CRAIG HomeCare

A DIVISION OF CRAIG RESOURCES, INC.

# Nursing Management of the Pediatric Tracheostomy and Mechanical Ventilator

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## Introduction

Welcome to Craig HomeCare! Home care of infants and children who require life-sustaining technological interventions has been an alternative to long term hospitalization since the early 1980s. A child who is dependent upon technological devices such as tracheostomy tubes or mechanical ventilatory support requires an intense level of professional assistance and clinical expertise.

During the last 2 decades, despite technological advances in home monitoring, the accidental death rate has remained almost the same at nearly 24%. Analysis of the data indicates that the primary causes of preventable death in ventilator-dependent children at home are inadequate training, improper response to emergencies, and lack of vigilance by the clinicians and family members who care for them. It is essential to Craig HomeCare that every nurse in the home providing care to these fragile children is competent with the most recent protocols. This course endeavors to teach those skills.

**NOTE: While we attempt to cover as much information as possible in this training booklet, no training program can be completely comprehensive. If you have any additional questions please contact the branch office to speak to the RN Supervisor. Please remember that there is an RN on call for support 24/7.**

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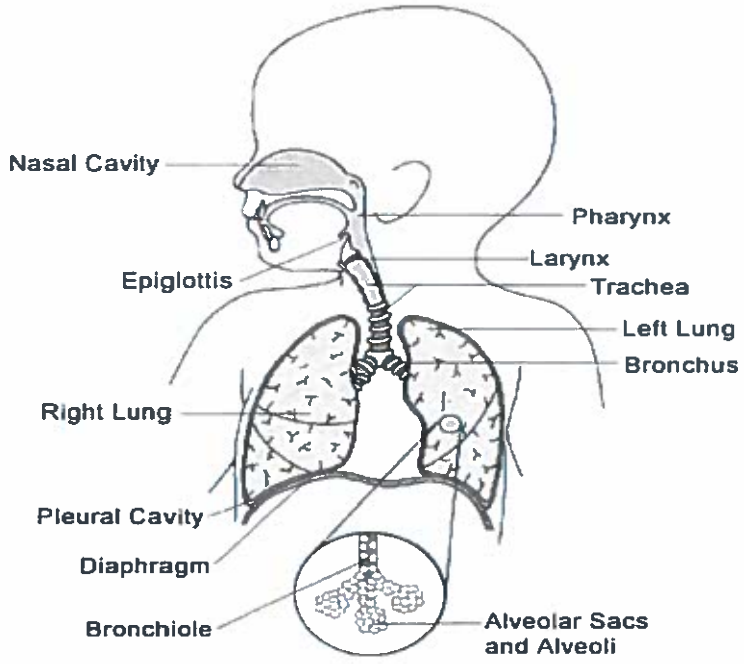
# ANATOMY AND PHYSIOLOGY OF THE PEDIATRIC RESPIRATORY SYSTEM

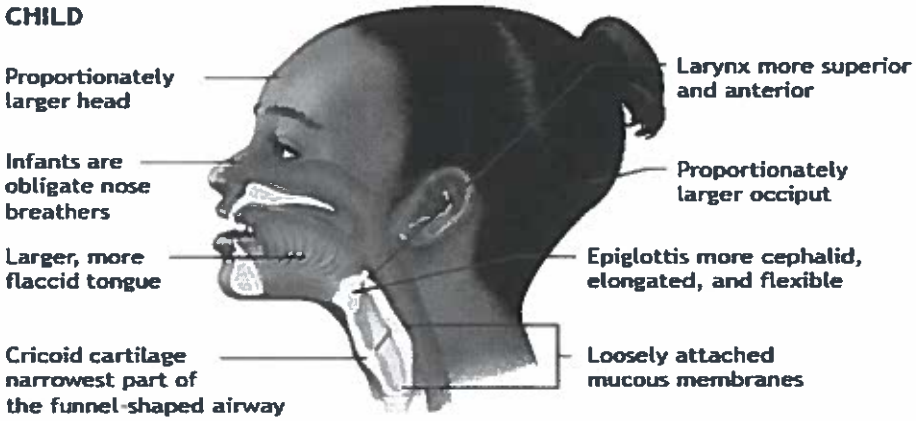



**Upper Airway**: nose, mouth, and throat (pharynx/larynx). The job of the upper airway is to warm, moisten, and filter the air before it enters the lungs

**Lower Airway**: Trachea, bronchi and lungs. The job of the lower airway is to take in oxygen and give off carbon dioxide which maintains the acid-base balance.

**Diaphragm**: The diaphragm is the primary muscle responsible for respirations. The diaphragm is connected to the abdominal wall, lumbar vertebrae, lower ribs, sternum, and pericardium of the heart. The job of the diaphragm is to create a partition between the thorax and abdomen. Upon contracting the diaphragm flattens causing a vacuum.

**Pediatric vs. Adult Airway**:
The pediatric airway has smaller nasal passages, more pliable airway cartilage and a smaller trachea.




Infants and young children rely on the diaphragm to breathe more than adults do.

