Respiratory Care: Artificial Airways, Mechanical Ventilation, and Chest Tubes

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Faculty Disclosure

Contributing faculty, Jane C. Norman, RN, MSN, CNE, PhD, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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Division Planner Disclosure

The division planner has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for nurses working in critical care and general and specialty medical-surgical units in which patients require assistance maintaining a patent airway and respiration.

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Course Objective

The purpose of this course is to reinforce nurses' knowledge and skills related to the care of patients with artificial airways and/or chest tubes in order to improve outcomes and patient quality of life.

Learning Objectives

Upon completion of this course, you should be able to:

1. Outline the types and potential complications of artificial airways.
2. Discuss nursing management and patient education for patients with mechanical ventilation.
3. Describe available chest tubes and nursing care of patients who require them.

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

Artificial airways are used for a variety of patients who require assistance in maintaining a patent airway. The indications for placement of an artificial airway are to relieve obstruction, facilitate suctioning of the lower airway, allow for mechanical ventilation, and/or prevent aspiration. Artificial airways include endotracheal, tracheotomy, and laryngectomy tubes [1].

Mechanical ventilation may be necessary for any patients for whom the process of ventilation has been significantly altered. This alteration may be caused by any condition that prevents the patient from maintaining normal oxygen and carbon dioxide (CO_2) levels in the blood [2; 3]. Mechanical ventilation may also be indicated for patients with an inability to protect their airway.

In conjunction with artificial airways, some patients with respiratory conditions will require chest tubes. Chest tubes re-establish normal intrapleural pressure in the event of trauma, pleural collection or effusion, or postsurgical drainage.

TYPES OF ARTIFICIAL AIRWAYS

ENDOTRACHEAL TUBES

Endotracheal intubation (by nasal or oral routes) is one of the most widely used methods to institute and maintain an open airway. The oral route is most often employed when emergency intubation is required because of the relative ease of insertion. When long-term intubation is anticipated, the nasal route is preferred. Nasotracheal intubation is better tolerated by conscious patients and allows for optimum tube stabilization. Placement of an endotracheal tube requires the use of a laryngoscope to visualize the area and facilitate passage of the tube into the trachea.

Endotracheal tubes come in various lengths and sizes. The physician or anesthetist intubating the patient will choose a suitable tube size for the route employed and the size of the patient's airway. A tube that is too large can damage the airway structure and mucosal lining; a tube that is too small will not allow adequate ventilation. The tube should be inserted gently to avoid structural damage.

Most tubes are disposable and are made of polyvinyl chloride or silicone rubber. Nondisposable tubes are used less frequently. The majority of endotracheal tubes have cuffs that may be inflated by injecting air into the pilot balloon. The amount of air required varies with the type of tube and is detailed in the package directions and may be printed on the tube itself. The cuff provides a seal to prevent air leaks when the patient is ventilated and to prevent aspiration of material into the lungs. Newer endotracheal tubes have a low-pressure cuff that is more compliant and less likely to cause injury to the tracheal mucosa [1].

Nursing Care

Immediately after intubation, the lung fields should be auscultated and an x-ray ordered to determine if the tube is placed properly. Because the right bronchus is straighter than the left, the tube may be improperly inserted into the right mainstream bronchus, permitting aeration of the right lung only. If the end of the endotracheal tube rests on the carina (i.e., the area where the trachea bifurcates into the left bronchus and right bronchus), partial or complete obstruction results. Inadvertent slipping of the tube into the esophagus will result in gastric dilatation [1; 4].

Endotracheal tubes can also provide a means of suctioning secretions from the lower respiratory track. Sterile technique is used, and the tube should be stabilized to prevent inadvertent removal (extubation) or change in placement. When the patient is intubated nasally, tape is applied at the insertion site. Stabilizing the oral endotracheal tube involves placement of an oral airway to prevent the patient from biting down and obstructing the tube. It is important to avoid applying excessive tape at the mouth, which could make inspection of the oral cavity difficult [1; 4]. Plastic devices may also be used rather than tape to secure the tube. Meticulous oral and skin hygiene are important for these patients. The position of the orotracheal tube should be changed daily and the tape replaced at the same time. Care should be taken to avoid skin breakdown from irritation by the tape. The patient's skin should be assessed daily when tape is changed; a rash may indicate an allergic reaction. The use of nonallergenic tape or plastic devices may then be indicated, particularly for patients who are likely to have skin breakdown and/or poor wound healing (e.g., those with diabetes).

