Pediatric Tracheostomy and Ventilator Care

Home care for children who require long-term tracheostomies and mechanical ventilatory support has become a common alternative to hospitalization. However, these children can benefit from home settings only when expert care is available. Caregivers need to be skilled in respiratory assessment; tracheostomy care, suctioning, and tube changes; the management and troubleshooting of ventilators; and handling related respiratory emergencies.

Nurses not only play a critical role in helping these children, but also in preparing and supporting the family and other caregivers to provide care. This change in practice has made skills in routine and emergency tracheostomy and ventilator care procedures essential to pediatric nursing in both hospital and community settings.

Trachs & Vents

A child may need a tracheostomy tube for bypassing an anatomical obstruction of the airway, removal of excess pulmonary secretions, and long-term mechanical ventilation. For some conditions, short-term use of an endotracheal (ET) tube is an appropriate alternative. Infants can tolerate these tubes for short periods because their laryngeal tissue is soft and yielding. However, extended use can lead to subglottic stenosis - a narrowing of the trachea - so a tracheostomy is often indicated when an infant receives ventilatory support for longer than two to three months. For children over one year of age, tracheostomy placement usually occurs within two months.

In the event of respiratory failure, a child may need mechanical ventilatory support. Respiratory failure occurs when children are unable to achieve an adequate oxygen-carbon dioxide exchange on their own. Failure may result from an inability to initiate breathing, as in disorders of the central nervous system; or to process brain-diaphragm signals via the phrenic nerve, such as in cases of diaphragmatic or chest wall disorders; or from diseases of the airway or lungs, such as bronchopulmonary dysplasia. Until adequate ventilation is achieved without the use of mechanical support, procedural guidelines are useful for providing nursing care.

Assessing Respiratory Status in the Young Child

When performing a pediatric respiratory assessment, consider the child's age. Compared to older children, infants have narrower breathing passages and less rhythmic breathing. The thoracic cage is soft, allowing easy retraction during episodes of respiratory distress. However, nonrhythmic breathing and mild retractions may be a normal variation in infants. In children under six years of age, diaphragmatic breathing with minimal chest excursion is predominant and you can best detect respirations by looking at the abdomen. Complete assessment of the child age six years or older includes direct observation of chest movement.

If possible, compare observations when the child is asleep, awake, and active to determine baseline status. By following the same procedure for assessment every time, you can ensure a comprehensive evaluation. During assessment of the child who is being mechanically ventilated:

- Evaluate the child's color. A blue hue to nailbeds, lips, and/or skin may indicate respiratory distress or an underlying chronic respiratory or cardiac problem.
- Watch for nasal flaring, retractions, or an increase in respiratory effort.
- Look for abnormal breathing patterns, such as asymmetrical chest movements, irregular respirations, or prolonged expiration.

Note changes in behavior, such as intensified irritability. Ask the caregivers about this, if necessary.

Monitor for alterations in vital signs, oxygen saturation, end-tidal carbon dioxide levels, secretions, activity, and appetite.

Auscultate the lung fields systematically and symmetrically. If the patient is being mechanically supported, ventilate the patient with a resuscitation bag during auscultation to avoid confounding noises from the ventilator. To determine if sounds are referred from the upper respiratory tract in the presence of upper airway congestion, place your stethoscope near the child's tracheostomy tube, nose, and/or mouth, and listen for louder sounds.

Interventions: If a child has rhonchi, suction the airway and then reassess breath sounds. If there is no change, perform chest percussion and postural drainage followed by suctioning. If breath sounds are diminished in an area, concentrate percussion and postural drainage on that region. If the child has a wheeze, administer a respiratory treatment if prescribed, and perform percussion and postural drainage followed by suctioning. When adventitious breath sounds persist despite interventions, notify the primary provider.

Maintaining the Tube

The tracheostomy site and neck need to be examined and cleaned at least once daily to prevent skin breakdown, irritation, or infection. Adjust the frequency of care if secretions become excessive or conditions warrant closer monitoring.

When cleaning the tracheostomy stoma, use water on a clean gauze or cotton-tipped swab to wipe from the stoma outward. If the stoma is well healed, a clean washcloth with mild soap is acceptable. If the secretions are encrusted, one-half strength hydrogen peroxide and water can be used to cleanse the skin. Rinse with water to prevent dryness. Observe the skin for areas of heightened redness, drainage, or open sores, and report these changes to the primary provider. If the neck is red under the trach ties or flange, apply a light coat of barrier cream or Vaseline to the affected area, avoiding the stoma.

Tracheostomy tube strings, made of cloth or velcro, should hold the tracheostomy securely. Velcro is only used for children who do not frequently pull at their tracheostomy tube. To check for tightness, flex the child's neck forward and ensure a fit that permits one index finger to be slipped under the strings. Tie cloth strings in a triple knot. Strings may be padded with moleskin, foam, or other padding to prevent skin irritation or tissue necrosis.