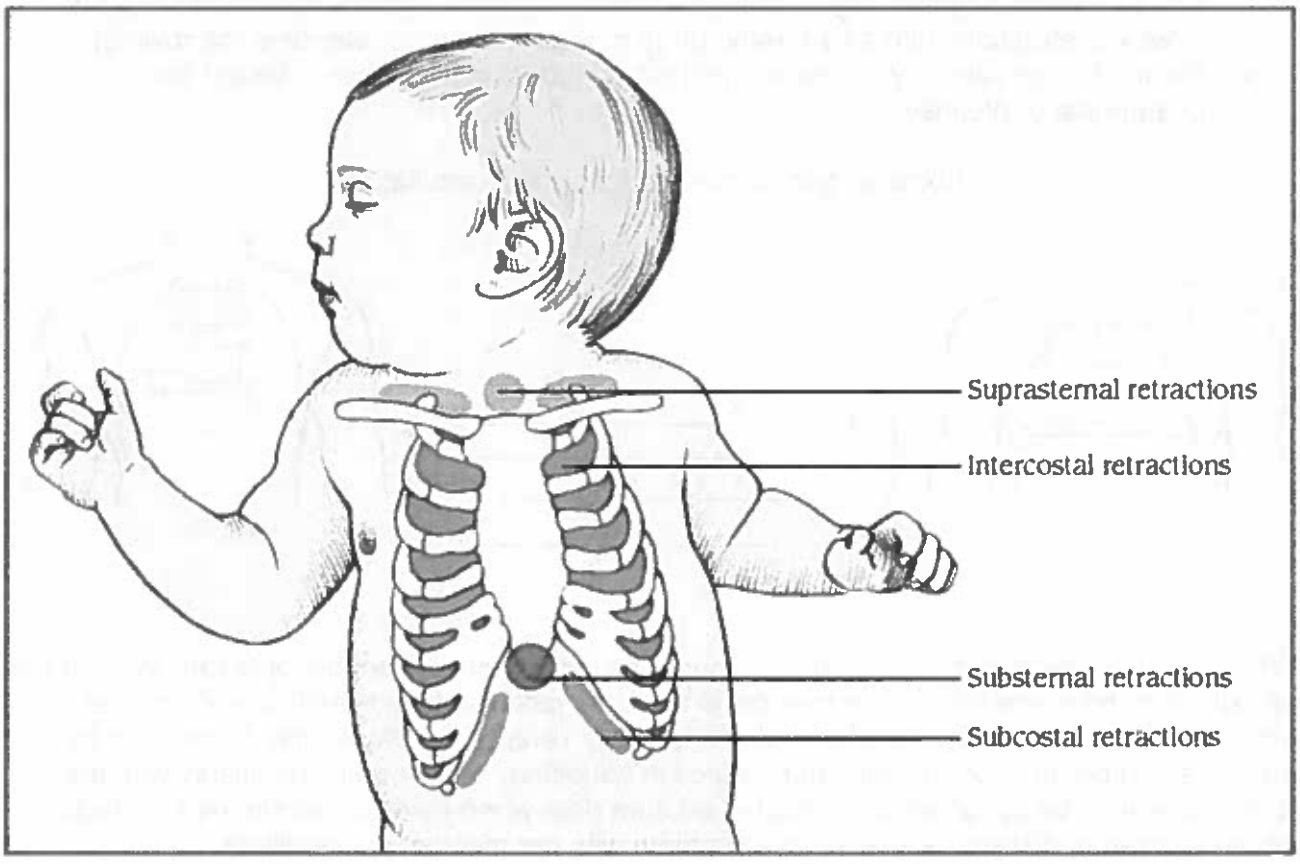
## PROPER PEDIATRIC ASSESSMENT

Proper assessment is a vital step in caring for a child with a tracheostomy or mechanical ventilator. 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, non-rhythmic breathing and mild retraction may be a normal variation of 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.

Proper respiratory assessment includes two key areas- Observation and Auscultation

**Observation:** If possible compare observations when the child is asleep, awake and active to determine baseline status. By following the same procedure every time, you can ensure a comprehensive evaluation

- Evaluate the child's color. A blue hue to nail beds, lips, and/or skin may indicate respiratory distress or an underlying chronic respiratory or cardiac problem.
- Watch for nasal flaring, retractions (see diagram below for areas of retractions) or an increase in respiratory effort.
- Look for abnormal breathing patters, such as asymmetrical chest movements, irregular respirations or prolonged expiration.
- Note any 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.



**Auscultation:** Auscultate the lung fields systematically and symmetrically. If the patient is being mechanically supported, ventilate him or her 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.

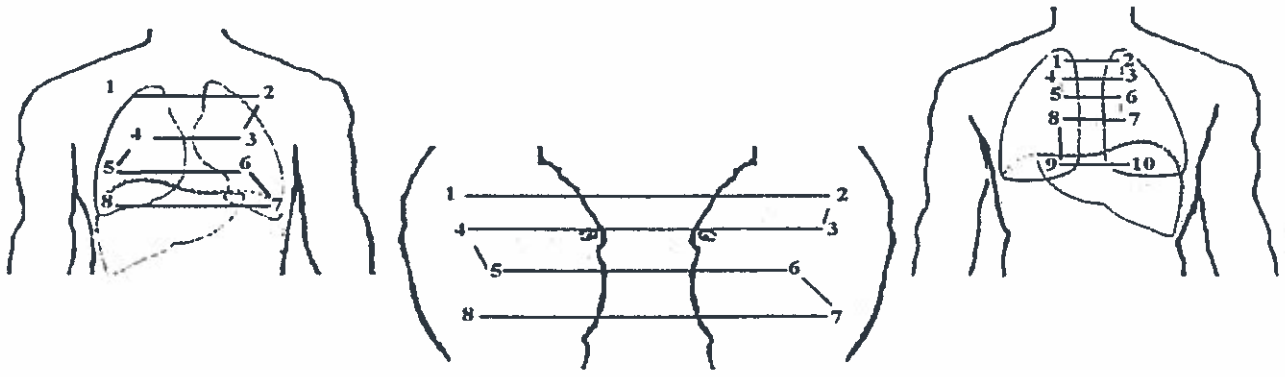
Normal Breath Sounds:

- Bronchial- heard only over the trachea near suprasternal notch. Short inspiration and longer expiration
- Bronchovesicular- heard in area where trachea bifurcates into primary bronchi. Inspiration is louder and higher pitched than vesicular sounds.
- Vesicular- heard over most of the lungs. Inspiration is louder, longer, and higher pitched than expiration. Soft, swishing sound.

Abnormal Breath Sounds:

- Crackles (rales)- Crackling noise (rub hair between 2 fingers; rice krispies) heard primarily with inspiration. Crackles are caused when Alveoli that close with expiration and pop/force open with inspiration with air popping through fluid/mucous in the alveoli in small airways. Assess for fluid imbalance and pneumonia
- Rhonchi- Gurgling or bubbling sound on inspiration and expiration. Rhonchi are heard primarily with exhalation through narrow large airways. Assess for excess secretions.
- Wheezes- Whistling or musical sound. Wheezes are caused by a narrowing or spasm of small airways on inspiration, expiration, or both, heard primarily with inspiration. Assess for bronchospams or asthma.
- Consolidation- Decreased or absent sound. A finding of consolidation may be the most critical. Assess for atelectasis (collapse of lung tissue).
- Stridor- Harsh, crowing, high-pitched, continuous sound. Stridor is caused by upper airway obstruction such as a foreign body or tumor, croup, or stenosis (narrowing).
- Pleural friction rub- Dry course sound that is loudest in the bases. Assess for pneumonia or pleurisy.

