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Protocol Issue

Special Dysphagia Supplement

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Welcome to Passy-Muir, Inc.'s *Aerodigestive Health*:

Protocols Impacting the Care of Patients with Tracheostomy and Mechanical Ventilation

Welcome to this issue of *Aerodigestive Health*. The focus of this publication is to provide educational and clinically relevant information for the safe and effective use of the Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve (PMV®). Each edition of Aerodigestive Health will provide articles and other resources on the care of patients who are tracheostomized, with or without mechanical ventilation. It is the editor's objective that Aerodigestive Health will provide readers with clinical perspectives and cutting-edge research to address specific questions raised by practitioners relating to use of the PMV.

In this edition, you will find key elements:

- Editor's Commentary – An overview of the publication topic
- Healthcare Practitioners' Perspectives – Articles by healthcare professionals on clinical issues
- Peer-Reviewed Published Research Studies – Top studies with summaries of each featured article
- Research Bibliography – A bibliography of the recent research related to care of patients with tracheostomies
- Clinical Take-Home Boxes – Relevant clinical information for healthcare practitioners, including protocols
- Special Supplement – Section on the impact of tracheostomies on swallowing in pediatric and adult populations

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For this issue, the primary focus is: *Protocols impacting the care of patients with tracheostomy and mechanical ventilation*. Working within the field of patients with tracheostomy and mechanical ventilation, the care of patients varies based on physician preference, facility policy and procedures, existence of a trach team, and several other factors. Because an acceptable, consistent standard of care does not exist, the issue of protocols and how other facilities establish a standard of care often arises. To best manage the complexity of working with these patients, developing a protocol for consistency and being familiar with best practice through the research is imperative.

A primary means for closing the system is to use the Passy Muir Tracheostomy & Ventilator Swallowing and Speaking Valve, a bias-closed position, no-leak valve. When a patient has a tracheostomy, airflow is directed in and out through the tracheostomy tube and bypasses the upper airway. Using the Valve allows a patient to breathe in through the tracheostomy tube and out through the upper airway (mouth and nose). The Valve works by closing at the end of inspiration, which redirects airflow upwards through the vocal folds and upper airway. Research has shown that this redirection of airflow assists with improving secretion management, increasing sensory awareness, improving swallowing, improving communication, restoring a pressurized system, and restoring natural physiologic PEEP (positive end-expiratory pressure), among other benefits.

This issue of *Aerodigestive Health* brings together a multidisciplinary perspective that presents protocols for establishing care from the intensive care units to home. The variety of healthcare professionals participating in this issue is broad and makes the issue a strong representation of multidisciplinary care. The authors include physicians, nurse practitioners, respiratory therapists, and speech-language pathologists. Their knowledge and skills combine to enlighten the reader on how to establish early interventions in the Intensive Care Units (ICUs), transition patients from the ICU to other levels of care, and transition to home. The focus is on protocols that have been established in their respective facilities to provide best practice for patients with tracheostomies. These protocols address the impact that is observed when using a PMV for closing the system and restoring more natural airflow through the upper airway.

A special, supplemental section of this edition is: *The impact of a tracheostomy on swallowing and the role of the PMV to improve functions*. These two articles discuss the potential negative impact of an open tracheostomy tube on swallowing and how closing the system restores functions that are critical to swallowing. The two articles provide an overview of swallowing for both the pediatric and adult populations, reviewing the impacts that occur due to changes in anatomy and physiology following a tracheostomy.

Each author emphasizes that team management is a key element when working with patients of any age following tracheostomy and mechanical ventilation; additionally, the management of an open tracheostomy tube by using a PMV provides multiple benefits that assist with transitioning patients through the levels of care and may improve swallowing. The primary take-away from this issue is that an established protocol improves team communication, patient care, and patient satisfaction.

Kristin A King PhD, CCC-SLP

About the Editor

Kristin King, PhD, CCC-SLP has been a speech-language pathologist in a variety of settings since 1995. She earned her PhD in Communication Sciences and Disorders from East Carolina University in 2008. Her expertise is in cognitive-communication and swallowing disorders with medically complex patients of all ages, particularly those with needs secondary to traumatic brain injury (TBI), tracheostomy/ventilator, and pre-term birth. Dr. King has published several peer-reviewed articles regarding evaluation and treatment of TBI, and she speaks to both domestic and international audiences regularly on the use of speaking valves, evaluation and treatment following TBI, and swallowing disorders.

Upcoming Issues:

If you have an interest in submitting or writing for one of our upcoming issues, please contact me at ***aerodigest@passymuir.com***. The upcoming topics include: home health care, communication and ethics, dysphagia, and therapeutic interventions (including early intervention and mobilization); however, we are open to accepting articles on other topics related to use of the Valve for patients with tracheostomy and ventilators.

Infants and Children with Tracheostomy and Ventilator Dependence in the Intensive Care Units: Candidacy and Early Intervention with a Bias-Closed, No-Leak Speaking Valve

Laura Brooks, MEd, CCC-SLP, BCS-S

Extensive research on the Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve (PMV®) exists within the adult population to support the benefits of voicing, secretion management, physiologic PEEP, swallowing, olfaction, quality of life, and weaning. However, working with infants and children, who have tracheostomies with or without ventilator support, can be more challenging than with adults due to multiple factors. Developmental factors, in combination with medical concerns, impact treatment considerations, but the research literature in the pediatric population is inadequate to provide sufficient evidence-based practices (Suiter, McCullough & Powell, 2003). Review of recent literature suggests that approximately half of all pediatric patients who receive a tracheostomy are younger than one year of age (Barbato, Bottecchia & Snijders, 2012; Lewis, Carron, Perkins, Sie & Feudtner, 2003). Early tracheostomy may lead to an opportunity for early application of the PMV that may otherwise be missed if the medical team does not have a clear understanding of practice guidelines for PMV application.

Because of the paucity of research in pediatrics, it is challenging to have consensus among physicians and clinicians regarding candidacy for Passy Muir® Valve application with medically complex infants and children. This is particularly difficult for infants in the Neonatal Intensive Care Unit (NICU), patients who are ventilator dependent, and individuals with airway compromise (i.e. stenosis or vocal fold paralysis). As a result, patients who may be a candidate for Valve placement may not receive this intervention due to physician concern for use in what is viewed as a higher risk population.

Therefore, it is critical that the speech-language pathologist has a thorough understanding of the ventilator and the patient's specific settings, how the PMV changes the mechanics of inspiration and expiration when on the ventilator, and medical co-morbidities that may compromise successful PMV application. The clinicians and facility should have a practice guideline in order to ensure consistent application of the PMV and to provide an understanding of any potential contraindications.

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Understanding the Ventilator

The PMV was invented for use in-line with ventilator circuitry (for patients who are ventilator dependent) by a patient who was ventilator dependent. It is a bias-closed, one-way Valve that allows inspiratory support from the ventilator and allows 100% of exhalation to occur out through the patient's nose and mouth. For best practice, the PMV is typically placed in the ventilator circuit and not directly on the tracheostomy hub. Placement of the PMV on the hub of the tracheostomy tube may create torque. If torque or movement of the tracheostomy tube occurs, there is a higher risk for potential tissue erosion, laceration of the skin, or an exacerbation of granulation tissue growth (Keens, Kun, & Davidson Ward, 2017). Because of the variety of hospital and home ventilators and circuits, clinicians and caregivers must understand the differences between them and the level of support that the patient is receiving from the ventilator.

Some ventilators are designed for use with patients in intensive care units. These ventilators are precise and most frequently used for higher risk patients, who require more ventilator support. Home ventilators, such as the LTV and Trilogy, are more portable, less expensive, and may be used for patients transitioning from the ICU to the acute care floor and then to home. Pediatric candidates for home ventilators are children who have relatively stable ventilator settings, with lower FiO_2 (<40%) and peak inspiratory pressure (PIP) (<40 cmH_2O) (Keens et al., 2017).

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When working with patients on mechanical ventilation, an understanding of the ventilator settings and patient parameters is essential for all healthcare professionals. There are two primary types of ventilation: pressure controlled and volume controlled. A physician orders the type of ventilation, depending on the patient's needs. The following terms are some of the common terms related to the care of a patient on mechanical ventilation with which the healthcare professional should be familiar:

Breath Types:

Volume breath: Ventilator delivers a pre-set volume, regardless of the pressure required to do so. Volume is constant, whereas pressure is variable (pressure varies depending on lung compliance/resistance).

Pressure breath: Ventilator delivers a pre-set pressure over a pre-set inspiratory time. Pressure is constant, whereas volume is variable (volume varies depending on lung compliance/resistance).

Common Modes of Ventilation:

Pressure Control Ventilation (PC or PC/PS): Ventilator delivers a predetermined number of breaths per minute, with a pre-set pressure over a pre-set inspiratory time. Pressure support may be provided during spontaneous breathing on some ventilators.

Assist Control (A/C): Ventilator delivers a predetermined number of breaths per minute, using either a specified volume or pressure. All triggered breaths are fully supported.

Synchronized Intermittent Mandatory Ventilation with Pressure Support (SIMV/PS): Ventilator delivers a predetermined number of breaths per minute using either a specified volume or pressure. Pressure support is provided during the spontaneous breath.

Pressure Regulated Volume Control (PRVC): Ventilator adjusts the pressure delivered during each breath to ensure target volumes are delivered.

Pressure Support with Continuous Positive Airway Pressure (PS w/ CPAP): Continuous positive airway is maintained during exhalation, while each spontaneous breath is supported with a set pressure.

Ventilator Settings (what the physician orders):

Breath types:

Pressure breaths: Physician orders set pressure.

Volume breaths: Physician orders set volume.

Positive End-Expiratory Pressure (PEEP): Amount of pressure that remains in the lungs at the end of exhalation.

CPAP: Continuous positive airway pressure.

Pressure Support (PS): Positive pressure provided during a spontaneous breath.

Respiratory Rate (RR): Number of breaths per minute delivered by the ventilator.

Fraction of Inspired Oxygen (FiO_2): Percentage of oxygen the ventilator delivers. For reference, room air has FiO_2 of 21%.

Tidal Volume (Vt): Volume of gas inhaled with each breath, recorded in cc/ml. Physicians prescribe tidal volume using ideal body weight and lung pathology.

Other:

Peak Inspiratory Pressure (PIP): Highest level of pressure applied to the lungs during inhalation.

End-Tidal Carbon Dioxide ($EtCO_2$): Capnograph measures exhaled CO_2. This value can either be found on the ventilator or on a separate machine. $EtCO_2$ readings may indicate the quality of ventilation or cardiac output and is the gold standard to confirm endotracheal tube placement.

Partial Pressure Carbon Dioxide ($PaCO_2$): Measured from an arterial blood sample. Normal values range from 35-45 mmHg.

Inspiratory Time/I-Time: Duration of inspiration in seconds.

Indications for the Tracheostomy

When working with this patient population, it is important to understand the indications for a tracheostomy. The disease process and reason for tracheostomy may impact the timing of intervention as it relates to PMV use. With infants and children, several causes may lead to a tracheostomy. Three main categories of tracheostomy indications include airway obstruction, lung disease, and neuromuscular/neurological involvement. These categories include, but are not limited to, chronic obstruction within the airway, such as choanal atresia, subglottic stenosis, tracheomalacia, laryngomalacia, and bronchomalacia;

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vocal cord paralysis, leading to chronic aspiration or poor pulmonary toileting with an inability to clear secretions; severe CNS (Central Nervous System) impairment, such as seen with Arnold-Chiari malformation, Werdnig Hoffmann disease, and Congenital Hypoventilation Syndrome; craniofacial anomalies, such as seen with Pierre Robin sequence and Treacher Collins, Beckwith-Wiedemann, and CHARGE syndromes; and chronic lung disease, including bronchopulmonary dysplasia (Shaker & Mutnik, 2012). Timing of interventions and establishing access to the upper airway for communication, speech-language development, cough, and other pulmonary functions is crucial. Early intervention and use of a PMV provides benefits which may assist in the recovery process.

If the patient has neurologic indications for a tracheostomy, but the lungs are healthy and the muscles are weak, these patients generally do not require frequent changes in ventilator settings (Keens et al., 2017). For patients with upper airway anomalies requiring a tracheostomy, the ability of the patient to adequately exhale around the tracheostomy tube is of concern and would need to be considered during the evaluation. This diagnosis may even require a Direct Laryngoscopy and Bronchoscopy (DLB) to be performed by the otolaryngologist. This assessment would address the severity of the obstruction. Because of the wide variety of causes for a tracheostomy, the history provides crucial information which may impact the assessment process.

Understanding the Impact of a Cuff and Its Proper Management

Generally, uncuffed tracheostomy tubes are the preferred tracheostomy tube type for children. However, patients with severe restrictive lung disease or neuromuscular disease require a high pressure be delivered, and it is done more effectively with the cuff inflated (Hess & Altobelli, 2014). Previously, only uncuffed tracheostomy tubes were available for pediatrics, but in the past decade, cuffed tracheostomy tubes have become more popular (Watters, 2017). The choice of cuffed versus uncuffed tracheostomy tubes is usually institution or patient dependent. The uncuffed tracheostomy tube has benefits not observed in cuffed tracheostomy tubes, such as reducing the incidence of acquired tracheal wall injury (Hess & Altobelli, 2014) and improving phonation (DeMauro et al., 2014; Cowell, Schlossler, & Joy, 2000).

The patient with an uncuffed tracheostomy tube also may have less difficulty with the application of the PMV as there is less change in the exhalation physiology. Typically, a patient inhales and exhales through the tracheostomy tube, which is either cuffed or cuffless. Cuffed trach tubes must be completely deflated prior to PMV application, and the deflated cuff material may still cause some resistance when exhaling (Beard & Monaco, 1993). A tight to the shaft (TTS) tracheostomy tube or uncuffed tracheostomy tube may allow for more space in the tracheal lumen for exhalation out through the mouth and nose. When the PMV is placed, a child still inhales through the Valve and tracheostomy tube, but the Valve closes at the end of inspiration and redirects airflow out through the upper airway, mouth, and nose. For children, the most common reasons for PMV success involve both physiologic and behavioral factors (Lieu, Muntz, Prater, & Stahl, 1999). As such, uncuffed tracheostomy tubes can help prepare the patient physiologically and behaviorally for the change in exhalation. Additionally, an uncuffed tracheostomy tube has the potential to allow the patient to sense the secretions in their pharynx, resulting in a swallow or cough in response. One study with critically ill patients with a tracheostomy, who were randomized to groups, found that deflating the tracheostomy tube cuff shortened weaning time, reduced respiratory infections, and improved swallowing (Hernandez et al., 2013).