Suctioning of the child's tracheostomy tube is necessary to maintain a patent airway. Frequency of suctioning depends on the child's condition. You can determine when suctioning is warranted by monitoring for agitation or restlessness, signs of airway obstruction, chest congestion, or secretions in the trach tube. Sterile technique for suctioning had been widely used in hospitals, but many personnel are now using a modified clean technique (nonsterile gloves and sterile catheters). Clean technique is recommended for home care settings (clean hands, gloves, and catheters).

The child who is ventilated should be hyperoxygenated before, during, and after a suctioning procedure. Also, listen to breath sounds before and after suctioning to determine procedural effectiveness. When suctioning through a tracheostomy tube, insert the catheter about 0.5 cm or less past the length of tracheostomy tube. Do not suction deeply to the carina because this may worsen irritation and secretions. For this reason, deep suctioning has not been recommended for more than a decade. Maintain suction pressure between 80 mm-120 mm Hg. Observe for changes in secretions, such as amount, color, consistency, and/or odor, and notify the primary provider as indicated.

The use of saline instillation with suctioning is not recommended. Although it was once considered beneficial for loosening secretions, studies have shown that this is not the case. In fact, saline

instillation may contribute to diminished oxygen saturation during the suctioning procedure. Proper airway humidification and general hydration will keep secretions thin.

To minimize infection and tracheostomy obstruction, practitioners change most tracheostomy tubes regularly, anywhere from one to thirty days, depending on a child's condition and type of tube. There is no data to support the best trach change frequency. The advantages of frequent changes are that infection is minimized, obstruction prevented, and caregivers become comfortable with the trach change procedure. Disadvantages are discomfort of the child and stomal irritation. The most common practice is to change the tube every one to two weeks. Two people are typically required when performing routine changes because of the complexity of the tasks and the possibility of complications.

If the child has eaten, wait at least one hour. To visualize the airway, hyperextend the neck using a towel roll under the shoulders. Lubricate the tracheostomy tube with sterile, water-soluble jelly before insertion. If the child receives mechanical ventilation, hyperoxygenate before and after the procedure. After inserting the new tube, listen for breath sounds to check for accurate placement. If breath sounds are faint or absent, remove the tube, reinsert immediately, and listen again.

Trach Emergencies

Because airway-related emergencies may arise at any time, emergency equipment, relevant telephone numbers, and medical information should always accompany the child. Emergency equipment includes a same-size tracheostomy tube, an ET tube that is one-half size smaller than the outer diameter of the tracheostomy tube, a mask if the child has a functional upper airway, scissors and hemostats, suction machine and supplies, resuscitation bag, and an oxygen source. **Accidental decannulation, a difficult trach tube insertion, or a mucous plug or excessive water in the tracheostomy tube are emergencies and require immediate intervention.** If cardiopulmonary resuscitation is initiated in severe emergencies, use the tracheostomy tube as the primary airway.

Accidental Decannulation: This emergency can be prevented by maintaining proper tightness of tracheostomy strings, relieving excessive tension on the tracheostomy tube, and discouraging the child from pulling on the tracheostomy tube. If you believe that decannulation has occurred, hyperextend the neck and check tube placement. If necessary insert a new tube immediately. If a new tube is not available, reinsert the old one until a new airway is available. Hyperoxygenate the child after reinsertion, and perform a respiratory assessment. Manually oxygenate the child until the individual appears comfortable, and then reattach the ventilator.

Difficult Tracheostomy Tube Insertion: If a tracheostomy tube cannot be inserted, reposition the child and hyperextend the neck to visualize the stoma. If the child is crying or has a partially closed stoma, wait for child to sigh or inhale and immediately insert the tube. If unable to insert a new tube, reinsert the old one. If you are unable to insert either tracheostomy tube, place a half-size smaller ET tube into the stoma at approximately the same depth as the trach tube. Listen for equal bilateral breath sounds. If breath sounds are loud on the right side and diminished on the left, the ET tube is probably in the right bronchus, which is straighter and easier to access. Pull the tube back until breath sounds are equal. If breath sounds are absent or diminished, insert the tube slightly further than the depth of the tracheostomy tube. There may be an area of stenosis or granulation tissue that needs to be bypassed in order to establish airway patency for ventilation. Once the airway is patent, attach the ET tube to a resuscitation bag or ventilator and call for emergency assistance.

The use of a half-size smaller trach tube rather than a smaller ET tube is controversial. Some physicians prefer the use of the trach tube, which is more convenient because it can be tied in place during the emergency of a difficult insertion. Others prescribe an ET tube replacement that is longer and may be able to extend past stenotic problem areas in the trachea. Establish the provider's preference before an emergency occurs.

If an ET or smaller trach tube cannot be placed, insert a suction catheter into the stoma and attach it to an

oxygen source. Cover the suction port of the catheter to ensure oxygen delivery, and call for assistance. The catheter cannot be attached to a resuscitation bag or ventilator. If the child is unable to breathe, cover the stoma and manually ventilate via mask over the child's mouth and nose. Do not use a mask if the child does not have a functional upper airway. The stoma is used to resuscitate.