Location and Sequence for Lung Auscultation



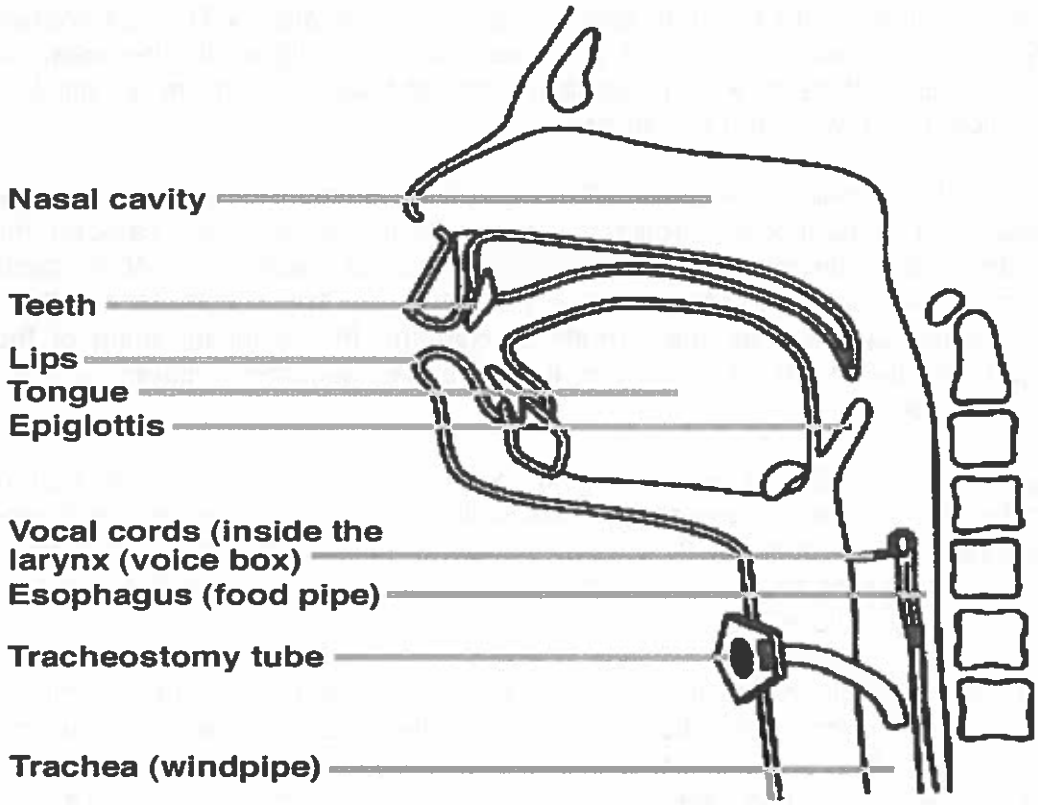

While using the resuscitation bag during your auscultation evaluation, become familiar with the amount of hand pressure needed to expand the chest and produce breath sounds similar to those produced while the child is being mechanically ventilated. Day-to-day changes in this pressure can be an important sign in changes in condition. Additionally, familiarity with the look and feel of "bagging" will be crucial at a future date when trying to determine if a child's acute respiratory distress is a result of a problem with the mechanical ventilator.

## TRACHEOSTOMY: PURPOSES AND CONDITIONS

Certain conditions and diagnosis common to children often signal a need for a tracheostomy tube. 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. Structural abnormalities of the pediatric airway may be congenital or acquired. Some children are born with subglottic stenosis (narrowing of the subglottic area), vocal cord paralysis or laryngomalacia (softening of the laryngeal tissue). Others may have craniofacial anomalies, such as Pierre Robin syndrome, which includes a small jaw, retraction of the tongue, cleft palate and upper airway obstruction.

Neuromuscular or neurologic impairments may result in severe hypotonia (low muscle tone) and upper airway obstruction. Abnormalities may result from trauma or burns to the upper airway, tumors above the trachea or subglottic stenosis acquired from extended use of an edotracheal tube. Children with neuromuscular or neurologic disorders often cannot cough and have weak gag reflexes, putting them at risk for aspiration of secretions, food and fluids into the lungs. These children may have a tracheostomy tube to manage their tracheal secretions and prevent aspiration.

Other children who may require a tracheostomy tube and/or mechanical ventilation include those with congenital heart disease, diaphragm abnormalities, or chronic lung disease resulting from infection, chronic aspiration or premature lungs (bronchopulmonary dysplasia or BPD).



## TRACHEOSTOMY CARE AND SUCTIONING

Proper routine care of the tracheostomy stoma and tube can prevent infection and airway accidents. The tracheostomy site and neck need to be examined and cleaned as often as ordered by the physician and at least daily to prevent skin breakdown, irritation or infection. The site should also be assessed for any drainage, swelling and odor. The frequency of care may be adjusted depending on the child's condition. Site cares should be performed as ordered by the physician (see nursing plan of care) and the dressing and ties should be changed as needed.

**Suctioning**: Suctioning of the tube is a critical skill to master in order to safely and effectively clear the airway of secretions while avoiding injury to the tracheal lining. Improper suctioning may cause traumatic inflammation and ulcerations, destroy tissue in the trachea and damage the normal expulsion of mucous. A clean (rather than sterile) technique may be used for suctioning at home. The healthcare provider must have clean hands and use clean gloves and catheter. In the home it is acceptable for catheters to be re-used as long as they are properly cleaned and stored in between uses. Since secretions move through the interior of the catheter in one direction only, the cleanliness of the outside of the catheter is more important than the cleanliness of the internal surface of the catheter. However, dried secretions on the surface of the catheter will interfere with the ability of the catheter to suction optimally.

You can determine when suctioning is warranted by monitoring for agitation or restlessness, signs of airway obstruction, chest congestion or secretions in the tracheostomy tube. The American Thoracic Society recommends that a tracheostomy should be suctioned at least twice daily to maintain and evaluate airway patency. It is also NOT recommended to pre-oxygenate using a resuscitation bag as this could force secretions into the distal areas of the airways. If a patient does need bag ventilation you should first perform an initial pass of the catheter to clear the airway prior to bagging.