Patients with endotracheal tubes should be assessed daily for complications involving the nose, mouth, pharynx, sinuses, and ears. Nasotracheal tubes can obstruct the Eustachian tube, causing otitis media. Damage to the nasal mucosa may occur from pressure or irritation [1; 4]. Other possible complications include damage to the vocal cords, laryngeal edema, and laryngeal ulcers, caused by traumatic insertion, improper stabilization, and/or unnecessary manipulation of the tube. Laryngeal ulcers occur more frequently with oral intubation than with nasal intubation. This is because it is difficult to anchor the endotracheal tube in the mouth, and an unanchored tube exerts pressure on the posterior rim of the glottis [1].

The length of time an endotracheal is left in place varies with agency policy and the physician. If prolonged intubation (longer than 10 to 14 days) is anticipated, a tracheotomy is usually performed, because longer endotracheal tube placements are associated with greater risks of complications [1].

Extubation

Patients should be adequately ventilated, oxygenated, and suctioned before extubation is attempted. The nurse deflates the cuff and again suctions the patient to remove secretions that may have accumulated. The tube is removed, and oxygen is administered. An individual qualified to reintubate the patient should be present, and an intubating tray should be ready at the bedside. Complications that may follow tube removal include laryngeal edema and laryngospasm. The patient should be observed for signs of complications, including labored breathing, use of accessory muscles, and stridor. Laryngospasm and laryngeal edema can result in upper airway obstruction and may require the administration of parenteral corticosteroids and reintubation.

TRACHEOTOMY TUBES

Other methods of establishing an artificial airway include tracheotomy and cricothyroidotomy. Tracheotomy tubes are placed during these procedures. These short, curved tubes have a flange that assists in stabilization of the device on the neck. A variety of tubes are available, including metal or disposable silicone types in several sizes. Most tubes have an inner cannula to facilitate cleansing and are packaged with an obturator, which is used to minimize trauma when the tube is inserted [5; 6].

The terms "tracheotomy tube" and "laryngectomy tube" are often used interchangeably. Actually, a laryngectomy tube is shorter and consists of an obturator, inner cannula, and outer cannula. These tubes are usually placed following a total laryngectomy to provide a route for removal of secretions and to maintain a patent airway [6].

Tracheotomy and Laryngectomy Tube Care

Tracheotomy care is performed to minimize bacterial contamination and to decrease the possibility of obstruction by secretions. Patients with tracheotomy tubes require suctioning when they experience difficulty breathing, noisy/increased respirations, or cyanosis. Routine care consists of cleaning of the inner cannula and the area around the stoma. The frequency of cleaning varies depending on the amount of secretions present—it may be necessary as frequently as every 30 minutes or only once per shift. Some experts advocate cleaning the inner cannula as often as necessary, while others believe that proper humidification and suctioning negate the need for frequent cleaning [5]. It is important to remember that more frequent cleaning may increase the risk of infection.

When caring for patients with a tracheotomy or laryngectomy tube, it is wise to have another sterile tube at the bedside in case of accidental decannulation or obstruction of the tube. A clearly labeled obturator should also be in the room to be used in cases of emergency reintubation. Some prefer to keep sterile forceps at the bedside as well, because decannulation in the period immediately after tube insertion may result in closure of the stoma. Scissors should also be at the bedside to cut the tracheotomy tube ties if they become too tight or if the tube is partially dislodged by coughing [6].

Extubation

Prior to removal of a tracheotomy or laryngectomy tube, the patient should be ventilated, oxygenated, and suctioned to remove tracheal and pharyngeal secretions. The cuff is deflated, and the patient is again suctioned. The tube is then removed, and a dressing is placed over the stoma. Normally, the opening closes within five days [5; 6].

Fenestrated tracheotomy tubes are used in some cases prior to extubation of the patient. This tube has an opening, or fenestration, in the outer cannula; it may or may not have a cuff. If the fenestrated tube is cuffed, the cuff should be deflated to allow the patient to breathe around, as well as through, the tube and adjust gradually to its removal. It also allows healthcare professionals to assess how the patient will tolerate removal. Covering the tracheotomy tube enables the patient to talk, to breathe normally through the upper airway, and to expectorate secretions [5; 6].

Another way of preparing the patient for permanent removal of a tracheotomy tube is by applying a tracheotomy button. The button extends from the tracheotomy opening to just inside the tracheal wall. If the tracheotomy tube has a cuff, the cuff is deflated before the tracheotomy button is placed to allow the patient to breathe around the tube. To determine readiness for decannulation, a tracheotomy button is most effective with a fenestrated tube. Placement of this button facilitates talking, coughing, and normal breathing through the upper airway. If the patient has difficulty breathing or expelling secretions, the button is removed, and the patient breathes through the tracheotomy tube [6].