Another Consideration: Ventilator Circuits

When working with a patient who is ventilator dependent, the speech-language pathologist (SLP) and the respiratory therapist (RT) must be familiar with the different ventilator circuits that may be used. The type of circuitry will dictate the type of adapters that may be needed for successful placement of the PMV in-line with the ventilator circuit. The types of adapters are usually either a 15/22 mm step-down adapter or a 22mm silicone adapter (*see Image 1*).

It is important to understand the different circuits and know whether the patient is on a single limb circuit or double limb circuit. In addition, the team should be aware if the circuit is a passive circuit or an active circuit. An example of a ventilator that has both an active and passive circuit that is used often in pediatrics is the Trilogy. Both circuits are single limb circuits. The passive circuit has the whisper swivel valve, and the active circuit has a mushroom valve for exhalation. With the passive circuit, the PMV is used with patients who require pressure ventilation. With an active circuit, the PMV is used with patients who are volume ventilated.

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Image 1

PMV-AD1522™ Step-down Adapter (on left):
Color coded for use with the PMV® 007 (Aqua Color™), the adapter provides a secure connection between the Passy Muir Valve and ventilator tubing, closed suction systems, or other adapters. 15mm OD – 22mm ID.

PMV-AD22™ Flexible Silicone Adapter (on right):
Color coded for use with the PMV® 2001 (Purple Color™), the adapter provides a secure connection between the Passy Muir Valve and tubing, closed suction systems, or other adapters. Stretches to fit 22mm.

The SLP and the RT work together as a team and rely heavily on the expertise and support of the other team members when determining patient candidacy, problem solving ventilator application, and evaluating and treating the patient for Valve use. For successful application and early intervention in critical care, all team members should have extensive understanding of PMV use; otherwise, there may be roadblocks to early application of the Valve on a patient who is ventilator dependent. While the SLP should be educated on ventilator settings, modes, and circuits to help advocate for application of the PMV, the SLP relies on the expertise of the RT for ventilator adjustments and patient safety. The RT relies on the SLP to provide assessment of voice, swallowing, speech and language skills, and cognition.

Application of the PMV:
How to Maximize Safety and Success

Understanding the value of the PMV application for patients and the benefits that may be achieved assist with improved patient use and care. However, many patients are underserved due to a lack of clinician and physician consensus for understanding the range of benefits and for determining candidacy. Members of the medical team may ask such questions as: is this patient too young? Too small? Too sick? On too much PEEP? Can the patient tolerate the PMV with any degree of airway obstruction or narrowing?

The benefits of using a bias-closed, one-way valve have been reported in the literature and include access for the infant to be able to communicate via cries and other sounds; have improved taste and smell; generate subglottic pressure for cough, cry, and swallowing; reduce the potential for further vocal cord dysfunction; restore laryngeal/pharyngeal sensation; and improve secretion management (O'Connor, Morris, & Paratz, 2019; Hull, Dumas, Crowley, & Kharasch, 2005; Torres & Sirbegovic, 2004). Abraham (2009) investigated the use of a PMV in children and reported that children wearing a Passy Muir Valve during waking hours normalized secretion management within two weeks due to improved sensation of secretions. Benefits also were reported for reduced time to decannulation and restored physiologic PEEP, which led to diminished WOB (work of breathing) (Hull et al, 2005; Torres & Sirbegovic, 2004; Sutt et al., 2016).

Review of the current literature supports safety of PMV application with certain patients, depending on the medical comorbidities. Passy Muir Valves have been used with both pediatric and adult populations, with the PMV being used with infants as young as one day old and within the NICU (Torres & Sirbegovic, 2004). Some specialists may have concerns that an infant's airway is too small and will not have enough room around the tracheostomy tube (Torres & Sirbegovic, 2004). However, the concerns related to upper airway patency may be assessed in two different ways: visual observation by the otolaryngologist via DLB and testing with manometry. If it is determined initially that the patient's upper airway is not patent via endoscopy or manometry, then the infant should be followed and retested, as appropriate, during their admission. Retesting is warranted because an infant or young child may have significant improvement in airway patency secondary to changes in age, weight, or growth which may affect the size of the trachea.

Once it is established that the patient is a good candidate and has a patent upper airway, additional criteria are considered. For Valve placement, the following criteria may be considered for patients who are ventilator dependent:

a. The patient must tolerate cuff deflation. Set the patient up for success by slowly deflating the cuff. Some patients may even require deflation to take place over several minutes to adjust to the change in airflow (Hess & Altobelli, 2014).

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b. PMV, in the pediatric population, should be trialed following the patient's first trach change. The first trach change is often done by the surgeon as the immature stoma poses some risk for damage (Hess & Altobelli, 2014).

c. The patient must be hemodynamically stable.

d. Contraindications for PMV application:

   i. Significant upper airway obstruction (e.g. grade 4 subglottic stenosis).

   ii. Thick secretions.

   iii. Foam-filled cuff, as these cuffs cannot be safely deflated (Hofmann, Bolton, & Ferry, 2008).

   iv. With the Trilogy ventilators: For the passive circuit, use the PMV with patients who require pressure ventilation. With an active circuit, use the PMV with patients who are volume ventilated.

e. FiO2 < 50%

f. PEEP $\leq$ 10 cmH_2O

g. PIP/PAP= $\leq$ 40 cmH_2O

* *some variation exists between facilities (e.g. some use PEEP of 12 or less).*

It is recommended that the medical team continue to apply heated humidification. However, a heat-moisture exchanger (HME) should not be used with the PMV, as no exhaled gas passes to the HME through the tracheostomy tube when the Valve is in place (Hess & Altobelli, 2014).

When using the Passy Muir Valve during mechanical ventilation, respiratory therapists may make some adjustments, under physician direction, to improve patient comfort and safety. Some common and simple adjustments may include:

Reduction or elimination of PEEP:
The establishment of a closed respiratory system and exhalation through the oronasopharynx restores physiologic PEEP. This enables the clinician to reduce or eliminate set mechanical PEEP (Sutt et al., 2016). This adjustment may also eliminate any unnecessary continuous airflow within the circuit. Continuous flow in the circuit may make it difficult for the patient to close the vocal cords and may stimulate continuous coughing and auto-triggering of the ventilator.

Volume compensation:
For patients with inspiratory volume loss, after cuff deflation, additional Tidal Volume (Vt) may be provided until baseline Peak Inspiratory Pressure (PIP) is reached. When considering use of a PMV with mechanical ventilation, factors such as inspiratory support may be managed by ensuring the patient achieves baseline Peak Inspiratory Pressures.

Alarm adjustments:
All alarms on the ventilator must be re-evaluated for appropriate adjustments before, during, and after use of the Valve. Proper alarm management is essential for patient safety and best standard of care.

Options for alarm management are dependent upon facility policy. Patient safety is the priority and proper management of the ventilator is key. With clear understanding of the ventilator and the changes that the PMV applies to the respiratory system, the members of the care team may advocate for adjustments for best practice and improved likelihood of patient satisfaction and comfort (ordered by the physician). It is recommended that a procedure be in place to identify when settings were changed. Proper documentation allows for the ventilator to be returned to the baseline settings when the PMV is removed.

Manometry: Measuring Transtracheal Pressure and Ensuring Airway Patency

To address the issue of the airway and atypical airflow, the step of assessing airway patency with manometry may provide information to the medical team regarding the patient's ability to exhale adequately around the trachea. If there is obstruction and the patient cannot adequately exhale, pressure can incrementally increase with each breath, known as breath stacking or air trapping (Hess, 2005; Hofmann et al., 2008). Additionally, a higher end-expiratory pressure reading with manometry may indicate patient discomfort, even if the patient is not breath stacking.

For medically complex infants in ICUs, initiating Transtracheal Pressure (TTP) testing as part of every PMV assessment is a helpful tool for objective feedback to physicians and the team regarding safety and readiness for Valve application. Transtracheal pressure testing equipment includes a manometer to be applied within the ventilator circuit with O_2 tubing and an adapter. Adapters, such as the 15/22mm step-down adapter or a 22mm silicone adapter (*see Image 1*), may be added into the circuit as well

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as aiding proper fit of the Valve. The assessment team, typically respiratory therapy and speech-language pathology, determines how to place the Valve into the circuit, with and without the manometer.

Image 2

Transtracheal Pressure (TTP) measurement equipment with Tracheostomy P.A.M.™ (Pediatric Airway Model).

A TTP value is the number at the end of the exhalation or end-expiratory pressure with resting breaths only. This reading provides the patient's physiologic PEEP (positive end-expiratory pressure). When placing the PMV, a closed system is reestablished which restores a more normal physiologic PEEP, as compared to the PEEP provided by the ventilator. An adequate TTP reading provides feedback to the team that the airway is patent, and the patient may adequately exhale around the tracheostomy tube. The pediatric population presents a special challenge during evaluation because any movement or vocalization will increase the pressure and compromise the ability to read resting breaths. If an infant is crying, moving, vocalizing, or pushing, the pressures will be increased, and it will not be an accurate reading. Challenges with pediatrics occur not only because of the smaller anatomy but due to the difficulties with following specific directions, such as "just breathe" or "don't move."

One option to address these issues is to obtain TTP readings while the patient is sleeping in order to test true resting breaths, as the measurement can be taken in as little as 20 seconds. However, the team should consider that despite current literature supporting application of the PMV during sleep (Barraza et al., 2014), use of the Valve during sleep is an off-label use. Alternatives to placing the Valve for TTP measurement during sleep is to catch the child in either a drowsy state or to distract with toys or videos.

Another consideration is the current discrepancy as to what value is deemed acceptable, meaning what TTP reading or number demonstrates that the airway is patent, and the patient may comfortably and adequately exhale around the tracheostomy tube. An early study suggested that a tracheal pressure greater than 5 cmH_2O during passive exhalation may indicate excessive expiratory resistance (Hess, 2005). However, most studies have reported that pressures in the range of 2-6 cmH_2O indicate a patent airway and that assessment for use of the Valve may occur (Barraza et al., 2014; Buswell, Powell, & Powell, 2016). Additionally, recent research has indicated that children with end-expiratory pressure up to 10 cmH_2O may tolerate the Valve (Utrarachkij, Pongsasnongkul, Preutthipan, & Chantarojanasri, 2005). In an earlier study, Trotter (1995) found accurate predictions for success with the PMV occurred when patients' end-expiratory pressures were 15 cmH_20 or lower. Trotter also indicated that SpO_2 was not a good predictor for Valve use. The literature provides a range of airway patency measurements at which predicting success for Valve use has occurred. The use of TTP is one method for providing an objective measurement that may assist with evaluating patients and may identify potential airway difficulties or even successes. Due to the range of measurements, further research is warranted.

Obtaining an accurate TTP reading requires a good understanding of respiratory and ventilator basics, such as PIP and PEEP, and the differences between ventilators and circuits. Therefore, it may be helpful initially to test airway patency via manometry to obtain baseline measurements without the PMV. Generally, the manometer, without the PMV in place, will read PIP (inspiration) to PEEP (peak end-expiratory pressure) values, which are similar to what is set with the ventilator. For example, if the patient's ventilator is set to a PEEP of 8 cmH_2O and a PIP of 20 cmH_2O, the manometer should fluctuate between 8-20 cmH_2O with each breath. This consistency may provide a means of calibrating the TTP and identifying accurate readings. Although, at times, the PIP value on the manometer may be slightly lower than the ventilator PIP, such as when there is an exhalation valve, as seen with the Trilogy.

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Once the SLP and RT obtain a patient's manometry baseline, the PMV is placed in-line with the manometer and adapters. With resting breaths only, the TTP reading is the value at the end of exhalation. While this process may seem simple, in actuality, it is challenging to get accurate readings without proper training. The numbers may be misread, especially if a clinician is not familiar with the ventilator, respiratory function, or manometry readings. Importantly, the clinician should not initially read the high number as the inhalation or PIP and the low number as the exhalation or PEEP. In fact, with initial placement, a high number may be the exhalation, but once the patient settles and resting breaths are measured, the high number may be the PIP. It is helpful to watch the baby or child and the manometer for indicators. The RT also contributes information from the ventilator by monitoring inhalation via the ventilator and providing an indication when the patient is at the end of exhalation. Marking the end of exhalation provides a more accurate reading for expiratory pressure. Watching the infant's chest rise and fall provides relevant information as well. TTP readings may be impacted by position and state, so pressures may need to be retested if the child is moving, agitated, crying, or engaging in other activities that may interfere with readings. Because of the factors that may impact TTP measurements, the SLP and RT may need multiple sessions to get a proper measurement.

If the pressure is too high, breath stacking occurs, or discomfort is visible during exhalation through the nose and mouth, the following should be considered:

1. Repeat the DLB/endoscopy to examine the airway.
2. Downsize the tracheostomy tube (Mehta & Chamyal, 1999).
3. Change from a cuffed tracheostomy tube to an uncuffed one (Hess, 2005).

It should be noted that even if the airway is patent, other factors can interfere with use of the PMV. Therefore, the SLP and RT must offer the opportunity to use the Valve safely and consistently (Hull, 2005).

A Facility's Guideline to Passy Muir Valve Application and Best Practice

With limited research on PMV application in the pediatric, medically complex, ventilator-dependent population, it is recommended that facilities develop best practice guidelines for PMV application. Often these guidelines have input from and are approved by pulmonology, otolaryngology, respiratory therapy, and speech-language pathology, among other specialties. To provide best practice and state-of-the-art care for the medically complex, pediatric patient with tracheostomy or ventilator dependence, it is essential that the clinical professionals be familiar with all aspects of respiratory function, including appropriate interventions and assessments, to enhance access to and use of the PMV.