In most cases the physician will order the size of the suction catheter as well as the safe suction depth. The healthcare provider should use the largest size catheter that can be inserted without difficulty and that effectively removes the secretions. When suctioning the tube the pre-marked catheter should be inserted no deeper than 0.5cm beyond the end of the cannula. Suctioning too deep may irritate or damage the epithelial lining of the trachea. Blood-tinged secretions may be observed if the trachea becomes irritated by suctioning too frequently or too deeply.

The American Thoracic Society now recommends applying continuous suction both on the way in and on the way out for no longer than 5 seconds while using a twirling (not stirring) motion. When applying suction continuously greater amount of secretions can be removed than when only applying suction on the way out and studies have shown no significant change in heart rate and oxygen saturations.

Normal saline instillation is NO longer recommended as part of routine suctioning. Use of saline may reduce oxygen saturation and contaminate lower airways of the lungs. There is also little evidence that shows that normal saline is effective in thinning mucous or adding humidification as was once believed. Proper attention to maintenance of adequate humidification will be more successful in maintaining thin mucus than normal saline instillation.

## CHANGING THE UNCUFFED TRACHEOSTOMY TUBE

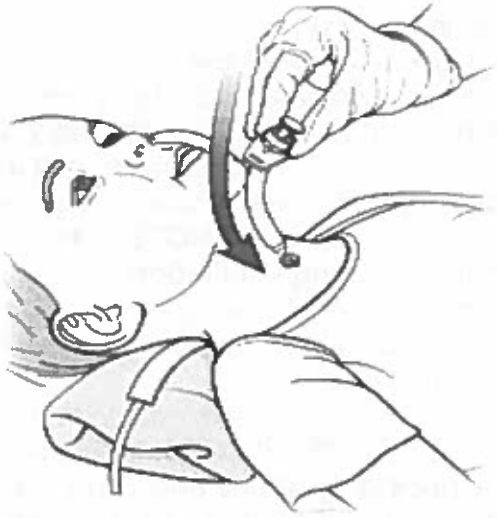
The healthcare provider on duty must be able to properly change the tracheostomy tube. The frequency of changes will be determined by the physician, usually every 1-2 weeks. Scheduled trach changes reduce the chance of infection and obstruction. To lower the risk of complications two people should always be present for routine trach tube changes. Trach changes can be scheduled at shift change or when family are present to ensure two caregivers will be present. Only in an extreme emergency should the healthcare provider change the tracheostomy tube alone. To minimize the risk of aspiration the trach should not be changed 1 hour before or after meals.

Prior to beginning a routine trach change the healthcare provider should ensure that all emergency equipment is at the bedside including a cell phone, suction machine, oxygen, and emergency bag. The healthcare provider should also have on hand a trach that is ½ size smaller in case the routine size cannot be inserted.

To change the tracheostomy tube- All of the providers present should wash their hands and put on clean gloves. Establish a clean work surface. Insert the obturator into the new tracheostomy tube. Attach the ties to the new tracheostomy. Place the prepared tube with ties attached in the opened package on your work surface. Position the child on his/her back with the neck hyper-extended. This can be accomplished by placing a towel or blanket under the child's shoulders. Have your partner restrain the child's arms while you detach the ties and remove the tube. In one smooth motion remove the old tube. Gently insert the new tube, pushing back, then down, in an arcing motion. Immediately remove the obturator as you hold the tube in place with your finger. Fasten the trach ties securely.

Proper Removal

Proper Insertion



## PROPER, STEPWISE APPROACH TO TRACHEOSTOMY EMERGENCIES

A vigilant, well-trained caregiver is the best prevention for tracheostomy emergencies in the home. To be prepared, healthcare providers as a team need to know the risk factors, prevention strategies and the stepwise approach for each emergency. A child with a tracheostomy is at risk for a respiratory emergency at any time. The primary risks are difficult insertion, accidental decannulation, mucous plug, and water in the tube.

**Difficult Insertion:**

The risk factors include:

- A stoma that is scarred, distorted, or obscured by granulation tissue. Prevention: Daily assessment of the stoma. If a new granulation tissue or changes to the stoma occur, it may lead to a difficult insertion. Delay the tracheostomy change until the physician can assess the child.
- Tracheomalacia (soft tissue) or tracheal stenosis (narrowing). Prevention: Always use an obturator coated liberally with water-soluble lubrication prior to insertion attempt.
- Difficulty visualizing the stoma. Prevention: Maintain a clear field of vision by hyper-extending the neck, using a towel rolled under the shoulder blades, and swaddling the child if necessary. Always have a 2nd person available to help. Scheduling a trach change at shift change may accommodate two nurses being present in the home.
- Airway growths such as granulomas or papillomas. Prevention: Abort the tracheostomy tube change if significant resistance is met while attempting to remove the tube. Delay the tube change until the physician can assess the airway. Encourage parents to keep scheduled physician appointments so that problems can be detected before emergencies arise.

**The Stepwise Response for Difficult Insertion**

1. Confirm continuous pulse Oximetry monitoring of the child
2. Re-adjust the child's head position so that the neck is hyperextended and the stoma can be easily visualized.
3. Re-attempt insertion
4. If still unable to insert a new tube, try to re-insert the old tube that had been removed.
5. If unable to re-insert the old tube, attempt to insert a ½ size smaller tube. **If a smaller size is inserted notify the MD immediately. Do NOT attempt to re-insert a larger size.**
6. If unable to insert a ½ size smaller- **call 911**
7. If no tube can be inserted, cover the stoma and use a face mask attached to a resuscitation bag to ventilate the child. **NOTE: The child must have a functional upper airway to use a face mask during ventilation.**
8. If the child does NOT have a functional upper airway and is breathing spontaneously through the tracheostomy stoma, closely monitor the child's respiratory status while waiting for the ambulance.
9. If the child ceases to breath, mouth-to-stoma breaths must be delivered until emergency help arrives. **NOTE: If the child loses consciousness at any stage, muscles around the tracheostomy stoma and in the airway may relax to allow re-insertion of the tube. Use the obturator coated with a generous amount of lubricant during all attempts will facilitate successful tube insertion. Once a tube is successfully inserted, closely monitor the child's respiratory status.**
10. Document and report incident and outcome to the family, physician, and CHC office ASAP.