POSSIBLE COMPLICATIONS OF ARTIFICIAL AIRWAYS

The insertion of an artificial airway can result in a variety of complications. Because inspired air bypasses the nose, air should be humidified to prevent drying the mucosa of the lower respiratory tract. Patients with artificial airways are also more vulnerable to the development of infection as a result of altered ciliary function, trauma to the mucosa caused by suctioning and intubation, and colonization of the airway with bacteria. Organisms commonly isolated from the respiratory tract in these patients include *Staphylococcus aureus* and *Pseudomonas* spp. [5].

According to the American Association for Respiratory Care, when the upper airway is bypassed during invasive mechanical ventilation, humidification is necessary to prevent hypothermia, disruption of the airway epithelium, bronchospasm, atelectasis, and airway obstruction. When the upper airway is not bypassed, such as in noninvasive mechanical ventilation, active humidification is highly suggested to improve comfort.

(https://www.guideline.gov/summaries/summary/36911. Last accessed October 13, 2017.)

Level of Evidence: Expert Opinion/Consensus Statement

Excessive pressure on the trachea from the endotracheal tube cuff can decrease blood supply to the area and cause tissue necrosis. This may lead to tracheal stenosis or a tracheoesophageal fistula.

Another possible complication is herniation of the cuff over the end of the tube, resulting in partial or complete airway obstruction. Signs include a significant air leak through the stoma, mouth, or nose; the sounding of the high-pressure alarm on the ventilator; and/or obstruction when attempting to suction the patient.

An underinflated cuff may be caused by instillation of an insufficient amount of air or a ruptured cuff. An air leak may be detected around the stoma, nose, or mouth, with the ventilator indicating a decrease in the expired volume of air by sounding the low-pressure alarm [6].

Obstruction of artificial airways may also occur because of accumulation of secretions or a kink in the endotracheal tube. This should be corrected immediately to prevent asphyxiation.

CARE OF ARTIFICIAL AIRWAYS

Placement of an artificial airway can be a source of anxiety and apprehension for the patient and family members. One major source of anxiety is an impaired ability to communicate. However, aside from patients who have undergone a total laryngectomy, this problem is temporary. To help allay patients' fear, nurses should provide an alternative means of communication. A white board or a pad of paper and a pencil should be available. The call light should be within reach of the patient at all times and should be answered promptly. The intercom at the nurses' station should be marked to indicate that the individual is unable to speak. Some patients who cannot communicate by writing may use gesturing as an alternative method [7]. Family members should always be included when providing information and reassurance.

Patients with artificial airways also have an impaired ability to remove secretions effectively. The artificial airway prevents the glottis from closing, which impedes the generation of the intrathoracic pressure necessary to dislodge secretions. Thus, cough is less effective. The artificial airway also decreases the effectiveness of the mucociliary mechanism. Secretions that accumulate in the airway may cause the patient to fear suffocation.

When the patient is unable to cough and expel secretions, suctioning is necessary. During this procedure, the patient will experience discomfort and a feeling of breathlessness. Nurses should attempt to comfort the patient by providing an explanation of the artificial airway and the suctioning procedure prior to their use, if possible [7].

Obviously, the placement of an artificial airway will result in a change in patients' body image. This not only affects the way patients view themselves but the way they are viewed by family members and significant others. Hospitalization, by its very nature, puts patients in a dependent role, and having an artificial airway compounds the feeling of lost autonomy. Patients should be encouraged to participate actively in their own care as much as possible. For most patients, an artificial airway is temporary, and they should be informed that the airway will be removed after they are able to ventilate adequately [7].

MECHANICAL VENTILATION

TYPES OF MECHANICAL VENTILATORS

There are basically three types of positive-pressure ventilators: time-cycled, pressure-cycled, and volume-cycled machines.

With the time-cycled ventilator, inspiration is terminated after a set time. The volume of air delivered is regulated by the length of the inspiratory cycle and the rate of flow of the pressurized gas. A disadvantage of this type of ventilator is that the tidal volume and the pressure required to deliver the gas vary with each breath, depending on the compliance of the patient's airway (i.e., ability of the lungs to distend with each breath of ventilation).