This sample guideline provides suggested steps for patient selection; proper ventilator and alarm considerations; and assessment and application processes for use of the PMV in the pediatric patient population:

I. PROCEDURE:

A. Criteria for candidacy:
   a. Placement after first trach change.
   b. Tolerance of cuff deflation.
   c. Being hemodynamically stable.
   d. Physician to review the most recent airway examination and determine if follow up is needed, before Valve placement.
   e. Physician to consider indication for tracheostomy, size of tracheostomy tube, and upper airway obstruction to determine if a patient is a candidate for Valve placement.
   f. Patient's age and weight.
   g. Contraindications:
      i. Significant upper airway obstruction per ENT or pulmonology.
      ii. Copious, thick secretions.
      iii. Foam-filled cuff.
      iv. Airway stenting.

B. Ventilator parameter recommendations for candidacy:
   a. $FiO_2 < 50\%$
   b. PEEP $\leq$ 10 cmH_2O
   c. PIP/PAP < 40 cmH_2O

C. Application of PMV for patients who are on a ventilator.
   a. Physician to order:
      i. Passy Muir Valve trial (Respiratory order) through SLP consult.
      ii. SLP conducts bedside evaluation, in conjunction with respiratory therapy.
   b. Supplies for in-line placement *(see Image 1)*.

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c. Pressure testing supplies *(see Image 2)*.
d. Position patient upright.
e. Observe baseline vitals.
f. Oral care and suctioning, as needed.
g. RT to:
    i. Deep suction tracheostomy, if needed.
    ii. Observe PIP and exhaled Vt.
    iii. Deflate cuff slowly.
    iv. Suction trach and mouth again, as needed.
    v. Look for loss of exhaled Vt.
    vi. Observe changes in vitals, color, work of breathing, and signs of stress.
h. Proceed, if tolerating the above steps.
i. Apply PMV and transtracheal pressure manometry in-line with the ventilator circuitry (not directly to the tracheostomy hub so as to avoid torque) with adapters and pressure testing supplies. Monitor transtracheal reading/pressure testing, which measures end-expiratory pressure.

D. Application of PMV for patients with tracheostomy tube only (without a ventilator)
a. Physician order.
b. SLP conducts bedside evaluation for use of PMV, in conjunction with RT, for initial placement.
c. Pressure testing supplies *(see Image 2)*
d. Position patient upright.
e. Observe baseline vitals.
f. Oral care and suctioning, as needed.
g. RT to deep suction trach, if needed.
h. Slowly deflate cuff.
i. Suction trach and mouth again, as needed.
j. Observe changes in vitals, color, work of breathing, and signs of stress.
k. Support tracheostomy tube neck flange with one hand and gently apply PMV and transtracheal pressure manometry to the tracheostomy hub, using a gentle quarter turn twist to the right to seat the Valve on the tracheostomy hub. To remove, support the tracheostomy tube neck flange and turn to the right, while using a gentle pulling off motion.
l. Monitor transtracheal reading/pressure testing, which measures end-expiratory pressure.
m. Monitor stability.
n. Pressure reading values:

Likely Pass: Resting TTP < 10 cmH_2O	**10-20 cmH_2O, Borderline**	**Possible Fail: Resting TTP > 20 cmH_20**
1. Action: Proceed with PMV trial. **a.** Children with mean TTP < 5 cmH_20 are more likely to proceed to full tolerance status. **b.** Children with mean TTP 5-10 cmH_2O- likely to cope with longer 1:1 supervised trials.	**1. Action:** Proceed with short trials with SLP, as tolerated. **2.** Closely monitor for work of breathing or stress signs.	**1. Action:** Review possible confounding effects. **a.** If deemed inaccurate, action is to retrial. **b.** Contact ENT. Next steps may include assessment of upper airway or downsizing tracheostomy tube.

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E. Signs that the patient has not tolerated the Valve
   a. Significant change in vitals with cuff deflation or Valve placement.
   b. Stress signs, such as changes in color or increased work of breathing.
   c. High-pressure testing with TTP.
   d. If a "whoosh" sound occurs when the Valve is removed following resting breaths, there is a concern for breath stacking.

F. Additional information:
   a. The patient may cough because of an increased sensation of secretions. This type of cough is not a sign of poor PMV tolerance.
   b. Oxygen may be delivered via T-piece, trach collar, PMV oxygen adapter, or ventilator.
   c. Humidity may be provided via a tracheostomy collar or T-piece. Humidification does not affect the function of Valve.
   d. Alarms may need to be adjusted or managed by RT with physician orders.

G. Following the PMV trial
   a. Either the SLP or the RT will document the patient's ability to wear the Valve.
   b. The SLP, RT, and ordering physician will determine the plan for ongoing Valve trials, and the physician will write any appropriate orders.
   c. Ongoing pressure testing will likely not be completed, unless concerns are noted.

PMV® 007 (Aqua Color™)

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From ICU to Home Care: A Protocol for Transitioning

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The Tracheostomy and Home Ventilator Program at Children's Hospital of Wisconsin is primarily comprised of children with a history of prematurity, severe bronchopulmonary dysplasia, and airway abnormalities. The care team includes neonatal and pediatric intensivists, pulmonologists and otolaryngologists, along with other consulting services. Additionally, the child is followed by the Trach/Vent Team comprised of RN (registered nurse) care coordinators, respiratory therapists, social workers, and discharge planners. The team meets weekly with the family and bedside nursing staff to outline progress towards discharge.

This population of children begin their journey with a tracheostomy tube in the Neonatal Intensive Care Unit (NICU). Historically, all children with ventilator dependence required transfer from the NICU to the Pediatric Intensive Care Unit (PICU) to complete family and caregiver training for ventilator management prior to discharge. While these were generally planned transfers, there were instances when the NICU bed census was at a maximum, and these older, chronic, and medically stable children were urgently transferred from NICU to PICU. It was identified that NICU to PICU transfers, especially urgent transfers, resulted in increased caregiver dissatisfaction, which subsequently led to consultations with patient relations regarding the difficult transfer process. Family feedback regarding the process included concerns such as "staff doesn't know my child," "we feel alone in the new unit," and "this unit is such a different feel than the NICU." These concerns were mirrored by nursing staff and leaders in the PICU, who felt that families were not properly prepared for the PICU environment and expectations, which differed from the NICU.

The need for clearer guidelines which outlined the transfer process and improved handoff between the NICU and PICU was well-established. Over a two-year period, multiple revisions were developed and streamlined for the transfer process. These changes included the ability to discharge children who are ventilator-dependent from the NICU. This change required additional education sessions on both home ventilators and on discharge planning and teaching for patients with ventilator-dependence. This additional education was provided to all NICU nursing and physician staff. The last revision resulted in the following criteria and transfer guidelines:

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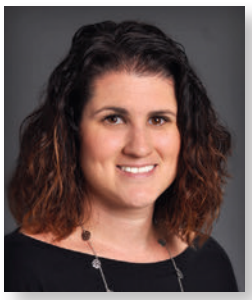

Clinical Criteria for Bed Placement:

Criteria for patients to remain in and discharge to home from the NICU:

1) Tracheostomy only patient.
2) Tracheostomy-dependent patient who is tolerating trach collar trials and may still be requiring low vent settings.
3) Patient is <6 months post-gestational age.

Criteria for patients to transfer to and discharge to home from the PICU:

1) Any patient who is anticipated to require 24 hour per day chronic ventilation when all the following criteria are met.
   a. The first tracheostomy change is completed (5-7 days following tracheostomy placement).
   b. NICU team feels comfortable with all of the patient's neonatal concerns.
   c. The patient is nearing the point of transitioning to the home ventilator.

   Or

2) Patient > 6 months post-gestational age and still requiring any ventilator support.

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Handoff and Transfer Process:

1. Trach team identifies patient who meets clinical criteria for transfer.
2. Initial email is sent to PICU and NICU leaders to start transfer planning.
3. The family is updated about the process of transferring (graduation) from NICU to PICU.
4. A handoff, in-person care conference is held the week of transfer with NICU and PICU teams (RN and MDs), Trach/Vent team, and family to outline the patient's history and current plan of care and outline goals for transfer.
5. A standardized tour of the PICU is provided by PICU leadership staff for the patient's caregivers.
6. A formal date is set for transfer and agreed upon by PICU, NICU, and family.

This updated process has been standardized and in use for over six months with very positive feedback from families, as well as NICU and PICU staff and leadership teams. A decrease in the volume of caregiver frustrations and patient relations consults has been observed. Family comments regarding this new process have included, "the transfer to the PICU was a positive experience", and "I felt like the PICU team knew my child." The staff in the PICU also have reported decreased frustration with unplanned transfers to the unit, as well.

Future goals to continue to improve this process include:

1. Addition of a graduation certificate for all NICU graduates upon transfer.
2. Standardized form used by PICU leaders when rounding with families.
3. Process map for transfer to be used with NICU/PICU leaders that clearly outlines operational steps in bed placement.

Caregiver satisfaction and patient experience continues to be a goal within the tracheostomy/home ventilator program. Our concentrated effort to improve our patient experience with a standardized transfer process has led to a decrease in patient relations consultations, as well as improved staff satisfaction.

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Delivering Complex Care for Complex Children: A Multidisciplinary Approach

Matthew T. Brigger, MD, MPH | Kimberly Morris, MS, CCC-SLP, BCS-S, IBCLC

An increasingly visible trend exists regarding efforts to improve the care of children with complex aerodigestive disorders. For many years and a variety of reasons, children with complex disorders have often been cared for in tertiary referral centers. Such centers have provided the availability of a wide range of subspecialty care. Multidisciplinary care centers have existed for many years to treat children with craniofacial anomalies, cystic fibrosis, and cancer. However, recently, pediatric aerodigestive centers have had increasing visibility and marketing presence. As such, it is important to understand who is involved, why such centers exist, and what it means.

Complex Care for Complex Children

Children with upper aerodigestive issues have a wide range of presentations, as well as degrees of severity. The spectrum of such disorders ranges from simple allergic rhinitis, associated with mild asthma, to tracheostomy-dependent former NICU graduates with a limited pulmonary reserve and a myriad of congenital anomalies. Regardless of the severity of such disorders, these children require care by a variety of both generalists and specialists.

The consensus statement by Boesch et al. (2018) provided an excellent description of the pediatric aerodigestive patient as:

> A child with a combination of multiple and inter-related congenital and/or acquired conditions affecting airway, breathing, feeding, swallowing, or growth that require a coordinated interdisciplinary diagnostic and therapeutic approach to achieve optimal outcomes. This includes (but is not limited to) structural and functional airway and upper gastrointestinal tract disease, lung disease because of congenital or developmental abnormality or injury, swallowing dysfunction, feeding problems, genetic diseases, and neurodevelopmental disability. (Boesch et al., 2018, p. 3).

The driving force behind the development of such centers is the inherent difficulties associated with delivering multidisciplinary care within other settings. A basic premise is that better outcomes will be achieved by avoiding fractionalized care. The trend of increased visibility provides an opportunity for children with a full range of presentations to receive multi-disciplinary care. An additional benefit of coordinated care allows a collective experience with developing both basic science and clinical research initiatives to better understand disease processes and further improve care.

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Boesch et al. (2018) described the following essential defining functions and features of aerodigestive care coordination:

- Team meeting
- Pre-visit intake
- Prescheduling of appointments and procedures
- Shared clinic
- Combined endoscopy
- Wrap-up visits with family
- Summary document
- Provision of follow-up care (when applicable)
- Operational meetings

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Who Is Involved?

Central to the care of children with upper aerodigestive problems are a pediatric otolaryngologist, pulmonologist, and gastroenterologist. From a coordination standpoint, the otolaryngologist often serves as a central figure as their anatomical area of expertise represents the junction between the disciplines. Additionally, the care of such children often requires access to speech-language pathologists with specific interests in swallowing and possibly even voice disorders. Furthermore, an allergist can provide much-needed insight and treatment for children with atypical allergic manifestations. Access to nutritionists and a feeding team provide valuable resources for determining nutritional needs and feeding/swallowing efficiency for intake with this patient population. At times, the team will include pediatric anesthesiologists with experience in spontaneous ventilation anesthesia techniques and access to a pediatric intensive care unit, if a child is to undergo the full range of operative airway care. The involvement of a strong support staff of case management, social work, and nursing ensures that once the children are discharged, they continue to receive the necessary care.

What Are Some Common Conditions That Are Treated?

A wide variety of conditions affecting the aerodigestive tract are within the scope of therapy for coordinated multidisciplinary care. Airway obstruction secondary to congenital or acquired anomalies, atypical reflux disease, chronic cough, aspiration, allergic conditions, as well as feeding and voice disorders, are commonly evaluated and treated (Gergin et al., 2017). Complex presentations, or children with multiple medical problems, are particularly well suited to this care model.

How Do Aerodigestive Centers Facilitate Care for Children Who Have Tracheostomies?

The genesis of medical complexities that ultimately lead a family and medical team to decide on tracheostomy placement is variable. Watters (2017), following a survey of 36 children's hospitals, indicated that chronic lung disease (56%), neurological impairment (48%), and upper-airway anomaly (47%) are the most common underlying comorbid conditions in children 0-18 years of age, who undergo tracheostomy. However, a common binding factor for these children is needed, specifically, a medical team who identifies the barriers and facilitates interventions that may aid in eventual decannulation. When tracheostomy placement does not have foreseeable options for decannulation, ongoing discussions should still occur regarding medical and therapeutic management for each child.