**Accidental Decannulation**

The risk factors include:

- Loose tracheostomy ties. Prevention: Tie or fasten tracheostomy ties securely so that only one finger fits between the child's neck and the tie.
- Trach sponges that are too thick. Prevention: Use a single thin drain sponge or thin foam dressing under the trach tube, especially on infants who require a small tracheostomy tube.
- The child pulls at the tracheostomy tube. Prevention: Discourage the child from pulling by making the ties as comfortable as possible; keeping the stoma clean dry and intact; distracting the child from awareness of the tube; and positively reinforcing the child's cooperation.
- Ventilator tubing that is not secured: Secure ventilator tubing safely to the child.

**The Stepwise Response for Accidental Decannulation**

1. Loosen the tracheostomy ties.
2. Adjust child's head so that neck is hyperextended.
3. Insert the same tracheostomy tube unless a clean same-size tracheostomy tube is immediately at hand.
4. Attach resuscitation bag and deliver breaths while listening with stethoscope.
5. Secure the tracheostomy ties.
6. Perform a complete respiratory assessment.
7. Document procedure and child's response in Craig HomeCare charting.

If the tracheostomy tube is partially or fully out of the stoma, don't panic. Most children can breathe through the stoma for a short time.

**Mucous Plug**

Secretions need to be removed from the tracheostomy tube to prevent respiratory distress in the child. As secretions collect, thicken and become dry, a mucous plug that obstructs the tube may form.

The risk factors include:

- Inadequate humidification. Prevention: Provide continuous airway moisture via a heat-moisture exchange unit (HME or "artificial nose") or a stationary humidifier. Ensure the client receives adequate dietary fluids.
- Infection. Prevention: Monitor changes in color, quantity and consistency of secretions. Increase frequency of suctioning as needed
- Dehydration. Prevention: Perform frequent assessments for adequate hydration. Maintain strict compliance to nursing orders regarding fluid administration.

**The Stepwise Response for a Suspected Mucous Plug**

1. Suction the child
2. If it is difficult to insert the suction catheter, perform an emergency tracheostomy tube change.
3. Apply a pulse oximeter probe and perform a thorough respiratory assessment to determine the child's need for supplemental oxygen.
4. Thoroughly document procedure and the child's response in Craig HomeCare charting.

**Water in the Tracheostomy Tube**

The risk factors include:

- Excessive water from humidification. Prevention: Empty water traps and prevent excess condensation from pooling in the tubing. Monitor the water temperature in the humidification reservoir. Monitor the temperature in the heated tubing.
- Swimming, water play and bathing. Prevention: Swimming is not recommended for children with tracheostomies. Never leave a child unattended or without a qualified caregiver. Never submerge a child while bathing.

**Note: As little as two teaspoons of water in the stoma can result in drowning.**

**The Stepwise Response for Water in the Tracheostomy Tube**

1. Quickly suction the child and assess respiratory status.
2. Administer oxygen as needed.
3. Use the child's prescribed coughing assistive device or provide chest percussion to stimulate the child's coughing reflex and effort.
4. Administer prescribed respiratory treatment, if needed, to relax or clear the child's airway.
5. Perform a thorough respiratory assessment and keep the child on a pulse oximeter until respiratory status returns to baseline.
6. Thoroughly document procedure and the child's response in Craig HomeCare charting

Of all of the tracheostomy emergencies, water accidents are the easiest to prevent. Keeping bath water shallow, prohibiting showers and swimming, and removing excess water from tubing will minimize the risk.

**The O2 Saturation is Falling!**

***Always check the child first!!!***

If the child appears to be in respiratory distress;

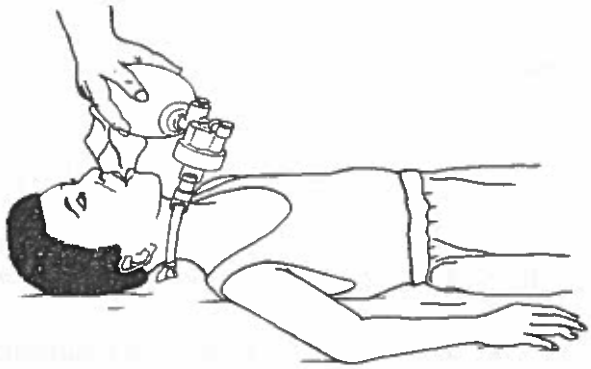
1. Quickly perform a respiratory assessment.
2. Suction and hand ventilate the child using an ambu bag
3. Auscultate breath sounds.
4. Perform emergency actions as needed.
5. Thoroughly document procedure and the child's response in Craig HomeCare charting

If the child appears to be in no respiratory distress:

1. Check the position of the pulse oximeter probe.
2. Check connections to the pulse oximeter.
3. Make sure the child is receiving prescribed oxygen if ordered- make sure O2 is turned on and tank is not empty.

The healthcare provider for a child with a tracheostomy must be prepared for emergencies. The cardinal rules are to ensure that all caregivers demonstrate competency in emergency procedures, have a clear plan for recognizing and treating each type of emergency, and stay calm while applying a step-by-step approach throughout execution of the plan. Preparation, prevention, and proper response to tracheostomy emergencies will significantly reduce errors and deaths in the home!

## CPR FOR THE CHILD WITH A TRACHEOSTOMY



Training in CPR is essential. Most pediatric cardiac arrests at home start with low oxygen levels (hypoxia) and progress to respiratory arrest and eventual cardiac arrest. Early detection of respiratory troubles can prevent a full cardiac arrest.

There are differences in CPR for infants and children with a tracheostomy. The tracheostomy tube will be the primary airway when performing CPR. The first step in resuscitation is to assess and establish a patent (open) airway by suctioning and giving breaths. The tracheostomy tube must be in place and free of secretions prior to starting CPR.

**NOTE: New CPR guidelines were released in October of 2010. The changes included "chest compression only CPR" for lay rescuers. Trained healthcare providers are still expected to provide breaths and compressions.**

**CPR for All Children with Tracheostomies**

1. Attempt manual ventilation using a resuscitation bag attached to the tracheostomy tube.
2. If the chest does not rise, change the tube immediately.
3. If a tube cannot be placed into the stoma, face mask ventilation is an option *if the child has a functional upper airway.* If not, mouth to stoma is performed.
4. Once breaths can be given, standard resuscitation sequence is followed.