With the pressure-cycled ventilator, the gas is delivered to the lungs until a predetermined pressure is reached, then inspiration is terminated. The disadvantage of this is that the tidal volume delivered to the patient can vary with each inspiration, depending on his or her airway [3; 8].

In volume-cycled ventilators, a set amount of air is delivered for each inspiration. The advantage of this form of ventilation is that the tidal volume remains consistent and the pressure necessary to deliver the volume varies, dependent on the patient's lung compliance. The volume-cycled type is the most frequently used ventilator for adult patients [8].

PATTERNS OF MECHANICAL VENTILATION

There are four common ventilation patterns: assist-control, intermittent mandatory ventilation (IMV), synchronized intermittent mandatory ventilation (SIMV), and positive end-expiratory pressure (PEEP). In assist-control mode, the inspiratory phase is initiated by the patient. However, modern ventilators have a built-in safety feature to ensure that the machine will deliver the volume at the ordered rate if the patient becomes apneic. In controlled ventilation, the machine has complete control of the patient's rate and depth of ventilation [2; 3].

IMV delivers a preset tidal volume at a specific rate while also providing a continuous flow of air for spontaneous breaths. IMV was originally introduced for the purpose of gradually weaning individuals from ventilators, but the use of this type of ventilation has expanded, and it has become popular for patients who require mechanical ventilation but are able to initiate some inspiratory effort on their own, such as patients with chronic obstructive pulmonary disease. IMV cannot be used for individuals who are apneic (e.g., those who have suffered damage to the brain stem). An advantage of IMV ventilation is that it allows the patient to use respiratory muscles, which prevents atrophy [2; 3; 5; 6].

With SIMV, air is delivered by the ventilator in synchronization with the patient's own ventilation efforts. If the SIMV is set at a rate of 10, the patient is assisted 10 times per minute [6].

PEEP prevents the collapse of the airways and alveoli at the end of expiration, facilitating the diffusion of more oxygen from the alveoli into the pulmonary capillaries. This allows for a reduction in inspired oxygen concentrations, because oxygen can diffuse during both inspiration and expiration. The setting for PEEP is usually in the range of 1–15 cm. However, levels greater than 40 cm have been used when treating patients with severe hypoxemia, as in those with acute respiratory distress syndrome [2; 6].

Physiologic changes occur with the administration of PEEP. PEEP causes an increase in intrathoracic pressure, which decreases the venous return of blood to the heart. The baroreceptors in the thoracic aorta interpret the decreased venous return as hypovolemia and stimulate an increase in production of antidiuretic hormone (ADH). Increased ADH can lead to the development of hypovolemia, which results in decreased cardiac output. Another potential problem encountered is the development of a pneumothorax [2; 6].

NURSING CARE OF PATIENTS WHO ARE MECHANICALLY VENTILATED

Nurses should take steps to ensure the comfort and safety of mechanically ventilated patients. Accidental disconnection of the patient from the ventilator should be prevented. A warning should be placed on all ventilators and on the nursing care plan reminding healthcare personnel to leave the ventilator alarm on at all times, even during suctioning. The sound of the alarm is a minor nuisance compared to the damage that may occur if someone fails to turn the alarm back on [2; 5].

A bag-valve mask (e.g., Ambu bag) should be kept at the patient's bedside to be used in the event of a power failure or ventilator malfunction. If the ventilator is not working properly, do not waste time trying to identify the mechanical difficulty. Instead, use the bag-valve mask to ventilate the patient while another staff member calls the respiratory maintenance technician [5].

Patients who are mechanically ventilated often require monitoring of central venous pressure or pulmonary capillary wedge pressures. The positive pressure exerted by the ventilator will alter these readings. It is important that they always be taken either with the patient connected to or disconnected from the ventilator in order to maintain consistency [2; 5].

As a rule, respiratory therapists are responsible for checking the function of the ventilator at regular intervals. However, nurses should also be familiar with the machine and how it functions [6]. The pressure indicator shows the amount of force required to ventilate the patient's lungs. If the amount of pressure required increases or decreases significantly, assess the situation to determine the cause, if possible. If any alarm sounds on the ventilator, it is crucial to respond immediately. If the reason for the alarm cannot be readily ascertained and rectified, the patient should be disconnected from the ventilator and ventilated manually with a bag-valve mask until the ventilator can be replaced or fixed. Because the alarms can be frightening to patients and any others in the room, reassure them that the patient can be adequately oxygenated [6].