The aerodigestive team values accountability for assessing and identifying the barriers to decannulation, as it is the unique role of each discipline to facilitate this process. This often includes debunking theories held by individuals on the team, including the extended healthcare community, because these myths limit the optimization of care (e.g., a cuff remaining inflated because of known dysphagia and aspiration risk; poor weaning from the ventilator because of vocal cord paresis; gastroesophageal reflux as a primary factor for poor pulmonary status; inability to trial food by mouth (PO) because of "aspiration on an instrumental assessment," and more). Although the previously stated scenarios are important discussion points for the aerodigestive team, the relevance of each concern may be highlighted, and the direction of care steered to achieve expedited progression of care. This may include immediate trials of partial cuff deflation during the visit to assess how swallow function changes when gaining access to the upper airway; use of Flexible Endoscopic Evaluation of Swallowing (FEES), to look at vocal cord function and secretion management; obtaining transtracheal pressure measurements, to assess upper airway access and efficiency of respiration; Passy Muir Valve or capping trials; decannulation during the visit; or even admission to facilitate establishment of a more thorough care plan. Throughout each appointment, the team communicates and orders the necessary ancillary testing or interventions deemed necessary to facilitate optimal outcomes for each child.

Optimizing Dysphagia Management for Children with Tracheostomies and Ventilator Dependency

The etiology of pediatric feeding and swallowing difficulties may arise from a variety of airway problems, including laryngomalacia, vocal fold paralysis or paresis, laryngomalacia, laryngeal cleft, choanal atresia or stenosis, facial hypoplasia, subglottic stenosis, as well as CNS and neuromuscular diagnoses. When considering the complexity of having a tracheostomy tube and the known increased risks of adverse events and mortality, a multidisciplinary approach to dysphagia is even more critical (Carron, Derkay, Strope, Nosonchuk, & Darrow, 2000).

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The potential effects of a tracheostomy tube on the aerodigestive system are well supported in the literature, including reduced laryngeal movement; aphonia; slower and reduced airway closure during the swallow; reduced cricopharyngeal opening (Deebs, Williams & Campbell, 1999); and tethering of the larynx during the swallow, when cuff pressures are not properly managed (Ding & Logemann, 2005). Additional impacts include reduced airflow to the upper airway, leading to reduced laryngeal sensation and increased pooling of secretions; alteration in subglottic pressure, affecting neuro-regulation and oropharyngeal swallowing physiology (Gross, Mahlmann, & Grayhack, 2003); loss of pressure, impacting breath support; decreased Positive End-Expiratory Pressure, leading to decreased ventilation of the alveoli (contributes to atelectasis) (Sutt, Antsey, Caruana, Cornwell, & Fraser, 2017); and reduced ability to expectorate secretions and to cough effectively (Oconnor, Morris, & Paratz, 2019). With an open system, loss of pressure within the thoracic and abdominal cavities also may impair core strength and stability, causing bowel movements to be more difficult and potentially increasing constipation (Simons, Mehta, & Mandell, 2010).

The cornerstone of comprehensive care for these children is the active communication that occurs between providers.

Having an aerodigestive team can speed the diagnosis and treatment of dysphagia for children with tracheostomy dependence. Focus is placed on helping children regain access to their upper airway to optimize the achievement of their ideal health and aerodigestive potential, which includes establishing the least restrictive diet. Key components of the multidisciplinary visit that uniquely facilitate feeding and swallowing outcomes in children with tracheostomy dependence include:

- Assessment of oropharyngeal swallowing status via clinical examination, including secretion management and response to facilitative swallowing strategies that may reduce suctioning needs.
- Establishment or modification of oral care plans.
- Instrumental assessments (FEES/Modified Barium Swallow Study), when appropriate.
- Assessment of cuff status and management with a clear reason and plan, if cuff needs to be inflated.
- Thorough assessment for Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve candidacy and rapid troubleshooting when tolerance of the Valve is not achieved.
- Assessments include the use of clinical airway and dysphagia evaluations by the team; use of transtracheal pressure manometry to determine end-expiratory pressures during Valve or capping use; direct visualization of airway via instrumental examination (at times including FEES), and recommendation of more invasive diagnostic procedures.
- Establishment of a plan to optimize access to swallowing skills and upper airway, if unrestricted cuff deflation or use of Passy Muir® Valve cannot be prescribed by the end of the visit.

Does It Need to Be in a "Center"?

Despite the recent popularity of such aerodigestive centers, the cornerstone of comprehensive care for these children is the active communication that occurs between providers. Furthermore, each provider must understand and have a common perception of the upper aerodigestive tract as a unified system, where there is a complex interaction between the gastrointestinal tract and the upper and lower airways. As such, though a center may allow for easier coordination of higher patient volumes, it is not necessary. Excellent care for these children may certainly be accomplished in a setting where active communication lines exist between subspecialists.

When Do I Refer?

Referral patterns are dependent upon your area of expertise, availability of pediatric subspecialists, and community resources. General guidelines for referrals include children with complex medical backgrounds and with aerodigestive symptoms that fail to subside with routine therapies. Furthermore, it may be useful to refer children who have airway symptoms that are on the mild end of the spectrum but have persistent difficulties. Many children seen in these clinics present with persistent symptoms, such as a chronic cough with no clear etiology, and only a multidisciplinary evaluation results in a unifying diagnosis. In some cases, a comprehensive evaluation may solidify the diagnosis and provide confidence in the devised treatment plan.

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Multidisciplinary coordination is a vital aspect in the care of children.

Bringing It All Together

The recent attention on such pediatric aerodigestive centers highlights something that has occurred in the care of medically complex children for many years. Multidisciplinary coordination is a vital aspect in the care of children. It is important to realize that the concept is not new. As stated above, such centers have existed for the care of children with craniofacial anomalies, cystic fibrosis, and cancer care for many years. The recent attention serves to highlight the importance of comprehensive, multidisciplinary pediatric care in patients with complex aerodigestive system disorders.

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Protocols Assist with Improving Communication for Patients with Tracheostomy & Ventilator Dependence

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Introduction

For patients with tracheostomy and ventilator dependence, communication in the intensive care unit can be difficult to achieve but having a reliable means of communication is imperative for health, safety, and well-being. The Speech-Language Pathology (SLP) team at Vanderbilt University Medical Center (VUMC) recently launched a six-month quality improvement initiative to promote early intervention for this patient population. The project, "Improving Communication for Patients with Tracheostomy and Ventilator Dependence," had a primary goal of establishing consistency with communication for these patients by having the entire SLP department trained in a newly developed protocol. Prior to this project, only some of the SLPs in the department were fully confident and competent in providing intervention to these patients. With the development and implementation of this program, patients may participate more readily in their medical plan, which can improve efficiency of care by all staff, preventing unnecessary delays in their care, which may have occurred secondary to the earlier difficulties with communication and patient participation.

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Purpose

Impaired communication can lead to safety concerns, violation of patient rights, poor quality of life, and may contribute to ICU delirium (Freeman-Sanderson, Togher, Elkins, & Kenny, 2018). Some of the reasons for addressing communication are:

- Safety concerns: Patients with communication problems were three times more likely to experience preventable adverse events than patients without such problems (Bartlett, Blais, Tamblyn, Clermont, & MacGibbon, 2008). Serious medical events have been reported for patients with impaired communication (Cohen, Rivara, Marcuse, McPhillips, & Davis, 2005).

- Patient rights: The Joint Commission set new standards which focus on all patients having their communication needs met, making communication a priority. The Joint Commission upholds that patients have a "right and need to effective communication." In the Elements of Performance for R1.2.100, No. 4 states, "The organization addresses the needs of those with vision, speech, hearing, language, and cognitive impairments" (The Joint Commission, 2010).

- Quality of life: Inability of the ICU patient to communicate can lead to frustration, anger, withdrawal from interaction, and reduced participation in treatment (Magnus & Turkington, 2006).

- ICU Delirium: Two out of three patients in ICUs experience delirium (Grossbach, Stranberg, & Chlan, 2011). In a Joint Commission webinar, *Call to Action: Improving Care to Communication Vulnerable Patients*, it was reported that communication-vulnerable patients have an increased diagnosis of psychopathology (The Joint Commission, n.d.).

- The Vanderbilt Promise: "As an institution, VUMC promises to include you [the patient] as the most important member of your healthcare team" and "communicate clearly and regularly, which is paramount during times of critical illness."

Implementation Methods and Communication Access

To improve the consistency and standardization of assessment and treatment for the patient with tracheostomy and ventilator dependence, the SLP team members who were competent with this patient population:

- Developed a protocol to standardize assessment of both verbal and non-verbal communication.
  - This protocol starts with a readiness screening. If the patient passes the screening, it then provides a workflow for a collaboration between the speech-language pathologist and the respiratory therapist (RT) during phonation trials.
  - Collaboration would involve basic assessment of speech, language, and cognition and the need for a simple AAC (Augmentative and Alternative Communication) tool.
- Disseminated this protocol to the acute speech pathology staff through didactic teaching, one-on-one training, and competency check offs.
- Met with the Director of the VUMC Critical Illness, Brain Dysfunction, and Survivorship Center to discuss the importance of communication for patients following tracheostomy and mechanical ventilation to potentially minimize delirium.
- Provided in-services to the interprofessional disciplines that collaborate on the care for these patients, including:
  - Respiratory therapists.
  - Medical Intensive Care Units (MICU) attendings and fellows (physicians).
  - Nursing staff throughout VUMC.
- Created a poster presentation for a hospital-wide Strategy Share Program in order to further disseminate the improvement process. The theme for the 2019 Strategy Share was "Design for Patients and Families." This CQI project fit perfectly with this theme and the VUMC goals of enhanced patient, clinician, and staff experiences.

continued next page

Results

This qualitative process and review of its impact provided a means of training personnel and reviewing the impact on staff confidence and workflow. Review of interview data demonstrated that implementing the improvement process through additional training increased the confidence of the SLP team when serving this population. After the departmental in-service trainings, SLPs commented:

- "The in-service enabled me to gain skills and confidence to feel more prepared to treat these complex patients."
- "I feel better equipped to manage our trach/vent patients."

Furthermore, respiratory therapists and speech-language pathologists demonstrated improved teamwork to establish communication for these patients. A pre-project staff survey was completed to ascertain staff comfort and efficiency when treating these patients. A post-training survey is in process. Preliminary results indicate that staff has the improved confidence, knowledge, and skills to work with these complex patients.

In addition to improvement in patient care, the SLP team also benefitted from this initiative by receiving increased recognition within the medical center. The poster, which provided education on the protocol for working with patients to enhance communication, was well-received at the VUMC Strategy Share event. This initiative also led to an invitation for the SLP team to participate in the VUMC Critical Illness, Brain Dysfunction, and Survivorship Center.

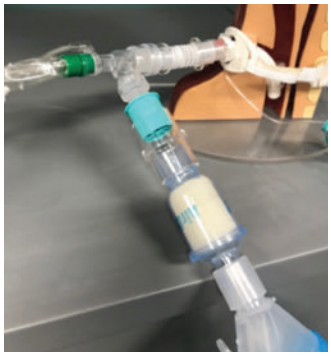
Most importantly, the patients who have benefited from this program consistently report appreciation for being able to express themselves and actively participate in their care. One patient stated, "It has been so frustrating trying to tell my husband what I want. He couldn't read my lips so I tried to write, but he couldn't read my writing. Now, I can just talk to him, and it's so much better."

Conclusions

In collaboration with physicians, ICU nurses, the Trach Consult Service, and respiratory therapists, the Adult Acute Speech-Language Pathology team is making verbal and non-verbal communication accessible for these otherwise non-communicative patients. Hospital staff will now interact more efficiently with patients from this intervention by using the newly implemented head-of-bed sign, directing them on how to facilitate verbal communication with their patient (*see Figure 1*). This simple form improves consistency in communication across the interdisciplinary team for these vulnerable patients. Improving communication with this population has resulted in improved safety, quality of life, and compliance with Joint Commission regulations, ADA laws, and the VUMC Patient Promise.

I CAN TALK!

Basic Instructions for Passy Muir® Speaking Valve (PMV®) in-line with the Ventilator:



1. Slowly deflate the cuff
2. Suction patient, if needed
3. Respiratory Therapist can make ventilator adjustments as needed (ie: increase tidal volume, decrease PEEP)
4. Place the Aqua Color™ PMV in-line with the vent; use the 22x22mm adapter (see picture)
5. Monitor vital signs; remove Valve in significant changes in RR, WOB, O2 Sats, patient comfort
6. Encourage voicing
7. Alarms will sound due to lack of return airflow to the vent (unless vent is changed to the non-invasive mode)
8. When a patient wants/needs the Valve removed:
   a. Remove the PMV and 22x22 adapter
   b. Re-inflate cuff (if needed)
   c. Return vent settings to pre-PMV parameters

Any questions, call speech pathology (615-322-5152)

Patient name:_____ Date:_____

VANDERBILT UNIVERSITY MEDICAL CENTER

Figure 1

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Having Protocols for Clinical Use to Improve Patient Outcomes

Cheryl Tansley, MS, CCC-SLP

Gaylord Specialty Healthcare was founded in 1902 as a tuberculosis sanatorium and has grown into a 137-bed long-term acute care hospital (LTACH) facility. Within this facility, specialties focus on the medical management and rehabilitation of patients who have suffered acute illness or a traumatic accident. Because of this focus, programs have been established in Pulmonary, Spinal Cord Injury, Traumatic Brain Injury, and Stroke as major diagnostic areas to provide intervention. Care of these medically complex patients is provided by a multidisciplinary team, including physicians, nurse specialists, respiratory care practitioners, radiology technicians, therapists (physical, occupational, and speech-language pathology), pharmacists, and care managers, for both adolescents and adults. The medically complex populations being seen also may include those patients with chronic obstructive pulmonary disease (COPD), restrictive lung disease, chronic emphysema, obstructive sleep apnea, bronchitis, asthma, respiratory complications from morbid obesity, and neurological disorders. Additionally, complex diagnoses also include muscular dystrophy and post-polio syndrome, as well as ventilator dependence due to illness or injury. Because of the wide range and complexity of the diagnoses being treated, a multidisciplinary team is essential to provide best outcomes.

As with many facilities in today's competitive healthcare domain, it is a struggle to balance patient satisfaction with decreasing length of stays, all while supporting better patient outcomes. Various approaches to patient care have attempted to address the many issues for these patients. The approaches have proven successful, not only at improving patient satisfaction rates, but at expediting ventilator weaning processes and decreasing patient length of stay. The multidisciplinary approach to the care of these complex patients included the development of an Early Ventilator Mobilization Program, increased Passy Muir® Valve use, and Tracheostomy and Ventilator Rounds.