**CPR- Infant**

1. Check for consciousness- gently tap the shoulder or flick the bottom of the heel.
2. **No response**- Have someone call 911. If alone, provide 2 minutes of care *before* calling 911.
3. **No breathing**- Suction the trach tube- if the tube has an inner cannula, remove it and suction the length of the trach tube. Change the trach if it is dislodged. Give 2 breaths to the trach, using a resuscitation bag.
4. **Breaths go in**- check for breathing and a pulse (no more than 10 seconds)
5. **Pulse but no breathing**- Begin rescue breathing. Place the resuscitation bag on the trach and give one breath every 2 seconds. Recheck for signs of life every few minutes but do not stop interventions.
6. **No pulse and no breathing**- Begin CPR. Position 2 or 3 fingers in the center of the baby's breastbone just below the nipple line. Compress the chest 1.5 inches in depth 30 times. Give 2 breaths using the ambu bag. Continue 30 compressions to 2 breaths cycle. Continue until another rescuer takes over or you see signs of life, or help arrives. NOTE: You no longer check pulse once CPR begins.

**CPR- Child Ages 12 and Under**

1. Check for consciousness. Gently tap the shoulder and shout
2. **No response**- Have someone call 911 – If alone, provide 2 minutes of care *before* calling 911
3. **No breathing**- Suction the trach tube. If the trach has an inner cannula, remove it and suction the length of the trach tube. Change the trach if it is plugged or dislodged. Give 2 breaths to the trach, using a resuscitation bag.
4. **Breaths go in**- Check for Breathing and a Pulse; Check for a pulse by sliding your 2 fingers into the groove on the side of the child's neck as you look for signs of life and breathing for no more than 10 seconds
5. **Pulse, no breathing**- Begin rescue breathing. Place the resuscitation bag on the trach and give one breath every 3 seconds. Recheck for signs of life every few minutes but do not stop interventions.
6. **No pulse, no breathing**- Begin CPR. Position the heel of one hand on the center of the child's chest, (if needed use two hands to compress the chest if the child is large). Compress the chest 2 inches in depth 30 times. Give two breaths using the resuscitation bag (continue with 30 compressions/2 breaths, 30 compressions/2 breaths. Continue CPR until another rescuer takes over, you see signs of life, or help arrives. NOTE: You no longer check pulse once CPR begins.

**CPR- Child 12 and Over**

1. Check for consciousness. Gently tap the shoulder and shout
2. **No response**- Call 911 - Important: If you are alone, CALL 911 BEFORE providing care.
3. **No breathing**- Suction the trach tube. If the trach has an inner cannula, remove it and suction the length of the trach tube. Change the trach if it is plugged or dislodged. Give 2 breaths to the trach, using a resuscitation bag.
4. **Breaths go in**- Check for breathing and a pulse. Check for a pulse by sliding your 2 fingers into the groove on the side of the child's neck as you look for signs of life and breathing for no more than 10 seconds
5. **Pulse, no breathing**- Begin Rescue Breathing. Place the resuscitation bag on the trach and give one breath every 3 seconds. Recheck for signs of life every few minutes but do not stop interventions
6. **No pulse, no breathing**- Begin CPR. Position the heel of one hand on the center of the chest. Place the other hand on top of the hand on the chest. With elbows locked and straight, compress the chest 2 inches in depth 30 times. Give two breaths using the resuscitation bag (continue with 30 compressions/2 breaths, 30 compressions/2 breaths). Continue CPR until another rescuer takes over, you see signs of life, or help arrives. NOTE: You no longer check pulse once CPR begins.

## OVERVIEW OF RESPIRATORY MEDICATONS

Respiratory medications are commonly prescribed for children with tracheostomies or mechanical ventilation. It is important for the care giver to understand the medications as well as the proper procedure for administration in order for the medications to be safe and effective.

**Common Pediatric Respiratory Medications:**

1. Bronchodilators- Used to treat and/or prevent bronchospasm and relax smooth muscles of the respiratory system. Examples include Albuterol Sulfate (Proventil, Ventolin) and Levalbuterol (Xopenex).
2. Corticosteroids- Preventative medication that works by reducing and preventing swelling and excess mucus in the airway cause by inflamation. Examples include Fluticasone Priopionate (Flovent), Beclomethasone Dipropionate (QVAR), and Budesonide (Pulmicort)
3. Mast Cell Inhibitors- Preventative medication that works by preventing allergy cells called mast cells from breaking open and releasing chemicals that help cause inflamation in the airways. An example is Chromolyn Sodium (Intal).
4. Mucolytics- Used to dry and/or thin secretions. An example is Mucomyst
5. Antibiotics- Used to treat infection. An example is Tobramycin Sulfate (TOBI).
6. Combination Drugs- A combination of two or more drugs, usually a bronchodilator with a steroid drug. Used to open airways, relax smooth muscle and treat or prevent inflammation. The combination drug creates a greater bronchodilating effect than when either drug is used alone. Examples include; Fluticasone Propionate & Salmeterol (Advair), and Ipratropium Bromide & Albuterol Sulfate (Combivent).

**Correct Sequence for Administration of Inhaler Medications and Rationale:**

1. Bronchodilators- Given first to relax the smooth muscles and open all the airways from the upper airway to the terminal bronchioles. A short acting systemic bronchodilator such as Albuterol can be followed by a short acting localized bronchodilator such as Atrovent.
2. Corticosteroids- Given next to reduce inflammation of the tissues within the airways. Corticosteroids such as Flovent, QVAR, or Pulmicort are often prescribed for the pediatric patient and should not be administered more often than prescribed.
3. Mast Cell Inhibitors and Mucolytics- These medications are most effective if given after the bronchodilators and steroids.
4. Antibiotics- Administration of antibiotic medications are most effective once all the airways have been opened and the inflammation has been reduced. This allows the medication to reach the most surface of the lung tissue.

## MECHANICAL VENTILATOR THEORY

Safe and effective home care for ventilator dependent children requires a thoroughly trained pediatric pulmonary team committed to the management of the moment-to-moment ventilatory needs of the child. The competent caregiver must be fully aware of the function of the ventilator as well as the appropriate response to alarms or emergency situations.