The settings on the ventilator should be checked hourly. This includes making sure the tidal volume, respiratory rate, fraction of inspired oxygen (FiO_2), and other parameters are set as ordered. Also, the ventilator tubing should be checked for water condensation; if any is found, the tubing should be disconnected and the water emptied. This will prevent impairment of ventilation or accidental aspiration of water into the trachea [2; 6].

In addition to checking the ventilator, carefully assess the patient for overt clinical signs of hypoxia, hypocapnia, or hypercapnia. Arterial blood gas values should be obtained at regular intervals. Monitoring these values is particularly important when ventilator settlings are changed, as when the FiO_2, IMV, or PEEP settings are decreased. Assess the patient every hour to ensure that both lungs are aerated by auscultating lung sounds and observing for symmetrical expansion of the chest. Because hyperventilation can occur, patients should be monitored for signs of respiratory alkalosis [2; 6].

A major responsibility is careful monitoring of the patient's vital signs. Because the application of PEEP can result in a decrease in cardiac output, particular attention should be paid to blood pressure, pulse, and urine output. Any time the setting for PEEP is altered, the patient should be re-evaluated. Increasing the amount of PEEP can further compromise venous return, whereas decreasing could result in cardiac overload and pulmonary edema. Often, patients with PEEP have a central venous pressure (CVP) line, a peripherally inserted central venous catheter, or a pulmonary artery catheter, which allows for more accurate assessment of physiologic parameters. Because of the increased positive pressure exerted with PEEP, the patient should be observed for signs and symptoms of pneumothorax [2; 6].

Nursing care of the patient who is mechanically ventilated also includes position change and skin assessment every hour, putting joints through active or passive range of motion exercises every eight hours, and frequent oral care. Patients who are comatose will also require eye care, including use of artificial tears to keep the eyes moist, removal of crusts on lashes and lids with sterile saline or sterile water-soluble lubricants, and/or protection from corneal drying, irritation, or trauma by taping the eyelids closed [2; 7].

Patients will occasionally "fight" the ventilator, also referred to as "being out of phase with the ventilator." In these cases, the patient attempts to actively exhale while the ventilator is delivering the inspired volume. This conflict should be corrected because it results in decreased volume delivery and excessively high airway pressures. A bag-valve mask may be used to increase volume delivery gradually and decrease the respiratory rate. Altered inspiratory flow rates may be ordered for the ventilator to correct the situation, or medication may be prescribed to sedate the patient and allow the ventilator to function more efficiently [2; 7].

Another possible complication of prolonged mechanical ventilation is the development of stress-related mucosal damage. This is a broad term that encompasses a spectrum of inflammatory damage to the upper gastrointestinal tract, ranging from superficial lesions to significant gastrointestinal bleeding (e.g., a stress ulcer). The mechanism of the formation of stress ulcers is not entirely understood, but it is believed to be related to a combination of hypersecretion of hydrochloric acid and decreased resistance of the gastric mucosal lining. The resultant gastric irritation may lead to bleeding, so nurses should assess stool and nasogastric drainage for fresh and occult blood.

Gastric dilatation may also occur from introduction of air into the esophagus. This may necessitate the insertion of a nasogastric tube [2; 7].

PSYCHOSOCIAL CONSIDERATIONS AND PATIENT EDUCATION

Patients receiving mechanical ventilation require frequent attention and care in an environment with a lot of activity and a high noise level. This may result in sensory overload, so it is important that nursing care be organized to give the patient periods of uninterrupted rest.

Mechanical ventilation can be frightening for patients and their families. Staff members are often so familiar with their routines and equipment that they discount the potential impact on patients and their families. It is important to take time to explain equipment, alarms, and lights. The patient and significant others should be assured that a nurse is always close by and will respond promptly to the patient's call and alarms. Patients should not be left alone in the room until they appear relatively comfortable with the situation. Be careful not to become so involved with monitoring the equipment and performing the procedures that the patient is forgotten; patients and family members should be given time to express fears and concerns. These patients are acutely ill and may have realistic fears about being dependent on the machine and the possibility of dying [2; 6].

Mechanical ventilation obviously limits patient mobility, and patients are confined to their rooms with limited contact with the larger world, which may lead to disorientation. Make a point to interact with the patient frequently and orient him or her to day, time, and place to minimize confusion and prevent anxiety. Lighting can also be controlled to create a day-night change. It can be helpful to keep a large calendar in the room so the patient can remain knowledgeable about passing time. Family members may also bring pictures or other articles to the hospital to personalize the environment. Patients should be encouraged to become actively involved in their care to the extent they are able in order to maintain a sense of control over their lives [2; 6].