Research has shown that patients with tracheostomy and mechanical ventilation are particularly vulnerable due to the diminished options for mobility, communication, and participation in their care (Freeman-Sanderson, Togher, Elkins, & Kenny, 2018). Not only can this impact a patient's motivation and psychological state, but immobility through bedrest has been shown to cause a rapid increase in muscle atrophy which may further complicate recovery (Adler & Mallone, 2012). To combat these issues, the implementation of several protocols may assist with improving patient care, satisfaction, and outcomes.

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Early Ventilator Mobilization Program

Early Ventilator Mobilization (EVM) is an initiative designed to increase activity amongst the patient population with ventilator-dependence. There is no evidence that bedrest has any therapeutic value and often worsens outcomes (Adler & Malone, 2012; de Jonghe, Lacherade, Sharshar, & Outin, 2009; Forte, 2009).

During bedrest, such as occurs in an intensive care unit (ICU), it has been reported that significant changes can occur in both body mass and strength. In his 2009 presentation, Forte discussed that:

- Muscle mass decreases by up to 5% per week.
- Skeletal muscle strength decreases as much as 20% in the first week.
- An additional 20% loss may occur each subsequent week.
- Weakened muscles generate increased oxygen demand.

The initiative has led all disciplines to have more accountability for mobilizing patients and improving outcomes.

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Even high intensity bed exercises do not counteract the adverse effects of bedrest. To address these issues with patients who are ventilator-dependent, EVM is a program designed for the physical therapist (PT), occupational therapist (OT), speech-language pathologist (SLP), respiratory therapist (RT), and nursing to be responsible parties in the documentation and mobilization of patients with ventilator-dependence. To increase mobilization, this program includes supine therapeutic exercise, bed mobility, seated balance activities, standing with a walker with assistance, transfers, and upright positioning for meals. All these activities may take place prior to a patient's ability to be out of bed for walking or moving in the hallways.

The selection criteria for patients, who are candidates for EVM, may be those patients who are:

- Minimally able to participate with therapy.
- Stable hemodynamically.
- Receiving acceptable levels of oxygen.
- Medically stable (sufficient perfusion to maintain normal organ function).

Additionally, acceptable parameters for determining EVM candidates include:

- Heart rate < 110 beats/minute at rest.
- Mean arterial blood pressure between 60 and 110 mmHg.
- FiO_2 (Fraction of inspired oxygen) < 60%.
- Maintenance of oxygen saturation > 88% with activity.

The initiative has led all disciplines to have more accountability for mobilizing patients and improving outcomes. This program allows the team to track performance and to have the ability to adjust treatment plans based on trends seen in a patient's performance. To increase staff communication, a shared documentation site was created to note patient performance with increased activity, including frequency and tolerance of mobilization, and all parties are responsible for the documentation related to the patient's mobilization. In addition, signs were developed for posting on the doors of EVM candidates to remind all staff to participate in the program and to provide appropriate documentation.

Increasing Use of the Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve

The Passy Muir® Valve (PMV®) is a speaking Valve that is placed on the end of a tracheostomy tube or in-line with ventilator circuitry. It allows air intake to continue though the tracheostomy tube during inhalation; however, air is redirected out through the upper airway during exhalation. The Valve closes at the end of inspiration and remains closed throughout exhalation, allowing airflow out of the nose and mouth, providing readiness for speech production. Studies have supported that wearing a PMV improves true vocal cord closure; restores voicing and communication; restores smell and taste; improves swallowing, by decreasing aspiration risk and restoring subglottic pressure; improves coughing; restores upper airway sensation; restores PEEP, alveolar recruitment to minimize atelectasis; increases gas exchange and improves saturation levels (O'Connor, Morris, & Paratz, 2018). It may also expedite the time to ventilator weaning and tracheostomy tube decannulation by rehabilitating respiratory musculature, increasing confidence and motivation, and potentially decreasing the need for sedating medications (Freeman-Sanderson et al., 2018; Kinneally, 2018; Sutt, Antsey, Caruana, Cornwell, & Fraser, 2017).

Healthcare facilities need to develop the right team, so that all staff are on the same page. This can be done by improving the education of staff and providing research to perspective team members, through readings, demonstrations, and webinars. Adopting a "Ventilator Bundle" order set, where the physician chooses the appropriate bundle, allows for physical therapy, occupational therapy, and speech therapy orders for Valve use to generate automatically. Having an order set also reduces the amount of time it would take to obtain the orders to initiate a PMV assessment and assists with getting the team onboard early in the process.

The respiratory and speech departments work collaboratively during both the evaluation and treatment sessions to improve troubleshooting and education. Respiratory and speech therapists work to place the PMV in-line for new patients, who are on a ventilator, usually within the first 24 hours from admission. A team assessment benefits the patient and facilitates success of Valve use because each person contributes a different aspect to the evaluation. Respiratory therapists have a primary focus on the tracheostomy tube type and size, proper cuff management, settings on the ventilator, patient's vital signs, and safe and proper management of the ventilator and alarms during use of the Valve. The speech-language pathologist focuses on the patient's ability to voice, their speech and language function, access to communication, cognition, and swallowing. Throughout use of the Valve, all team members maintain vigilance on the patient's vital signs and status during use.

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Many patients and their loved ones have not heard their voice in several days or even weeks but may with use of the Valve. Communicating with family members, significant others, and staff improves a patient's mood, psychological state, and motivation (Freeman-Sanderson et al., 2018). Lastly, to assist with communicating among the multidisciplinary team members, speech pathology, respiratory therapy, and nursing share a documentation site to note patient tolerance and progress with PMV use.

Establishing Tracheostomy and Ventilator Rounds

Developing a Tracheostomy and Ventilator Rounds Team as a part of the protocol for the care of patients with tracheostomy and mechanical ventilation is another way to enhance team communication and improve the standard of care. This team includes pulmonologists, hospitalists, respiratory therapists, speech pathologists, registered nurses, dieticians, pharmacists, and physical therapists. The Team coordinates all care of patients who are dependent on a ventilator or require use of a tracheostomy tube. Typically, meetings are held one time per week and may take up to an hour, depending on census. The team leader, often an RT, introduces each patient and the team members add to the discussion. Some rounds will incorporate a closed-circuit monitor to review chest x-rays, lab values, and medications, as needed.

In 2016, Gaylord expanded this process to weekly tracheostomy rounding on the rehabilitation and pulmonary floors. Having tracheostomy and ventilator rounds, with participation of a multidisciplinary team, has expedited decannulations (when appropriate) and facilitated better communication amongst the team regarding the plans and goals for the patients. Rounds also ensure the discharge plan is on target by regularly discussing the patients' goals. Studies have shown that implementing Tracheostomy and Ventilator Round Teams improve recovery by increasing the speed at which the ventilator weaning process happens, improving the quality and safety of patient care, ensuring early patient mobility, and supporting early communication (Speed & Harding, 2013; Yu, 2010).

Impact of Change

Challenges to implementing new protocols must be addressed to improve the transition into new processes. It is important to monitor change and conduct Quality Improvement (QI) studies to ascertain the impact. The biggest financial impact realized at Gaylord was seen in the decrease of ventilator days. A ventilator day at the facility costs an average of $1,400. Ventilator days were decreased by an average of 4.33 days. This translated to a cost savings of $6,062 per patient. From 2013-2015, an average of 65 patients were weaned from the ventilator per year. Decreasing the days on a ventilator for this population by 4.33 days translated to a savings of $394,000 per year.

Additional improvements were seen in the consistency of weaning rates and occurrence of decannulation. For this patient population from 2012 - 2017, ventilator weaning rates improved by an average of 6.8% and decannulation rates increased by an average of 447.4 patients per year following implementation in 2012 (*see Figure 1*).

When these protocols and plans were implemented, patient satisfaction improved, ventilator weaning increased, more patients were decannulated, and length of stay decreased. By working together as a team and implementing protocols designed to improve collaboration and accountability on the part of all staff members, the multidisciplinary team becomes a leader in the care of medically complex patients.

Figure 1

Ventilator Wean Rates

Year	FY12	FY13	FY14	FY15	FY16	FY17
Ventilator Weaning Rate	62%	66%	67%	73%	69%	69%

Decannulating Tracheostomy Patients Per Year

Timeline	Prior to May, 2013	May – Sept. 2013	FY14	FY15	FY16	FY17
# of Patients	50	81	131	83	102	90

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Article Summary

Kristin King, PhD, CCC-SLP

Reduction in Length of Stay

Alabdah, J., Lynch, J., & McGrath, B. A. (2018). Reduction in hospital length of stay via tracheostomy quality improvement collaborative. *British Journal of Anaesthesia, 120*(5): e25-e26. DOI: 10.1016/j.bja.2017.11.058

The Global Tracheostomy Collaborative (GTC) has initiated a program at a global level to improve the care of patients with tracheostomy. In the UK through the National Health System, the UK has the Improving Tracheostomy Care (ITC) a project to improve the care of patients, and 20 facilities within this project also have GTC resources. The global program of the GTC reports that these facilities used speaking valves in-line with ventilation in 6.6% of their patients while the ITC reported 0% use with patients on mechanical ventilation. Through analysis of this data from the participating medical facilities, the GTC reports that the use of the Valve with in-line mechanical ventilation appears to positively impact decannulation rates and length of stay for patients. The GTC also suggests that establishing an international/global standard of care will improve overall education, training, and care of patients with tracheostomy.

Using the Passy Muir® Valve in Conjunction with High Flow Oxygen Therapy

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Our facility, Madonna Rehabilitation Hospitals, utilizes warm mist humidification during the care of patients with tracheostomy. As innovation is one of the facility's core values, the Vapotherm Precision Flow device for High Flow Oxygen Therapy (HFOT) was introduced at Madonna in January 2016. This technology allows for delivery of gas flow rates of up to 40 LPM (liters per minute) without discomfort or damage to airway epithelia (Lindenauer, Stefan, Shieh, Pekow, Rothberg, & Hill, 2014). Key clinical benefits of the Vapotherm Precision Flow device include:

- Humidification at body temperature and saturated – 37°C.
- Delivering consistent, energetically stable, vapor phase humidity.
- Rainout prevention.
- Mitigation of contamination via humidity.
- Mitigation of stoma irritation.
- Better secretion mobilization.

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A comparison of HFOT and low flow O_2 (oxygen) demonstrates that:

	HFOT	FiO_2	Flow	Humidification
HFOT	Precise	21 – 100%	1 – 40 LPM	At body temperature and 100%
Low Flow O_2	Variable	Variable	Limited	None

In January 2016, HFOT was used consistently in the Specialty or LTACH units, including patients with tracheostomy tubes. In 2017, Madonna Rehabilitation Hospitals earned recognition as the second Vapotherm Center of Excellence in the United States. A year later, HFOT use was expanded to include the Acute Rehabilitation and Pediatric Hospitals. Currently, use of Vapotherm has been extended to include the long-term ventilator assist unit and the Skilled Nursing Facility level of care. Facility protocols for ventilator weaning and tracheostomy decannulation processes were updated to standardize the safe application of HFOT. In addition, multidisciplinary competencies were developed for staff training that provide for:

- Indications, contraindications, risks, and guidelines.
- Patient safety.
- Application of HFOT.
- Procedures for safety and use.

Indications for Use

HFOT is indicated for patients requiring:

- Humidification of an airway stoma, with or without a tracheostomy tube or larynx tube.
- High oxygen needs.
- A need for high flow therapy.

Patient selection also includes those patients exhibiting increased work of breathing or refractory hypoxemia (generally refers to inadequate arterial oxygenation despite optimal levels of inspired oxygen or onset of barotrauma in mechanically ventilated patients).

Patient Safety and Application

Tracheostomy Tube Application: Connect a patient to HFOT using a 22mm tubing adapter to their tracheostomy mask or T-piece. Do NOT connect the delivery tubing or the tubing adapter directly to a patient's tracheostomy tube (*see Image 1*). ***The tracheostomy tube cuff must be completely deflated when using the Passy Muir® Valve (PMV®)***, including in conjunction with HFOT. If the Passy Muir Valve is not being used, the tracheostomy cuff may remain either inflated or deflated, as needed for the patient.

Nasal Cannula Application: Nasal cannula application may be used during the tracheostomy tube weaning process, when the tracheostomy tube is capped, or with use of the PMV. The nasal cannula application is then utilized for humidifying the upper airway to help jumpstart the natural system and ensure success with secretion mobilization and tracheostomy tube weaning. The flow that is given by the nasal cannula application also helps to flush out the upper airway or deadspace of CO_2; decreases work of breathing; and overall, increases patient comfort and satisfaction.

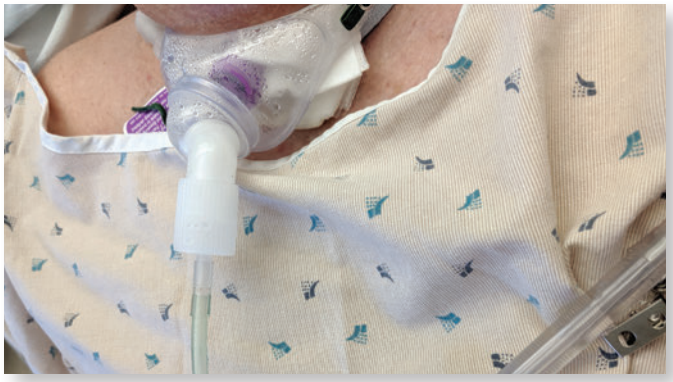

Image 1: Passy Muir Valve on with tracheostomy mask application of HFOT

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Outcomes

Over the last three years of utilizing the Vapotherm, positive outcomes in numerous areas have been observed. Not only have objective changes in care measurements been observed, but patients' anecdotal reports include reports of improvement in comfort, noise, and overall, satisfaction. Staff also reports that HFOT has allowed efficiency of care and participation in therapy, including early mobilization. It also allows the staff to focus on other important patient care needs. Lastly, since the Passy Muir Valve can be used in conjunction with HFOT, communication for the patient is improved and increases their participation in their medical care decisions.