The purpose of mechanical ventilation is to promote gas exchange in the lung. It does so by producing positive intrathoracic pressure and positive airway pressure. This positive pressure may be delivered to the airway though a mask, cannula, or endotracheal or tracheostomy tube. The amount of gas exchange that takes place is then dependent on the resistance and compliance of the lung itself. The goals of positive pressure ventilation are to maintain adequate alveolar ventilation, correct hypoxemia, and decrease the work of breathing while providing adequate respirations and provide rest for the child.

Positive pressure ventilation is indicated for the child with respiratory or ventilatory failure. Hypoxemia, metabolic acidosis, respiratory acidosis, inadequate tissue oxygenation, and respiratory muscle are all signs and symptoms of respiratory or ventilatory failure. This may be due to acute or chronic lung injury, neurologic disorders, trauma, chemical or medical respiratory depressants, multi-organ system failure, or disease entities.

**Types of positive pressure ventilation**:

1. Pressure Control- This is primarily used with premature infants due to their fragile lungs. Pressures that are too high can cause lung damage. With pressure control you set the Peak Inspiratory Pressure (PIP) and inspiration ends when pre-set pressure is reached.
2. Volume Control- This is the most common type of ventilation. This is used most commonly with children who are chronically mechanically ventilated. In volume ventilation mode the Tidal Volume is set and the inspiration ends when the pre-set volume of gas is delivered.

**Modes of Ventilation**:

1. Assist/Control- The minimum guaranteed breath rate is set. The patient can *trigger* breaths, but all breaths are machine-delivered breaths. (There are no spontaneous breaths).
2. IMV (Intermittent Mandatory Ventilation)- Guaranteed, pre-set breath rate. With IMV there are three types of breaths: Mandatory (machine delivered), Assisted Mandatory (patient-triggered and machine delivered), and Spontaneous (patient delivered).
3. SIMV (Synchronized Intermittent Mandatory Ventilation). This mode is the same as the IMV mode, but the machine breaths are set with a minimum amount as well as allowing the patient to have spontanious breaths over the set amount.
4. CPAP (Continuous Positive Airway Pressure). In this mode all breaths are spontaneous (patient delivered). The ventilator delivers positive pressure to the airway to prevent collapse and atelectasis. This mode is often used in children with hypoxemia who do not respond to supplemental oxygen. CPAP and PEEP (positive end expiratory pressure) serve the same purpose; however, CPAP is a *mode* and PEEP is a *ventilator setting*.
5. BiPAP (Bi-level Positive Airway Pressure). In this mode there are two different pressures for inspiration (high) and expiration (low). Pressurized air maintains an open airway to assist work of breathing.
6. Pressure Support- A pre-set small amount of pressure from the ventilator during inspiration that assists patients with spontaneous breathing. This mode is often used during weaning to reduce the work of breathing while the patient breathes spontaneously.

## PROPER RESPONSE TO VENTILATOR ALARMS

The patient's physician will prescribe alarm parameters and ventilator settings. A respiratory therapist will set the ventilator according to the provider's orders, and monitors the equipment in the home. Most DME companies will have 24/7 support to manage equipment related emergencies. Nevertheless, caregivers must know how to respond to a ventilator, humidifier, and oximeter alarm.

Whenever a ventilator alarms, check the patient first. If the child is comfortable, check the ventilator to determine the source of the problem. If the child is uncomfortable, immediately ventilate the patient by ambu bag to stabilize the patient before trouble-shooting the machine. If secretions are present in the tracheostomy, the trach should be suctioned prior to ventilating with an ambu bag to prevent forcing secretions lower into the lungs.

**Types of Alarms, Causes, and Action:**

1. **Low pressure alarm**- This is a continuous alarm that protects the patient from prolonged low pressure. This alarm is usually set at 10-15 cm H2O below PIP but never lower than PEEP. This alarm is generated with the ventilator senses a decrease in pressure within the circuit. A low pressure alarm can be caused by decannulation, tubing disconnection from the patient or ventilator, open port (temperature probe, water trap, etc.), a large tracheal leak, or defective tubing or valve. It is important to determine that this alarm is set high enough that it will sound when decannulation occurs AND the trach tube is still connected to the ventilator circuit.
2. **High Pressure Alarm**- This is an intermittent alarm that protects patients from dangerously prolonged high pressures. This alarm is set at 10-15cm H2O above PIP. This alarm will sound when the ventilator senses an increase in pressure in the system. The alarm may be caused by a mucous plug or thickening secretions, kinked tubing, excess water in the tubing, partial decannulation, coughing, sneezing, hiccups, laughing, if the patient is breathing out of sync with the ventilator, bearing down, or straining.
3. **Minute Volume Alarm-** Minute Volume= RxVt. This alarm will occur when exhaled minute volume is falling. The main cause of this is decannulation! This alarm can also be caused by circuit leaks. **NOTE: This alarm is the failsafe for detecting decannulation. The lowest alarm setting is 0.1 and may not be adjusted or silenced without a physicians order. If this alarm is set at 0 it is possible for the patient to be decannulated and expire without the ventilator ever alarming.**
4. **Humidifier Alarm-** Humidifiers signal an alarm at temperature extremes. When an alarm sounds, check for incorrect temperature settings, 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 using an ambu bag until the defective equipment is repaired or replaced. Some children may require hospitalization if a ventilator cannot be repaired or replaced within an appropriate time.

**Alarming reality**: This document began with the premise that nearly 24 percent of home ventilated patient deaths are accidental. The appropriate and continuous use of alarms is the most important thing you can do to improve this statistic. Awareness and use of current best practices enable the provision of high-quality care in the home. 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 needs of children who are technology dependent.

## GLOSSARY OF VENTILATOR TERMS

**Bias Flow**- Flow through the ventilator circuit during the exhalation phase

**Exhaled Tidal Volume (VTE)**- The amount of air (measured in milliliters) passing through the ventilator circuit during exhalation

**Inspiratory/Expiratory ratio (I:E ratio)**- The amount of time the ventilator allows inspiration versus exhalation during the breath cycle.

**Inspiratory time (I Time)**- The amount of time the ventilator allows for delivery of a machine driven breath.

**Minute Ventilation**- respiratory rate times the tidal volume.

**Peak Inspiratory Pressure (PIP)**- The amount of pressure generated by the ventilator to deliver a breath to the patient. This is measured at the end of the inspiration phase.

**Positive End Expiratory Pressure (PEEP)**- The amount of pressure (measured in centimeters of water/cmH2o) maintained in the airways at the end of exhalation.