When patients require indefinite mechanical ventilation after discharge, they and their family members/caregivers will require instruction. Ancillary healthcare providers may also be needed in the home. The nurse can facilitate proper care by coordinating activities among different departments, such as respiratory therapy, social service, public health nurses, and any other healthcare team members involved [2; 5].

WEANING THE PATIENT FROM THE VENTILATOR

Weaning the patient from mechanical ventilation involves reducing physiologic and psychologic dependence on the ventilator. Before weaning, the patient's arterial blood gas values on a liter flow of oxygen should be greater than 40% to 50%.

If the patient is receiving PEEP, it should be no higher than 5 cm; otherwise, it will interfere with the patient's independent inspiratory efforts. Vital capacity should be greater than 15 mL/kg of body weight, as this indicates that the patient is able to move enough air. This measurement can be obtained using a respirometer attached to the end of the patient's endotracheal or tracheotomy tube. Maximum inspiratory effort should also be assessed to determine whether the patient's chest expansion is sufficient to produce negative alveolar pressure and stimulate a deep inspiration. The greater the patient's ability to inhale, the more negative the inspiratory pressure will be. This is assessed by attaching a pressure gauge to the end of the endotracheal or tracheotomy tube and instructing the

patient to take in a deep breath. The patient is considered to be ready for weaning with a pressure of -25 to -30 cm. Respiratory rate and minute volume measurements should be taken. The respiratory rate should be at least 12 breaths per minute, but no greater than 20 breaths per minute [6; 7]. Additional criteria for weaning include a stable chest wall, an acceptable chest x-ray, adequate cardiac output, normal body temperature, adequate nutritional status, and a generally well-rested condition.

Before beginning, the weaning process should be explained to the patient. Two methods used to wean patients are the T-piece and IMV. Regardless of the weaning method employed, the cuff of the endotracheal or tracheotomy tube is usually deflated first. In T-piece weaning, the patient is taken off the ventilator and a T-tube carrying humidified oxygen is attached to the airway. Patients should be encouraged to use the breathing exercises taught to them while they were on the ventilator. Weaning is started during the day and scheduled around medications and activities so the patient is not uncomfortable or interrupted. The patient should be suctioned prior to disconnection from the ventilator. A semi-Fowler's position will facilitate the weaning process by preventing abdominal contents from pressing on the diaphragm [2; 6].

Weaning is usually started with 15 minutes off the ventilator and gradually increased if the patient's respiratory status remains stable. The patient's vital signs should be checked frequently during this period. Indications that weaning is being poorly tolerated include increased respiratory rate and dyspnea, tachycardia, cardiac dysrhythmias, change in mentation, fatigue, and decrease in pulmonary volumes. Arterial blood gas measurements are obtained for objective evidence of how well the patient is independently ventilating [6].

The other method of weaning is via the IMV method. The number of IMV breaths per minute is gradually decreased (without exceeding the patient's tolerance) until the patient is breathing totally spontaneously. The same nursing implications described for T-piece weaning apply [5; 6].

Psychologic Considerations and Counseling

Patients who are mechanically ventilated for extended periods may develop a psychologic dependence on the ventilator that makes weaning difficult. Psychologic factors that impair the weaning process include fear of sudden death, anger from being asked to give up dependence on the ventilator, secondary depression when the illness is chronic, and interpersonal problems (e.g., a resentful or impatient spouse) [2; 6].

Counseling may be necessary for patients and family members when attempts to wean from the ventilator are resisted. This is particularly true when physiologic parameters clearly indicate that weaning is feasible but difficulties are encountered. Along with counseling, psychotropic medications may be necessary. Antianxiety medications administered to patients who are near panic prior to weaning have been found helpful. If depression is a problem, antidepressants may be prescribed. Regardless of whether medications are used, weaning difficulty can be associated with emotional as well as physiologic factors [2; 7].

CHEST TUBES

Inspiration and expiration depend partly on the presence of normal intrapleural pressure. Although this pressure varies with breathing, it remains lower than atmospheric pressure. Disruption of intrapleural pressure by trauma, disease, or surgery will decrease the effectiveness of ventilation. To re-establish normal intrapleural pressure, the insertion of chest tubes with a drainage system may be required. This will also prevent mediastinal shift [7].

CHEST TUBE INSERTION

The insertion of a chest tube can be painful. If the procedure is not an emergency, analgesics or pain medications should be given 30 minutes prior to tube insertion. It is of utmost importance that the nurse explain the procedure and equipment used. Patients and/or their family should be told that the tube(s) will be placed through the chest wall to drain air, fluid, or both, so the lungs can function normally. The tubes are secured by a dressing and connected to a drainage apparatus.