Use of HFOT and the PMV have led to the following changes in quality improvements for patients:

Ventilator Weaning Rates	Tracheostomy Decannulation Rates	VAP Rate
5.3% increase in weaning rates for 2019 as compared to the previous three years	21% increase in decannulation for 2019 as compared with the previous four year average	In 2019, 1.55 occurrences per 1,000 vent days versus 2018, 2.01 per 1,000 vent days

Case Study

Karen, a 74-year-old female, was admitted post-emergent left ventricular assist device (LVAD) placement due to a mixed cardiomyopathy that was related to coronary artery disease and chemotherapy for breast cancer. Her acute care stay was complicated by renal failure, requiring hemodialysis; right ventricular heart failure; and respiratory failure, requiring mechanical ventilation and tracheostomy tube.

Upon arrival, Karen was ventilator dependent 24 hours per day. She required a multidisciplinary team approach to establish an individualized plan of care. This multidisciplinary team consisted of physicians, respiratory therapists, speech-language pathologists, physical and occupational therapists, nutritionist, nursing staff, and others. The initial plan of care included primary goals to address mobility, self-care, ventilator/tracheostomy tube weaning, and dysphagia.

Despite Karen's complex medical history, integrating rehabilitation with medical management would contribute to optimal outcomes. Management included the use of protocols for ventilator weaning and tracheostomy tube weaning. These protocols are typically instituted upon admission as part of the admission order sets and the standard of care. With these protocols, both use of the Passy Muir Valve and HFOT were implemented to improve communication and humidification for the patient. Each healthcare discipline provided a different focus for therapy. The comprehensive plan of care included mobility, communication, dysphagia, self-care, and respiratory management.

Upon admission, Karen was evaluated for mobility, self-care, and swallowing function. Evaluation results indicated that Karen's functional levels upon admission were:

- Maximum Assistance for mobility, transfers, and dressing.
- Minimum Assistance for grooming and eating.
- Severe dysphagia with a determination for nil per os (NPO or nothing by mouth).

At the time of admission, Karen also was ventilator dependent and her ventilator settings were:

- Ventilator Settings without the Passy Muir Valve
  - PC/AC (Pressure Control/Assist Control)
  - Vt (Tidal Volume) = ~500
  - PC (Pressure Control) = 17 cmH2O
  - PEEP (Positive End-Expiratory Pressure) = 7 cmH_2O
  - RR (Respiratory Rate) = 12 bpm (breaths per minute)
  - FiO_2 of 35%
- Ventilator Settings with the Passy Muir Valve
  - NIV S/T (Non-Invasive Ventilation, Spontaneous Timed)
  - Vt = ~500
  - PC = 28 cmH_2O
  - PEEP = 0 cmH_2O
  - RR = 12 bpm
  - FiO_2 of 30%

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She also was provided with HFOT and the settings for the Vapotherm with the Passy Muir Valve in place were a flow of 20 – 25 LPM, temperature of 37° C, and an FiO_2 of 30%-40%.

Due to Karen's complex medical needs, ongoing assessment and collaboration with the team were necessary throughout her stay. This integrated, multidisciplinary approach ensured that Karen's respiratory needs were met in a safe and effective manner.

With both the input of the multidisciplinary team and the implementation of the appropriate protocols, Karen progressed to the following functional levels:

- Standby assistance for walking and bathing (*see Image 2*).
- Minimum Assistance for dressing; however, her limitations were due to the LVAD and edema.
- Returning to a regular diet without restrictions for food consistency or diet levels. She had a regular diet with thin liquids (*see Image 3*).

Image 2: Karen working with PT to improve her level of mobility by working on stairs

Image 3: Karen enjoying a regular diet and thin liquids when eating

Karen was successfully weaned off the ventilator during her stay. She also progressed to decannulation, having her tracheostomy tube removed (*see Image 4*). The current plan is for her to return home soon. Prior to her discharge home, Karen and her husband will go on a community outing to practice skills and ensure safety.

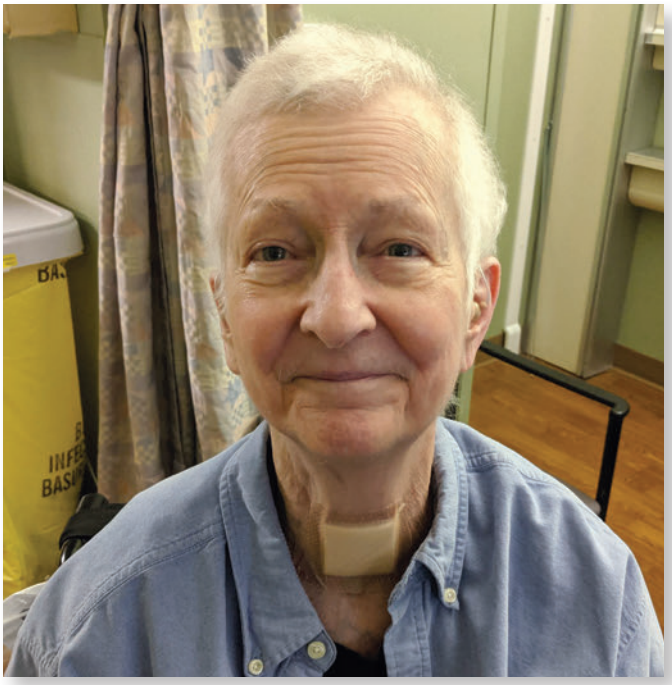

Image 4: Karen following decannulation

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Conclusion: Implementing standard protocols and having a multidisciplinary team providing a plan of care has been shown to improve patient outcomes (Santos, Harper, Gandy, & Buchanan, 2018). Using both HFOT and a standard decannulation protocol (*see the Decannulation Protocol on page 29*), patients, such as Karen, may progress to higher levels of function and independence (Gotera, Díaz Lobato, Pinto, & Winck, 2013). A patient with a tracheostomy tube and mechanical ventilation has implications for all clinical professions and each clinician is essential to the plan of care. The use of HFOT has been shown to enhance secretion management and facilitate weaning. It is through the use of standard protocols for HFOT and the PMV in tracheostomy care that facilities have found faster weaning times, which decreases overall lengths of stay and medical costs.

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The Madonna Rehabilitation team

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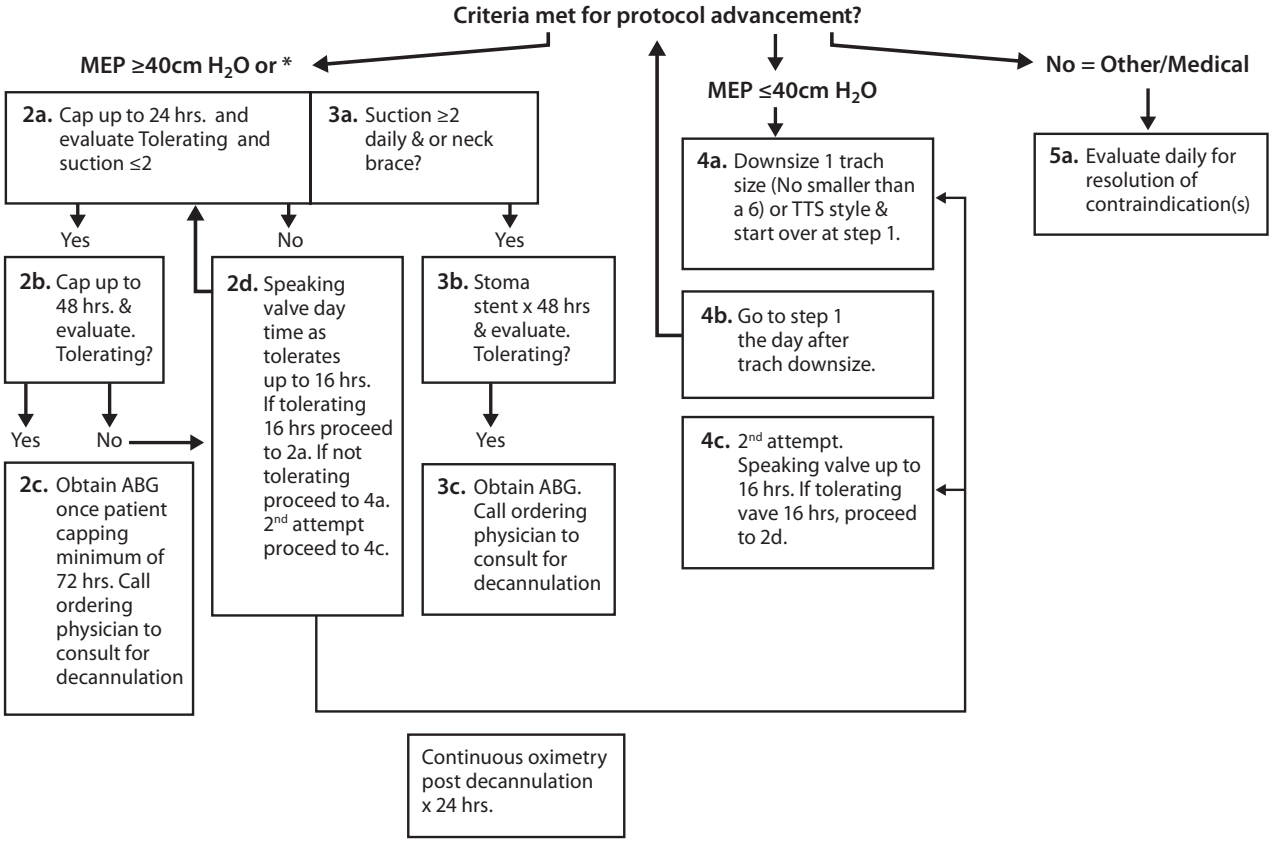
MADONNA
Rehabilitation Hospital

Madonna Rehabilitation Hospital Tracheostomy Decannulation Protocol
For Non-ventilated Patients

Step 1. Criteria for tracheostomy decannulation protocol initiation following successful liberation from mechanical ventilation

- Free of respiratory distress post ventilator liberation for 2 days
- Stable vital signs and absence of fever, sepsis, or untreated infections
- Maximum expiratory pressure ≥ 40cm H_2O (MEP). Notify physician if patient unable to perform MEP.
- Obtain ABG PCO_2 of ≤ 60mm Hg prior to starting protocol unless done in step S6 of the vent wean protocol
- Obtain SpO_2 of ≥ 90% on less than .35 FiO_2 or 4LPM nasal cannula or previous home O_2 regimen
- Absence of know upper airway obstruction or airway disorder such as but not limited to tracheal stenosis and tracheomalcia
- * Spinal cord injury must show ability to clear secretions with manually assisted (Quad) cough *



- Trach decannulation no sooner than 5th day post ventilator liberation.
- If patient is unable to cap on day 3, contact physician for recommendation.
- With protocol assessment a patient may advance to the step they are currently weaning however decannulation no sooner than 5 days post ventilation dependence without physician order.
- Pysician must be called upon completion of trach wean protocol and readiness to decannulate for final decannulation order.
- This protocol is a physician order for trach capping and speaking valve use as detailed in this protocol.
- Speaking valves are never for use during sleep.

The Role of Pressures in Swallowing and Impact of the Passy Muir® Valve

Brett Nickisch, MA, CCC-SLP

The presence of a tracheostomy tube has been associated with aspiration and dysphagia, but exact prevalence has varied in the literature. Tracheostomy tubes have been shown to limit laryngeal elevation, decrease subglottic pressure, and mechanically alter the swallow (Suiter, McCullough, & Powell, 2003). Patients with tracheostomy tubes also have other risk factors, aside from the presence of the tracheostomy tube, that may predispose them to aspiration or dysphagia. This article will discuss the role of subglottic pressure and its relation to swallowing.

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Lung Volumes and Subglottic Pressures During Swallow

Transfer of the bolus from the oral cavity to the stomach requires successive movements and positive pressure generated above the bolus to propel it downward to regions of negative pressure. In the oral cavity, the tongue provides the initial bolus propulsion to initiate the swallow. The bolus is moved posteriorly in the oral cavity with the midline of the tongue by sequentially elevating, anterior to posterior, against the hard palate to propel the bolus. The soft palate elevates to contact the lateral and posterior pharyngeal walls to close off the nasopharynx. Then, the contact of the velum, base of tongue, and pharynx create positive pressure on the bolus. This drives the bolus to the region of negative pressure in the hypopharynx. The hyoid and larynx are pulled up and forward, and the epiglottis inverts over the airway. The true and false cords adduct, and the arytenoids tent forward. The actions of these structures help to protect the airway from the bolus. When the laryngeal vestibule closes and the vocal folds adduct, subglottal pressure increases immediately prior to the swallow (Wheeler Hegland, Huber, Pitts, & Sapienza, 2009).

Once the bolus reaches the pharynx, the pharyngeal constrictor muscles contract, shortening the pharynx and generating a stripping wave to propel the bolus through the pharynx. Hyolaryngeal excursion helps to relax the upper esophageal sphincter to open the esophageal lumen for passage of the bolus into the esophagus, which is a region of negative pressure. Once in the esophagus, the bolus is propelled by a peristaltic wave to the lower esophageal sphincter and the stomach.

Sensory receptors in the oral cavity provide the central nervous system with information about the properties of the bolus and adjust movements to prepare the bolus for swallowing. Pharyngeal receptors respond to the bolus to elicit the pharyngeal swallow. The sensory information from the pharynx directs the motor movement to activate the pharyngeal musculature to assist with protection of the airway during swallowing (Nishino, 2012). The swallowing center, located in the brainstem, includes sensory and motor neurons that produce a series or sequence of activities for the swallow process (Al-Toubi, Daniels, Huckabee, Corey, & Doeltgen, 2016). Sensory information is received from the oral cavity, pharynx, larynx, and esophagus to organize the motor movements for swallowing.