**Pressure Control**- The physician ordered setting which determines the maximum pressure allowed to be delivered by the ventilator with each breath.

**Pressure Support (PS)**- A pre-set amount of pressure within the ventilator circuit that assists the patient with spontaneous breaths.

**Rate**- The Number of breaths the ventilator delivers to the patient in one minute.

**Sensitivity**- The sensitivity determines the point at which ventilator recognizes that the patient is triggering a breath.

**Tidal Volume (VT)**- The amount of air (measured in milliliters) delivered by the ventilator to the patient in a ventilator driven breath. It is also the amount of air exchanged in each breath (from the beginning of the inspiration to the end of exhalation) by an individual.

# CRAIG HomeCare Clinical Competency

Nurse Name _____ Date(s) of Training _____

Instructions: Nurse Trainer demonstrates/explains skills/cares and initials "Trainer". The nurse being evaluated initials "Trainee" indicating competence and understanding of skill/care. Indicate how the nurse demonstrated that he/she was competent to provide that skill: on the Nikki Doll, on a patient, or by written test. Skills/cares that don't apply to current client assignment will be initialed by the Nurse Trainer in the "NA" section (These competencies will be assessed if the nurse accepts a client assignment requiring these cares).

| | Clinical Competency | NA | Trainer Initial | Trainee Initial | How demonstrated: doll(D)/patient(P)/verbal(V) |
|---|---|---|---|---|---|
| Gastrostomy Tube | Basics of gastrostomy tube cares | | | | D P V |
| | Gastrostomy feeding demonstrated: (Prior to feeding: wash hands, don gloves, check placment, vent GT, position patient, prime tubing, attach tubing to patient, administer feeding, disconnect tubing) | | | | D P V |
| | Gastrostomy tube change demonstrated: (Wash hands, don gloves, position patient, remove old dressing, empty baloon, remove tube, test fill new baloon, lubricate tube, insert tube, inflate baloon, check placement) | | | | D P V |
| | Other: | | | | D P V |
| | Gastrostomy feeding competency verified by written test | | | Score: | |
| Medications | Proper procedure for PO medication administration | | | | D P V |
| | Proper procedure for enteral medication administration | | | | D P V |
| | Proper procedure for IM medication administration | | | | D P V |
| | Proper procedure for IV medication administration | | | | D P V |
| | Proper procedure for inhaled medication administration | | | | D P V |
| | Proper procedure for PR medication administration | | | | D P V |
| | Proper procedure for SQ medication administration | | | | D P V |
| | 5 Rights of medication administration | | | | D P V |
| | Medication documentation proceedure | | | | D P V |
| | Medication procedure competency verified by written test | | | Score: | |
| Tracheostomy/Respiratory | Pediatric tracheostomy DVD viewed | | | | D P V |
| | Basics of tracheostomy cares | | | | D P V |
| | Changing tracheostomy ties | | | | D P V |
| | Demonstrates understanding of how to determine and measure suction depth | | | | D P V |
| | Tracheostomy suctioning demonstrated including suctioning both while inserting and removing sxn cath. | | | | D P V |
| | Verbalizes understanding of emergency supplies needed prior to tracheostomy change | | | | D P V |
| | Tracheostomy tube change demonstrated: (Establish a clean work surface, wash hands, don gloves, insert obturator into new trach, attach ties to new trach, place the prepared tube on a sterile field such as opened package, position patient with neck hyperextended, detach the old ties and remove old trach, insert new tube and immediately remove obturator while holdign tube in place, fasten trach ties securely) | | | | D P V |
| | Proper application of pulse oximeter probe | | | | D P V |
| | Cough assist competency demonstrated | | | | D P V |
| | Chest physiotherapy competency (CPT) demonstrated | | | | D P V |
| | Other: | | | | D P V |
| | Other: | | | | D P V |
| | Tracheostomy/Ventilator Test Completed | | | Score: | |

| | Clinical Competency | NA | Trainer Initial | Trainee Initial | How demonstrated: doll/patient/discussion |
|---|---|---|---|---|---|
| Ventilator | Patient specific ventilator DVD viewed | | | | D P V |
| | How to determine schedule of ventilation | | | | D P V |
| | Power source/charging the battery | | | | D P V |
| | Demonstrates understanding of ventilator settings: Vent Type, Mode, Rate, Tidal Volume, Pressure Control, Inspiratory Time, Pressure Support, Sensitivity, Alarm Settings, O2 | | | | D P V |
| | Assembly of ventilator/circuit | | | | D P V |
| | Understanding meaning of alarms: Low min vol, high pressure, low pressure, sensor disconnected, apnea, high O2, low O2, other specific to patient | | | | D P V |
| | Silencing alarms | | | | D P V |
| | Clearing alarms | | | | D P V |
| | Emergency procedures: Alarms/ambu bag use | | | | D P V |
| | Administration of O2 in line with ventilator | | | | D P V |
| | Appropriate response to power outage | | | | D P V |
| | Backup ventilator location | | | | D P V |
| | Other: | | | | D P V |
| Other | Venous access device (VAD) access and flushing | | | | D P V |
| | (VAD) access and flushing competency verified by written test | | | Score: | |
| | Urinary catheterization | | | | D P V |
| | Urinary catheterization | | | Score: | |
| | Seizure precautions | | | | D P V |
| | Understanding of seizure precautions verified by written test | | | Score: | |
| | Affecting patient outcomes | | | | D P V |
| | Understanding of role in affecting patient outcomes demonstrated by writen test: | | | Score: | |
| | Other: | | | | D P V |

FURTHER TRAINING NEEDS:

I have finished my clinical competency checklist and have had the oppurtunity to ask any questions or request further information. I have a clear understanding of the tasks and skills expected of me while carying out my current client assignment.

NURSE TRAINEE SIGNATURE _____ DATE _____

I have finished the training of this nurse to the above listed tasks and skills. This nurse has demonstrated competency in all of the skills or tasks as noted above.

TRAINING NURSE SIGNATURE _____ DATE _____

**TIME IN:** _____ **TIME OUT:** _____

THIS FORM MUST BE RETURNED TO THE OFFICE AFTER TRAINING IS COMPLETE.

***PLEASE NOTE: TRAINING WILL NOT BE PAID UNTIL COMPLETED FORM IS RECEIVED.***