trocar chest tubes are placed with the assistance of hemostat or carmalt forceps. The tube is guided in a cranioventral direction at about a 45° angle. The trocar should not extend beyond the tip of the chest tube during insertion. The trocar is removed and

FIGURE 5. Placement of a trocar chest tube. Note how the assistant is pulling the skin cranially to help facilitate the creation of the subcutaneous tunnel.

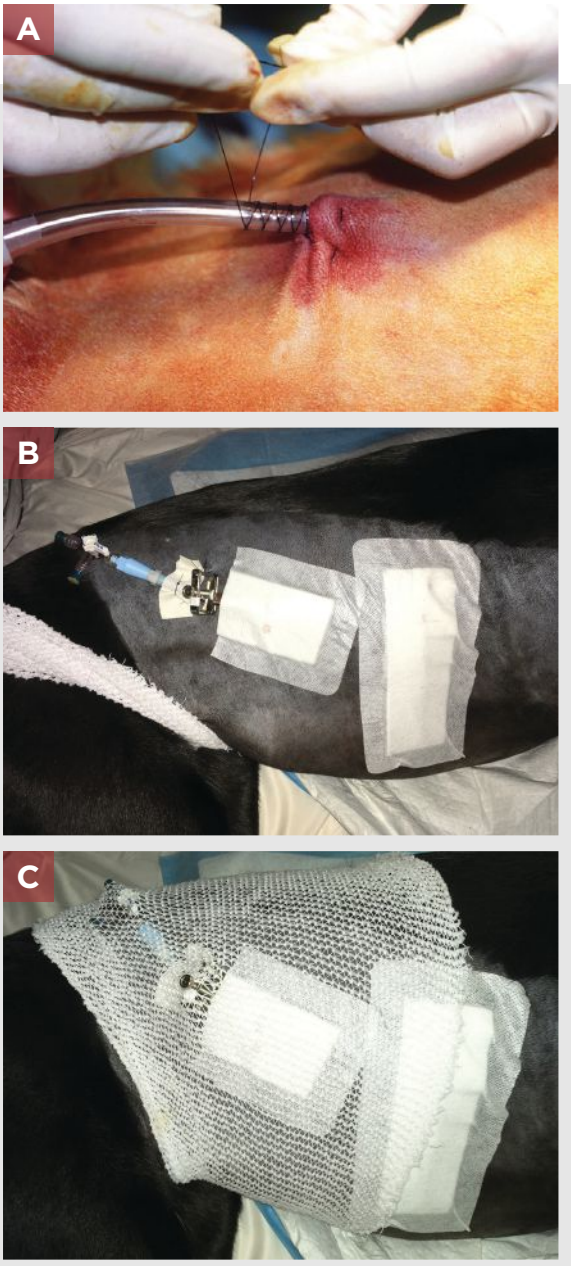

FIGURE 6. Securing and dressing the chest tube. **(A)** A finger lock suture is used to secure the chest tube to the skin at the insertion site. **(B)** Additional attachment using tape and sutures to secure the distal end of the chest tube to the skin. A "C" clamp provides additional protection in the event of inadvertent disconnection, and the chest tube has been covered with an adhesive dressing. **(C)** A fishnet stockinette has been placed to further protect the dressing.

BOX 6

Complications Related to Chest Tubes and Drainage Systems

Tube-related issues

- Trauma to heart, lungs, or great vessels during placement
- Iatrogenic pneumothorax
- Subcutaneous emphysema
- Inadvertent removal
- Malpositioned
- Tube migration
- Obstruction
- Infection

System-related issues

- Tube kinking leading to occlusion
- Retrograde flow of fluid (may occur if the collection chamber is raised above the level of the patient)
- Tension pneumothorax caused by failure to remove chest tube clamp
- Inadvertent disconnection of the chest tube from the drainage system
- Loss of underwater seal (may occur if the drainage system is not maintained upright)

the tube clamped. The assistant releases the skin, creating a tunnel that prevents air from entering the pleural space. The chest tube is secured to the chest wall and a protective dressing is placed (**FIGURE 6**).

Guidewire-based chest tubes exist (Mila International, milainternational.com) and are placed using the Seldinger insertion technique (**FIGURE 7**). These chest tubes come in 12- to 14-Fr diameters and 20- or 30-cm lengths with various fenestrations.