Gross, Atwood, Grayhack, and Shaiman (2003a) conducted a study with the rationale that pressurized air during the swallow may play a role in the neuro-regulation of swallowing function by stimulating subglottic mechanoreceptors. The study was designed to determine the effect of lung volume on specific measures of swallowing physiology in individuals without tracheostomy tubes, dysphagia, respiratory disease, or neurological impairment. Subglottic air pressure was altered with extremes in lung volume. Swallowing was completed at total lung capacity (TLC), functional residual capacity (FRC), and residual volume (RV). TLC occurred at the end of maximal inhalation and before onset of exhalation, providing the highest positive subglottic air pressure (Psub). Swallowing at FRC was at resting expiratory level where recoil forces are inactive or less active (~34%

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vital capacity) and equated to a lower or midrange Psub. Lastly, swallowing at residual volume was measured at the end of forced exhalation and before the onset of inhalation (~0% vital capacity) and demonstrated the lowest Psub or a negative pressure.

The results of their study indicated significantly longer pharyngeal activity duration (PAD) for swallows that occurred in the low subglottic pressure condition (during RV) as compared with shorter PAD during swallows that occurred at higher lung volumes (during TLC and FRC) (Gross et al., 2003a).

Significant positive correlations between EMG (electromyography) duration, BTT (bolus transit time), and PAD were present only for swallows occurring at TLC. If TLC most closely approximates the initiation of the most efficient motor program, then these correlations may be indicative of the condition that is closest to the swallowing program (i.e., the lungs are filled and Psub is likely to be sufficiently positive). PAD of swallows occurring at FRC were not significantly different from TLC, perhaps because the potential to generate positive pressure was still present. PAD-FRC was significantly shorter than PAD-RV (Gross et al., 2003a p. 2215).

Significant differences in PAD were not found between swallows occurring at FRC and TLC. This finding was thought to be due to the generation of positive pressure in both conditions. The pharyngeal activity duration in the FRC swallows was significantly shorter than in the RV swallows (Gross et al., 2003a). These differences may indicate a relationship between lung volumes, subglottic pressure, and swallowing.

Gross et al. (2003a) also offered the dynamic systems theory as another explanation for motor control. The movement patterns for swallowing, the respiratory system, and the neural substrates coordinate the motor control for swallowing. The pressure within the airway during the swallowing sequence may signal the neural mechanisms within the brainstem for respiration and swallowing. The “attractor state” is the condition of highest equilibrium, which the dynamic system seeks for optimal functioning. The attractor state could be viewed as swallowing at higher lung volumes and positive Psub (FRC and TLC). Low Psub (RV) during the swallow may actually apply a constraint on the swallowing structures.

Based on the results of this experiment that show an influence of the respiratory system on swallowing, the larynx and pharynx, along with their neural substrates, may serve as coordinative structures. In the dynamic model, the mechanoreceptors of the subglottic larynx may have induced a new, unestablished attractor state, or applied a constraint on the swallowing structures, when low Psub (RV) was revealed during the swallow as the true vocal fold adducted. To ensure the successful completion of the overall motion goal (i.e., swallowing without aspiration), the coordinative structures changed their synergistic motions via compensatory adjustments that prolonged PAD (pp. 2215-2216). The findings from this study suggest that the respiratory system provides a portion of the afferent information to the swallowing motor pattern to generate its motor output (Gross et al., 2003a).

Gross, Steinhauer, Zajac, & Weissler (2006) conducted a study to determine if subglottic air pressure is generated during swallowing in a healthy, non-tracheostomized person. Direct measurement of subglottic air pressure was obtained through percutaneous puncture of the cricothyroid membrane. Swallows were timed with four randomly assigned lung volumes: TLC, TV (tidal volume), FRC, and RV. The results of the study indicated that in healthy persons without a tracheostomy, positive subglottic air pressure can be generated at the time of the swallow. The highest positive pressures were exhibited with the highest lung volumes. Negative pressure values were exhibited with the lowest lung volumes. Pressure values associated with the TLC condition were similar to those taken from patients with a tracheostomy who were not aspirating. The datasets suggest that successful swallowing may require, in part, subglottic pressure values relative to lung volumes. The researchers were able to apply their findings to improve the swallow function of a tracheostomy patient, while obtaining direct fluoroscopic evidence, by instructing him to increase his lung volume at the time of the swallow. Taking a deep breath may maximize subglottic air pressure during the swallow.

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Swallowing Pressures with Placement of a Tracheostomy Tube and Use of a Passy Muir® Valve

When a tracheostomy tube is present, airflow escapes through it and below the level of the vocal folds despite vocal fold adduction during the swallow. This open tracheostomy tube disrupts the pressures discussed in the previous section regarding the normal swallow. When the cuff is deflated, placement of a Passy Muir Valve restores airflow to the upper airway (Suiter, 2014).

Logemann, Pauloski, and Colangelo (1998) studied the effects of light digital occlusion of the tracheostomy tube versus no occlusion on oropharyngeal swallowing in head and neck cancer patients. Four of the seven subjects who swallowed thin liquid aspirated when the tube was not occluded. In two of these four subjects, aspiration was eliminated with digital occlusion. With light digital occlusion, five biomechanical swallow measures changed, including improvement in hyoid and laryngeal movement. The researchers postulated that this improvement may be due to the ability to build subglottic pressure with the tube occluded which increased resistance as compared to the tracheostomy tube not being occluded.

Gross, Mahlmann, and Grayhawk (2003b) studied the physiological effects of open and closed tracheostomy tubes on the pharyngeal swallow. They suggested that pressurized air may play a role subglottically by stimulating mechanoreceptors. Patients with a tracheostomy ventilate well but bypass the larynx; therefore, the role of subglottic pressure receptors is considered to be minimal in respiratory control. It was postulated that stimulation of subglottic pressure receptors may signal to the central nervous system that the larynx is ready (protected) for a bolus to pass by, and this, in turn, influences lower motor neurons which innervate the muscles of the pharynx. In addition, feedback from subglottic receptors also may influence recruitment of lower motor neurons in the pharynx during swallowing due to the neuro anatomical linkage between subglottic pressure receptors and lower motor neurons serving muscles of both the pharynx and larynx. It was thought that force, speed, and duration of muscle contraction would be altered with tracheal occlusion. To address this question, they studied the depth of laryngeal penetration, bolus speed, and duration of pharyngeal muscle contraction during the swallow in individuals with tracheostomy tubes while their tubes were open and closed.

Results of the Gross et al. (2003b) study indicated pharyngeal swallowing physiology can be measurably different in the absence of airflow and subglottic air pressure (open tube) as compared to the closed tube condition, in which airflow is redirected through the glottis and subglottic pressure is increased. Their findings indicated a more efficient swallow with decreased pharyngeal activity duration and decreased bolus transit times in the closed condition in three of the four participants. A rating scale used to characterize the depth and severity of laryngeal penetration increased in the open condition in three of the four participants as compared to the closed condition, indicating improved airway protection in the closed condition.

Gross et al. (2003b) found that when the system is closed, the pharyngeal musculature may be optimally "programmed" because of a consequential segmental reflex arc that is stimulated. The number of lower motor neurons recruited may increase with this stimulation. This, in turn, may increase bolus speed, decrease pharyngeal contraction time, and strengthen the pharyngeal muscle action. A loss of the stimulation of the reflex component may prolong bolus transit time and pharyngeal activity duration in the open condition due to a loss of subglottic pressure and failure to stimulate the subglottic receptors. A specific segmental swallowing reflex in the brainstem may be stimulated by tracheal air pressure. This may influence the recruitment of pharyngeal swallowing musculature or may signal to the oral cavity and the pharynx that the larynx has sufficiently protected the airway. When subglottal pressure is diminished significantly or eliminated, this reflex may not be elicited.

Suiter, McCullough, and Powell (2003) studied the effects of cuff deflation and one-way speaking valve placement on swallow physiology. Results found that one-way valve placement significantly reduced scores on the penetration-aspiration scale for the liquid bolus when compared to the cuff-inflated and cuff-deflated condition. Most of the patients (8 of 10) were able to safely swallow thin liquids with the one-way valve in place but aspirated thin liquids with their cuffs inflated or deflated and no valve in place. Cuff deflation alone did not reduce or prevent aspiration because subglottic air pressure cannot be restored by cuff deflation alone. Subglottic airway pressure is improved with the use of a one-way speaking valve.

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Occluding the tracheostomy tube with a Passy Muir Valve may improve subglottic air pressure and have an overall impact on improving safety and effectiveness of the swallowing mechanism.

Prigent, Lajaille, Terzi, Annane, Figere, Orlikowski, and Lofaso (2012) studied the effect of a tracheostomy speaking valve on breathing-swallowing interaction. It was found that without a speaking valve, a significant part of the expiratory flow leaked through the tracheostomy tube. Leaks occurred during all expirations. Leakage through the tube occurred before, during, and after swallowing. When swallows were followed by expiration, there was considerably lower volume expired through the upper airway after expiration without a speaking valve compared to with speaking valve use. After swallowing, there was increased expired volume through the upper airway with use of the speaking valve. The authors concluded that in patients with a tracheostomy, protective expiration toward the upper airway after swallowing is restored with use of a Passy Muir Tracheostomy & Ventilator Swallowing and Speaking Valve.

Conclusions

Research suggests that there may be an optimal subglottic pressure range corresponding with improved swallowing parameters (Gross, 2009). However, individuals with tracheostomy tubes frequently have respiratory variables to consider, including diminished or absent subglottic air pressure. To address restoration of pressures, which impact bolus transit, pharyngeal activity, upper esophageal opening, and airway protection, a closed system is needed. Occluding the tracheostomy tube with a Passy Muir Valve may improve subglottic air pressure and have an overall impact on improving the safety and effectiveness of the swallowing mechanism.

PMV® 2001 (Purple Color™) shown on tracheostomy tube

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Article Summary

Kristin King, PhD, CCC-SLP

Use of the Passy Muir Valve (PMV) in line with the ventilator

Cameron, T., Zaga, C., Rautela, L., Chao, C., Ross, J., & Marchingo, E. (2017). *Scheduled use of the Passy Muir Valve (PMV) in line with the ventilator.* Austin Health: Australia.

This procedure was developed by Austin Health and is designed for use by various facilities and healthcare professionals. It provides step-by-step guidelines for placing a Valve in-line with mechanical ventilation. The development of this procedure was based on the rationale that patients should have access to the benefits that the Valve provides in the areas of voicing, coughing, swallowing, return of sensation, and smell.

Clinical Relevance of the Sensorimotor Pathways in Dysphagia Management following Tracheostomy

Kimberly Morris, MS, CCC-SLP, BCS-S, IBCLC

The oropharyngeal and esophageal swallowing systems are a challenge to understand fully due to the interdependence of sensory, motor, and behavioral systems. When patients are tracheostomy-dependent, assessment of their swallowing, establishment of the least restrictive diet, and identification of interventions to improve swallowing function pose a more difficult challenge than with patients who have an intact system. Airway protection in these patients becomes highly dependent on reintegration of the upper aerodigestive tract, use of compensatory abilities, medical status, and the integrity of the physiologic aspects of swallowing. An understanding of these systems is an essential precursor to appreciating how they interplay and relate to swallowing safety in patients with tracheostomies.

Sensory inputs in the oral cavity contribute to the efficient preparation and transport of a bolus (bite of food or liquid), while sensory receptors in the pharynx facilitate timely initiation of the swallow (Sinclair, 1970). Aberrant sensations within the areas of the upper aerodigestive tract may have various negative effects on the oropharyngeal swallowing processing. The sensory innervations that are critical to the swallow process include the maxillary branch of the trigeminal nerve (V2), the mandibular branch of the trigeminal nerve (V3), the facial nerve (VII), the glossopharyngeal nerve (IX), as well as the superior laryngeal and recurrent laryngeal branches of the vagus nerve (X SLN/RLN) (Jafari, Prince, Kim, & Paydarfar, 2003).

The primary contributors for motor innervation of swallowing include the mandibular branch of the trigeminal nerve (V3), the facial nerve (VII), the vagus nerve (X), the hypoglossal nerve (XII), and the ansa cervicalis (C1-C2; XII). Although the cranial nerves (CN) receive much attention when evaluating the stability of an individual's swallowing potential, both cortical and subcortical structures are involved. Sensory input by way of afferent (sensory) pathways carries vital information to the swallowing centers of the brain. This swallowing center, known as a central pattern generator (CPG), has effects on swallowing, such as triggering swallow initiation, shaping the swallow, and timing the sequence of the swallow (*see Figure 1*). The motor activity is flexible and dependent on the response to sensory input. This relayed information, such as bolus size (size of the bite) and location, is vital to the performance of the swallowing process.

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Bidirectional sensory afferent (superior laryngeal nerve) and motor efferent (recurrent laryngeal nerve) input to the central nervous system in response to stimulation of laryngopharyngeal mucosa typically results in firing of the thyroarytenoid muscle bilaterally in order to close the vocal folds (adduction) for airway protection (Domer, Kuhn, & Belafsky, 2013). More complex in nature is the swallowing process, which can be modulated both volitionally and reflexively, through sensory input (Steele & Miller, 2010). The input provided to the sensory system for elicitation of a functional motor response can be affected when airflow through the upper aerodigestive tract is bypassed with a tracheostomy. For example, bypassing the supraglottis (above the vocal folds) and subglottis (below the vocal folds) may compromise the laryngeal adductor response (Martin, et al., 1999).

Closing the system with a PMV® generates a significantly improved environment for reception of sensory information and an opportunity to maximize the physiologic swallowing potential.