When chest tubes are inserted at the bedside, the nurse is responsible for obtaining equipment. The equipment may vary among institutions, but generally includes:

- Local anesthetic, usually 1% lidocaine
- Antiseptic, such as povidone-iodine
- Sterile gloves
- Collection receptacle
- Chest tube(s)
- Tape and gauze for an occlusive dressing

Unless contraindicated, the patient is usually placed in a recumbent position for insertion of the chest tube. If the tube is being inserted to remove air (e.g., in the case of pneumothorax), the patient should be supine. Because air rises, the chest tube is inserted anteriorly in the midclavicular line in the second to fifth intercostal space. If the tube is being placed to remove fluid (e.g., for hemothorax), the patient should be placed in a semi-Fowler's position. Because fluid collects in the dependent area, the tube is inserted in the sixth to eighth intercostal space in the midaxillary line. The patient who cannot tolerate a semi-Fowler's position should lie on the unaffected side [7].

DRAINAGE SYSTEMS

Chest tubes are connected to approximately 6 feet of tubing that leads to the collection system, which is placed considerably below the patient's chest in order to take advantage of gravity flow and facilitate removal of air and fluid from the intrapleural space. The tubing should be long enough that it allows the patient to move and turn without pulling. The dependent position and a long tube also prevent the backflow of fluid into the intrapleural space.

CLOSED-CHEST DRAINAGE

To prevent the re-entry of air into the intrapleural space, the distal end of the chest tube should be submerged under water. This seal is a necessary part of any chest drainage unit. During exhalation, the pressure in the lungs forces air out of the pleural space through the tubing and into the water (as shown by bubbling) [7].

There are a number of variations of chest drainage units available. Previously, reusable glass systems were the standard. Now, sterile disposable systems are common. These systems are lightweight, take up a small amount of space, and are not breakable. Disposable systems can have one or multiple chambers, a valve or water seal, and/or water- or dry-suction control.

NURSING CARE

The major objective of nursing care for patients with chest tubes is to facilitate drainage of fluid and air, fostering lung re-expansion. After insertion of the chest tube, a dressing is applied using sterile technique. Gauze or a hydrocolloid dressing is wrapped around the insertion site, and wide tape is applied to provide an occlusive dressing. This prevents air from entering the intrapleural space. Although the chest tube is sutured in place, further care should be taken to secure the tube when applying the tape. If drainage is present on the dressing, the physician should be notified [7].

The Eastern Association for the Surgery of Trauma concludes that there is insufficient published evidence to support any recommendation either for or against the use of presumptive antibiotics to reduce the incidence of empyema or pneumonia in tube thoracostomy.

(https://www.guideline.gov/summaries/summary/43777. Last accessed October 13, 2017.)

Level of Evidence: Expert Opinion/Consensus Statement

Characteristics of the chest tube drainage should be recorded, including amount, color, consistency, and odor. Initially, the drainage characteristics should be noted every 15 to 20 minutes. Persistent drainage of more than 100 mL per hour should be reported. The collection should be labeled with the time, and drainage volumes should be recorded each nursing shift [7].

An important aspect of care for the patient with chest tubes is assessment of the patient's respiratory status. Patients should be questioned about their level of discomfort and any difficulty in breathing. Lung fields should be auscultated to determine if all areas of the lungs are being aerated. Watch for symmetrical expansion of the chest when the patient breathes, and listen for any adventitious breath sounds. The rate, depth, and quality of respirations should be noted and the patient encouraged to cough and deep breathe every hour to facilitate lung re-expansion and prevent complications [7].

MAINTAINING THE SEAL

It is essential that the seal in the chest drainage unit be maintained to prevent re-entry of air into the pleural space. If a water seal is used, at least 2–2.5 cm of sterile water or normal saline should be placed in the water-seal bottle. The fluid level should be checked frequently and sterile water or saline added to replace water lost to evaporation. It is important that the drainage unit be kept well below the chest level; if any part of the system is lifted above the chest level, fluid may re-enter the pleural space (although most systems now have a one-way valve that prevents air or fluid from entering the chest). When transporting the patient, use a stretcher with a bottom shelf and place the collation unit on the stretcher shelf, keeping the system below the level of the patient's chest. It is recommended that someone familiar with the water-seal system accompany the patient during transport [7].