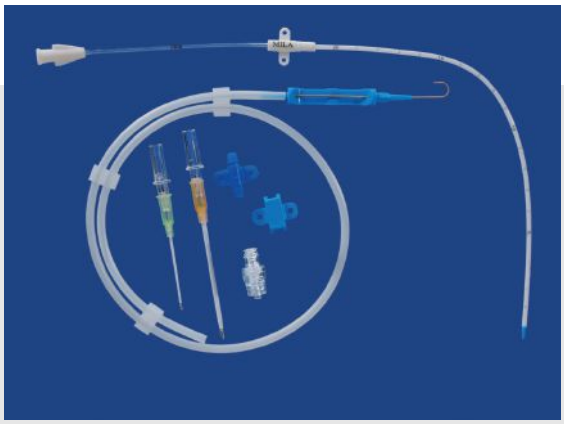

FIGURE 7. Mila guidewire chest tube.

Drainage

Once the chest tube is in place, it may be aspirated intermittently or attached to a continuous chest drainage system. Patients with chest tubes require 24-hour nursing observation. Several complications (**BOX 6**) may arise, and the veterinary nurse/technician should be cognizant of them. The chest tube can be removed from a pneumothorax patient when negative pressure has been achieved for 12 to 24 hours. Some fluid is expected as a normal response to the presence of the chest tube. The normal amount of fluid generated by the presence of the chest tube may range from 0.5 to 2.2 mL/kg/day.

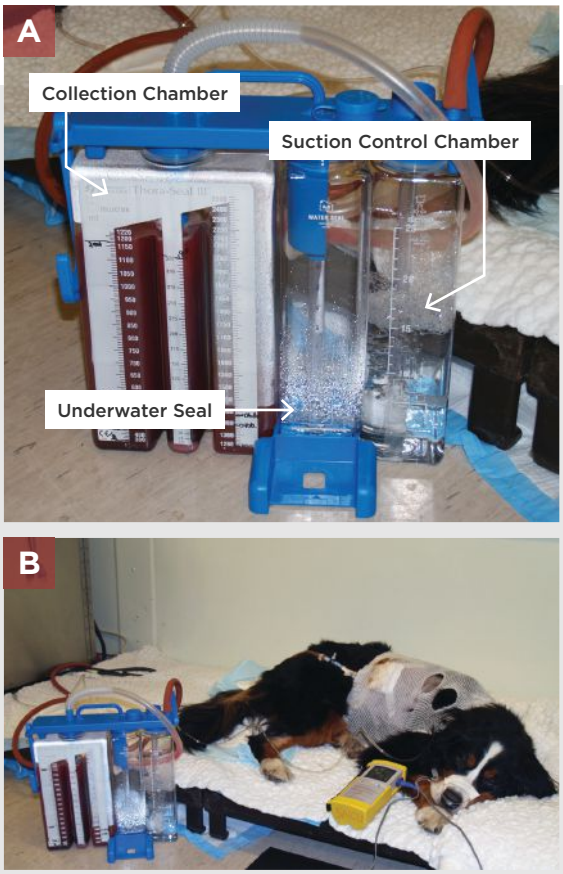

FIGURE 8. Example of an underwater chest drainage system (Argyle Thora-Seal III [CardinalHealth, cardinalhealth.com]). **(A)** The left chamber is the fluid collection chamber (contains exudate), the middle chamber is the underwater seal, and the right chamber is the suction control chamber. **(B)** A patient attached to the system.

Left: Courtesy Jeff Vitullo

BOX 7

Nursing Management Guidelines for Chest Drainage Systems

Note: Chest drainage systems require 24-hour nursing supervision.

1. Maintain sterility while setting up the system.
2. Maintain the system and tubing upright at or, ideally, below the level of the patient.
3. Avoid dependent loops if possible. Dependent loops containing fluid can completely block fluid drainage within 30 minutes and change pleural pressures from -18 cm H_2O to +8 cm H_2O, a change of 26 cm H_2O in pressure. If a dependent loop cannot be avoided, lift and drain it every 15 minutes to maintain adequate drainage.
4. Document the amount of suction used.
5. Note presence or absence of bubbling in the underwater seal; record the number of bubbles per minutes each hour. If bubbles are continuous, assess the system for leaks.
6. Mark the drainage level (exudate volume) on the outside of the collection chamber every 4 to 8 hours or as ordered by the clinician. Include this volume in the patient chart as a fluid output (i.e., an abnormal fluid loss).
7. Document the character of drained material.
8. Check the patient's respiratory status and mucous membrane color at regular intervals as dictated by the patient's condition.
9. Check the condition of the chest tube insertion site and perform chest tube care at least every 24 hours.
10. Have chest tube clamps near the patient to rapidly clamp the tube in case of inadvertent disconnection.
11. Monitor for equipment failure and complications (**BOX 6**).