Mucous Plug in the Tracheostomy Tube: An occluded tracheostomy tube is life threatening and requires immediate action. If the child is in respiratory distress and the tracheostomy tube is in place, immediately begin manual ventilation with 100% oxygen, and then suction. If secretions are thick and tenacious, use saline as you continue to suction. If suctioning is still difficult, change the tube, continue to suction, and ventilate manually until the child is comfortable.

To prevent mucous plugs, provide humidification through the tube, suction regularly, change the tube at regular intervals, and keep the child well hydrated. Thick secretions may indicate that the child has a respiratory infection, which should be suspected with a fever and/or a change in color and amount of secretions. Tenacious secretions may also indicate a need for additional humidification via the trach tube. Supplemental humidification is important because the tracheostomy bypasses the upper airway, which normally warms and filters inspired air.

Water in the Tracheostomy Tube: If water enters the tracheostomy tube from ventilator tubing, immediately detach the child from the ventilator and manually ventilate and suction. Continue this procedure until the child appears to be comfortable. Perform percussion and postural drainage, and suction the child again. Be sure to empty all water from the ventilator tubing before reattaching tubing to the tracheostomy. To prevent this occurrence, frequently empty water from the ventilator tubing and position the tubing below the level of the tracheostomy tube.

CPR: Most children who require CPR first experience a respiratory arrest, which can lead to cardiac event. Appropriate emergency interventions can prevent both occurrences. If CPR is necessary, ventilation can be performed via a resuscitation bag attached to a patent tracheostomy tube. If a resuscitation bag is not available, delivering breaths through the trach tube with your mouth is an alternative.

The Machine Behind the Child

Ventilators are designed to deliver oxygen mixtures through stabilized pressure and/or volume. Typically, volume-preset ventilators are more portable than pressure-preset devices. Pressure-preset ventilators deliver a set pressure at a predetermined rate, but the amount of air (tidal volume) given with each breath varies. Volume ventilators deliver a preset air volume at a predetermined rate, but the amount of pressure varies with each breath.

Nurses need to review the instructions that accompany a child's ventilator. If instructions are not available, contact the supplier of the respiratory equipment. Ensure that ventilator parameters, humidification, and alarms are set according to physician's orders.

Ventilator settings must be checked frequently. Settings include intermittent mandatory ventilation (IMV) rate or breath rate per minute, tidal volume (the volume delivered per breath), peak inspiratory pressure (PIP), positive end expiratory pressure (PEEP), FIO2 (the percentage of oxygen), humidification temperature, and alarms. Ventilator alarms must be on at all times, and caregivers need to remain within earshot of the sound. Some children may require a pulse oximeter and/or cardiorespiratory monitor only when unattended or asleep, while others may require continuous monitoring.

Ventilator tubing and humidification equipment should be changed regularly. Most tubing circuits are changed on a weekly basis; however, some may require more frequent changes. The child may need manual ventilation during the tubing change if the individual cannot breathe independently for a short time.

Troubleshooting: The primary provider prescribes alarm parameters and ventilator settings. A respiratory therapist sets the ventilator according to the provider's orders, and monitors the equipment at home. Most

equipment companies have 24-hour-a-day systems to manage equipment-related emergencies. Nevertheless, caregivers must know how to respond to ventilator, humidifier, and oxygen alarms.

- When a ventilator alarm sounds, check the child first. If the child is comfortable, check the ventilator to determine the source of problem. If child is uncomfortable, immediately ventilate the patient by resuscitator bag to stabilize before troubleshooting the machine.
- System disconnections or leaks typically generate low-pressure alarms. A disconnection can be obvious, such as at the juncture of the tracheostomy connector, or less obvious, such as a loose water trap. Resistance within the system typically generates high-pressure alarms. The resistance can be mechanical, like a kink or water in the tubing, or child- related, as with copious secretions that require suctioning or a plugged tracheostomy tube.
- Oxygen analyzers will alarm if the oxygen level differs from the preset range. Check the oxygen dial, oxygen source, connection, and/or analyzer as potentials for triggering the alarm.
- Humidifiers signal an alarm at temperature extremes. When an alarm sounds, check for incorrect temperature setting, water in the system, and humidifier malfunction.
- If you are unable to correct a technology-related problem, ventilate the child manually while finding an alternative solution. At home, many children have back-up ventilators for use during emergencies. For those who do not, the child can be hand-ventilated until the defective equipment is repaired or replaced. Some children may require hospitalization if the ventilator cannot be repaired or replaced within an appropriate time.

Awareness and use of current best practices enables the provision of high-quality care in hospital, home, or other community settings. Because emergency skills may be the least practiced, they are especially important to review periodically. Given the critical role of nursing in the delivery of pediatric home care, nurses have a responsibility to be prepared to meet the special needs of children who are technology-dependent.

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