The water seal can be lost by inadvertently disconnecting or dislodging the tubing. Disconnection should be suspected if one notices an absence of fluctuation in the water-seal bottle or chamber. In the event that a tube becomes disconnected, the end of the disconnected tubing should be cleaned with an alcohol swab and reconnected. The nurse should then ask the patient to cough deeply to remove any excessive air that may have accumulated in the intrapleural space [7].

A chest tube should never be clamped, because a tension pneumothorax can develop if a continuous air leak is present [5; 6]. If a chest tube is pulled out or falls out of the intrapleural space, the patient should be asked to exhale forcefully, and the opening should be immediately covered. Ideally, the wound should be covered with gauze or dressing and pressure applied until the tube can be re-inserted. If gauze is not available, the palm of the hand or a sheet can be used. If the patient develops signs and symptoms of a tension pneumothorax, the pressure should be momentarily relieved to allow air to escape [5; 6].

MAINTAINING PATENCY OF THE DRAINAGE SYSTEM

Maintaining the patency of the drainage system is necessary to facilitate expansion of the lung, and frequent, systematic observations should be made to determine that the system is patent. This includes checking for loose connections and reinforcing the dressing as needed. All connections should be secured with tape or bands [7].

The water in the seal rises and falls with changes in intrapleural pressure. As the patient inhales, fluid should be pulled up into the water-seal tube or the chest tube, and the level should fall back as the patient exhales. Absence of fluctuation may be caused by an obstructed tube, a disconnected tube, or re-expansion of the lung [7].

Bubbling is normally present in the water-seal chamber during exhalation. However, continuous bubbling during both inspiration and expiration may signal an air leak. The air leak can be from the patient's lung or from an opening in the tubing or collection receptacle. A physician should be notified of any absence of fluctuation or continuous bubbling [5; 6; 7].

The drainage tubing should be regularly inspected for kinks or dependent loops. Kinking, which can occur along any section of the tubing from the chest tube to the collection device, will obstruct the flow of air or fluid. To prevent kinking at the point of entry into the drainage device, the tubing may be secured to a tongue blade with tape. Dependent (hanging) loops, which allow fluid to accumulate and thus alter the pressure within the system, can be avoided by proper positioning of the tubing. The tube should be coiled flat and should fall in a straight line from the coil to the drainage receptacle. The coiled tubing can be secured to the edge of the bed [5; 6].

When suction is applied, the suction control bottle or chamber should be observed for bubbling. Absence of bubbling suggests that sufficient suction is not being applied to the intrapleural space, whether because of an obstructed suction control tube, a leak in the system, an obstructed air inlet, or simply setting the suction too low. Incomplete expansion on one side only is due to increased intrapleural pressure.

Milking or stripping of the chest tubes may be necessary to prevent the formation of clots or remove clots from the tubing. This can be achieved by gripping and stabilizing the tubing between the thumb and forefinger of one hand while compressing a section of the tubing and sliding the other hand from that point toward the drainage unit (away from the patient to the collection receptacle). Release the first hand, and repeat the procedure along the rest of the tubing. This may be facilitated by the use of lotion/lubricant or a chest tube roller [6].

PATIENT TEACHING REGARDING CHEST TUBES

As noted, the insertion of a chest tube is a painful, invasive procedure. Explanations and reassurance should be provided for the patient and family members. During the insertion, remain with the patient to provide emotional support.

Patients with chest tubes may restrict their breathing and movement not only to minimize pain, but because they fear they may dislodge the tube. They should be informed that the tube is secured with sutures and tape. Movement such as turning, coughing, and deep breathing should be encouraged, as this will facilitate re-expansion of the lung. The patient should be told that pain medication is available to decrease discomfort during breathing exercises. Opioids, however, should be avoided or administered judiciously because they can depress the respiratory rate [7].

The collection receptacle should also be explained to the patient. If suction is necessary, patients should be aware that bubbling and some noise are expected. Patients and family members should be given the opportunity to verbalize fears and ask questions regarding the procedure and equipment. Be aware that chest tubes may seem more frightening to visitors than other sorts of tubes, and be prepared to reassure patients that it is the visitor's lack of knowledge, not the patient's situation, that has caused the reaction [7].

CONCLUSION

With knowledge of the purpose and function of artificial airways, mechanical ventilation, and chest tubes, nurses can readily provide quality and even lifesaving respiratory care. All healthcare professionals involved in the care of these patients should have a knowledge of the function, potential complications, and care skills necessary to ensure the health and safety of individuals who require respiratory assistance.

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