Intermittent or manual aspiration of the chest tube is usually carried out via a 3-way stopcock and large syringe at specified intervals. Strict attention to aseptic technique must be followed when handling the chest tube. The force of aspiration should be very mild since extremely low subatmospheric pressures can easily be generated and can be very damaging to thoracic tissues. The chest tube is aspirated until negative pressure is achieved. Repositioning the patient and aspirating the chest tube may facilitate the additional collection of air. Increasing amounts of aspirated air may suggest a worsening of the pneumothorax; likewise, a decrease in the quantity of aspirated air may suggest an improvement in the patient's condition.

Cases requiring continuous drainage are attached to a 3-chamber disposable chest drainage system (e.g., Argyle Thora-Seal III; CardinalHealth, **cardinalhealth.com**). The 3 chambers are the collection, underwater seal, and suction control chambers (**FIGURE 8**). The collection chamber is where fluid or cellular debris evacuated from the pleural cavity is collected and quantitated. The underwater seal maintains a closed system so that the suction may be disconnected without exposing the pleural space to air. If the patient has a pneumothorax or there is a leak in the system, bubbling will be seen in the underwater seal. The suction control chamber controls the amount of suction being generated at the end of the chest tube in the pleural space. This amount depends on what is being evacuated. As a general guideline, 10 to 15 cm H_2O is an appropriate level for air evacuation. Viscous fluid or debris requires 15 to 20 cm H_2O.[15,16] **BOXES 6 AND 7** list chest drainage system complications and nursing management considerations, respectively.

MONITORING

Assuming the pneumothorax is secondary to trauma, all body systems will need to be reassessed after the patient is initially stabilized. Repeated physical examinations by the veterinarian and veterinary nurse/technician form the basis for continued monitoring. The patient's overall condition dictates the frequency and type of monitoring (e.g., electrocardiography, blood pressure, laboratory testing, ins and outs) performed.

Monitoring the respiratory system is of particular importance in pneumothorax patients. Questions that veterinary nurses/technicians should ask themselves with these patients include:

- Are the rate and tidal volume adequate?
- Is the breathing effort smooth and easy or labored?

- Is the breathing pattern regular?
- Are auscultated breath sounds normal or abnormal (e.g., crackles, wheezes, squeaks, muffled, quiet, absent)?
- Is the patient able to meet its ventilation and oxygenation requirements?

In some instances, repeated imaging will be required to assess pulmonary changes. If a continuous chest drainage system is used, the system must be monitored as outlined in **BOX 7**. Pain assessment should be performed using a validated pain scale. It is important that all staff who assess patient pain use the same scale.

CHEST TUBE CARE

The goal of chest tube care is to minimize or prevent tube-related complications. Chest tube care is performed every 24 hours and entails bandage removal, site inspection, cleaning, and rebandaging. Inspection of the chest tube site should include looking for signs of infection (e.g., erythema, swelling, heat, purulent discharge), tube migration, and subcutaneous emphysema. Following inspection, the site is cleaned with an antimicrobial scrub and solution before being re-dressed. Collection of a swab sample from a chest drain site should be considered for culture if clinical signs of infection are present. All findings during chest tube care should be documented in the medical record.

PAIN MANAGEMENT

Analgesia may be indicated to relieve pain from recent trauma or discomfort imposed by a chest tube. The patient will need to be evaluated to determine which analgesic, sedative, or combination of both will meet its needs. The drug option selected should:

- Allow for a normal respiratory pattern of breathing
- Have minimal cardiovascular effect
- Allow for a normal minute ventilation and large tidal volumes to promote efficient gas exchange and re-expansion of lungs, respectively
- Promote mobility for optimum breathing and comfort
- Be reversible

CONCLUSION

Knowledge of the pathogenesis and pathophysiology of traumatic pneumothorax enables the veterinary nurse/technician to understand the physiologic changes that affect the nursing care of these patients and the roles that various therapeutic modalities and general nursing care play in a successful outcome. Veterinary nurses/technicians should also know the indications for diagnostic and therapeutic procedures, how to set up or prepare for these procedures, how the procedures are performed, and the potential risk factors or complications, which allows the veterinary nurse/technician to proactively mitigate difficulties rather than react to them. Prognosis for traumatic pneumothorax is good to excellent if the animal is treated before severe clinical signs develop. Achieving a good outcome lies not only in the clinician's diagnostic ability but also in excellent nursing care. TVN

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