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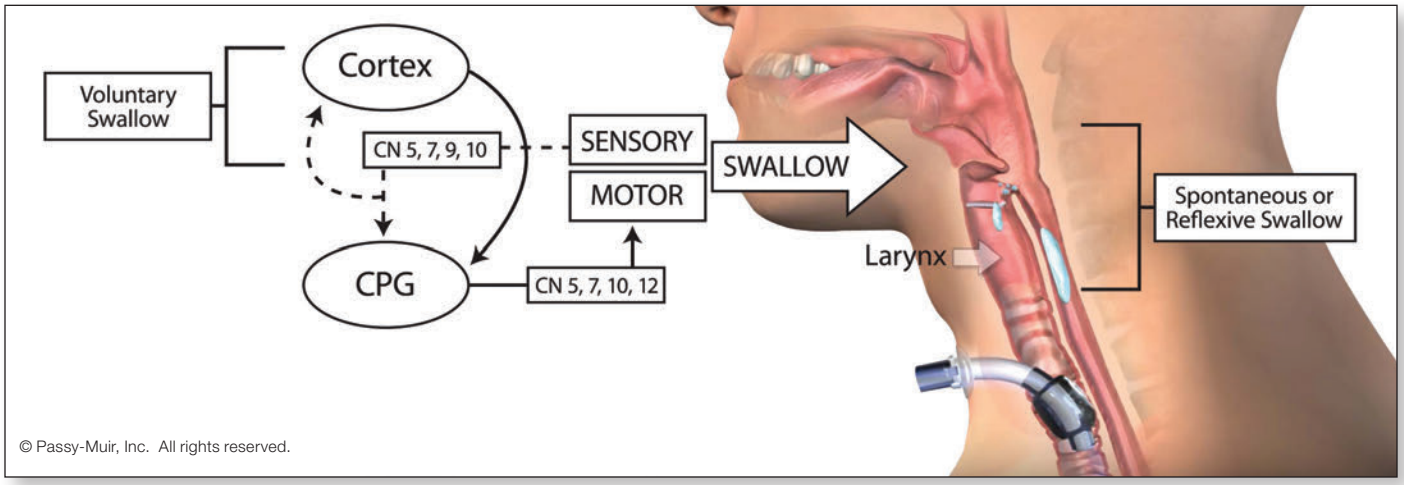

Figure 1: Sensory and motor inputs to the CPG and cortex for swallow function

The Passy Muir® Valve (PMV) is a unique option for patients with tracheostomies. The PMV may be used with a tracheostomy to restore a closed system. The Valve functions by closing at the end of inspiration and redirecting airflow during exhalation through the upper airway and out of the mouth and nose. This redirection of airflow would allow for increased distribution of sensory input to the larynx, pharynx, and oral cavity through re-establishment of the closed system (e.g., no escape of airflow through the tracheostomy tube) during swallowing. This effectively re-establishes subglottic pressure to facilitate respiratory and swallow processing by re-integrating the upper airway into the processes. Closing the system with a PMV generates a significantly improved environment for reception of sensory information and an opportunity to maximize the physiologic swallowing potential.

However, airway protection and overall swallowing function are not solely dependent on re-establishment of a closed system nor does a closed system dictate if a patient is safe to eat. As stated by Jadcherla (2017), "pharyngeal or esophageal stimulus evokes regional (pharyngo-esophageal reflex responses within the upper digestive tract), extraregional (responses within pulmonary and cardiac systems), and neurocognitive (sensation, perception, regulation of integrative reflexes) responses" (p. 14).

Further, a patient's control of respiration and the effect that swallowing may have on respiration and laryngeal responses must also be considered. The specific types of respiratory control and swallowing effectiveness for a patient depend on the consistency of the food and liquids being consumed, the manner in which someone receives oral intake, as well as the age of the patient, initial indication for tracheostomy, and other comorbidities. For example, establishment and maintenance of airway closure is different for single, large bolus swallows as compared to small, sequential swallows from a bottle (Gokyigit et al., 2009; Lazarus et al., 1993). Infants who are breastfeeding have even greater differences in swallow-respiration patterns than seen with bottle feeding.

Single sips of a liquid may serve as a reasonable means to maintain nutrition for an older child or adult who cannot sustain airway closure across sequential swallows. However, the integrity of an infant's laryngeal function and individual central pattern generators for respiration, sucking, and swallowing are essential in determining airway safety when feeding. Establishing an optimally closed system (e.g., through use of a Passy Muir Valve) during swallowing allows for generation of the subglottic pressure needed to establish and maintain laryngeal elevation with approximation of the arytenoids to the lower epiglottic petiole. This pattern may aid in more timely initiation of swallowing, improved airway protection, and more efficient respiratory processes.

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Given that infants are also at risk for reduced minute ventilation when feeding, efficient swallow-respiration patterns are essential elements to consider when attempting to optimize respiratory reserves and potential for oral intake. Assessment of baseline respiratory dynamics and any changes to both swallowing pattern and safety in various feeding contexts are needed to determine if airway protection is being achieved and maintained across a feeding. For example, when evaluating an infant, several conditions should be assessed. During the assessment, the clinician should consider unpaced bottle feeding, paced bottle feeding, and feeding with AND without the Passy Muir Valve. These considerations are combined with different nipples that may change the suck:swallow:breath ratio and provide valuable insight into the safest avenue for feeding.

Although the sensorimotor benefits of accessing the upper airway and generation of ideal subglottic pressures during swallow are more easily achieved when using the Passy Muir Valve, this does not always equate to airway safety. Special consideration in assessment of breastfed and bottle-fed infants who depend on rapid and timely sequencing of airway closure when eating must be investigated. A patient's compensatory strategies to meet respiratory needs may be uniquely demonstrated during feeding. For example, in babies with reduced respiratory efficiency that is not due to laryngeal abnormalities (e.g., diaphragmatic paresis, Spinal Muscular Atrophy), their systems may be hypersensitive to the slight increase in time for the expiratory phase to be completed.

While Passy Muir Valve use during feeding assists with closing the system and restoring pressures and sensation, use during non-feeding tasks also may be essential due to providing increased PEEP (positive end-expiratory pressure), sensation, increased swallowing frequency for secretion management, sustained voicing, and auditory self-feedback for speech/language development. The benefits achieved with a closed system are not limited to feeding only.

However, it is important to note that in children with tracheostomies the presence of the tracheostomy tube does not dictate that aspiration and impaired swallowing function will occur. The ability of a patient to achieve the necessary sensorimotor processes for airway protection are paramount, and the direct benefits that a Passy Muir Valve has on airway safety during breast/bottle feeding or cup drinking depends on the overall stability of the child's system. Knowing the stability of each system (motor and sensory) is essential in treatment planning and generating the least restrictive plan. Assessment of swallowing function, with and without Valve placement, should always be assessed during bedside evaluations, Flexible Endoscopic Evaluations of Swallowing (FEES), and Modified Barium Swallow Studies (MBSS). Valve use may address conditions that would otherwise make risks of aspiration higher. During these assessments, attention to oropharyngeal swallowing functions that support airway protection or result in compromise is critical.

If physiologic function and airway protection appear similar, the benefits of using the Passy Muir Valve during meals to optimize sensory feedback from the larynx and the potential for improved cough to expel aspirated material should be strongly considered when making follow-up recommendations. In addition, if a patient is not able to restore upper airway access through Passy Muir Valve use, the medical team should assess tracheostomy tube size and consider direct visualization of the suprastomal trachea. In some circumstances, use of the PMV is unable to be achieved due to limitations with airway patency. Although reassessment of candidacy should be ongoing, ways to improve access to the upper aerodigestive tract should be explored to allow for sensorimotor integration in support of feeding progression. Improving access may include continued trials in therapy or simply short bursts of tracheostomy tube occlusion on exhalation to redirect airflow through the upper airway. During treatment, observation of the effects on swallowing frequency, swallowing recruitment, physiologic stability, sensory response to pressure changes, vocal function, and oropharyngeal clearance should be observed.

Oropharyngeal swallowing function is dynamic in adults and pediatrics with comorbid diagnoses, especially in those who are tracheostomy dependent. Determination of airway safety when feeding and establishment of interventions to improve swallowing function are dependent upon the stability and integrity of individual systems. Additionally, the modulation of the central nervous system with the medullary controlled swallowing centers include significant contributions from both sensory and motor pathways (Lowell et al., 2008; Ludlow, 2015). Therefore, the use of a Passy Muir Valve to re-establish a patient's access and utilization of the upper aerodigestive properties and functions, including voice production, has the potential to optimize swallowing safety and function. However, swallow processing under certain contexts (e.g. high respiratory demands, conditioned behavioral responses, altered laryngeal/pharyngeal anatomy) is highly variable and individual compensatory

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differences may exist. Thorough assessment of swallowing physiology and generation of specific therapy targets should be completed in more than one context. This includes swallowing assessment with the use of a Passy Muir Valve, as well as with an open tracheostomy tube, in order to identify unique characteristics of each swallowing system that affect overall safety and progression of skills. This complete assessment allows for the best possible outcomes.

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Article Summary

Kristin King, PhD, CCC-SLP

Use of a Speaking Valve in Children

Zabih, W., Holler, T., Syed, F., Russell, L, Allegro, J. & Amin, R. (2017). The use of speaking valve in children with tracheostomy tubes: What is the scope of the literature. *Respiratory Care, 62*(12):1594-1601. doi: 10.4187/respcare.05599

This article provides a scoping review of the research related to children with tracheostomy tubes. From their review, the authors synthesize and summarize the current evidence on the use of one-way tracheostomy tube speaking valves in the pediatric population. From their initial search, the authors identified a total of 524 articles. After using inclusion and exclusion criteria, a total of 12 articles met inclusion criteria. The authors identified the levels of evidence (using the Sackett levels of evidence) to evaluate the qualitative strength of the evidence provided by the 12 studies and found that six studies were level 5, four were level 4, and two studies were categorized as level 3 evidence. The authors found that eligibility criteria for trials of speaking valves were inconsistent across all studies. The authors shared that all included studies had been conducted with the Passy Muir Valve®.

Much of the reviewed literature focused on tolerance or successful use of speaking valves in children with a tracheostomy but provided limited evidence on its impact on verbal communication. Four studies addressed successful use of the speaking valve as a primary focus and all studies reported use without adverse events during wake hours in 100% of the participants, and one study reported similar findings when used during sleep. Another benefit found in pediatrics was verbalizations and communication attempts. Various parameters for speech were assessed, including modal voice, phonation type, pitch, loudness, breath support, and voice continuity. The studies recorded spontaneous speech in older children and babbling in infants and those in the prelinguistic developmental stage. Communication attempts and verbalizations were found to be feasible in 74.3% of the children on first use. Additional benefits related to secretion management, improved cough, improved swallowing, ease of breathing, and reduced aspiration were a secondary focus in 50% of the studies. Current evidence on the use of the Passy Muir Valve in children with a tracheostomy demonstrated multiple benefits for infants through older children.

Carmin Bartow, MS, CCC-SLP, BCS-S

Carmin Bartow, M.S., CCC-SLP, BCS-S has over 20 years of experience as a medical SLP. She is currently employed at Vanderbilt University Medical Center, specializing in dysphagia management, trach/vent intervention, and in swallowing disorders in the head and neck cancer population. In addition to her clinical responsibilities, she facilitates a head and neck cancer support group, enjoys guest lecturing at Vanderbilt University, and is an Educational Consultant for Passy-Muir, Inc.

Matthew T. Brigger, MD, MPH

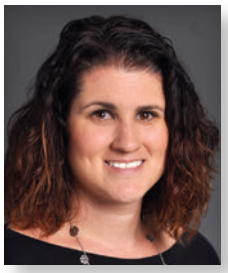
Dr. Brigger is Chief of the Division of Otolaryngology at Rady Children's Hospital-San Diego and Associate Professor of Surgery at UC San Diego School of Medicine. His primary clinical interests are diseases of the upper aerodigestive tract, with a focus on surgical management of children with breathing and swallowing disorders. Dr. Brigger conducts research on treatment outcomes for children with breathing and swallowing disorders and has authored over 60 peer-reviewed studies. He presents at national and international meetings.

Laura Brooks, MEd, CCC-SLP, BCS-S

Laura attended the University of Florida, finishing in 1997, and the University of Virginia, graduating in 1999. She worked at NYU Medical Center, became the supervisor of the pediatric SLP department, and then joined Children's Healthcare of Atlanta in 2009. She works with patients in the Intensive Care and acute care units; is Board Certified in Swallowing and Swallowing Disorders; and participates in research related to tracheostomies, speaking valves, and evidence-based care.

Melissa Gulizia, BS, RRT

Melissa Gulizia is currently the Pulmonary Program Manager at Madonna Rehabilitation Hospitals. She has worked at Madonna for 12 years in numerous roles across the continuum. Melissa is a graduate from Southeast Community College in 2006 with an AAS in Respiratory Therapy followed by a BS in Health Care Management in 2011 from Bellevue University. In addition to holding leadership roles, she has provided direct patient care, interdisciplinary education, trainings, and consultations to facilities in the region.



Jennifer Henningfeld, MD

Dr. Jennifer Henningfeld is the Medical Director of the Pediatric Tracheostomy and Home Ventilator Program at Children's Hospital of Wisconsin in Milwaukee, WI. Her research examines both ventilator weaning and decannulation protocols, as well as developmental outcomes in children with tracheostomy. She emphasizes a multidisciplinary approach to tracheostomy care.

continued next page

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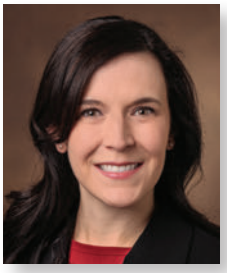
Cecilia Lang, MSN, CCRN, PPCNP-BC is the CNS Program Manager for the Tracheostomy/ Home Ventilator Program at the Children's Hospital of Wisconsin Milwaukee. Cecilia provides care coordination for an average of 175 patients and works collaboratively with her multidisciplinary team on patient and staff education, policy development, research, and quality improvement.

Kimberly Morris, MS, CCC-SLP, BCS-S, IBCLC

Practicing since 2006, Kimberly evaluates and treats patients with feeding and swallowing impairments, as well as cognitive-communication impairments in neonates through young adults. Kimberly joined Rady Children's Hospital San Diego in 2018, after previously working at Al duPont Hospital for Children and Miller Children's Hospital Long Beach. She conducts FEES assessments and is a Modified Barium Swallow Impairment Profile (MBSImP) registered clinician. She also participates in national research initiatives to optimize dysphagia outcomes for neonates with congenital heart disease and for children who are tracheostomy-dependent.

Brett Nickisch, MA, CCC-SLP

Brett Nickisch is an ASHA-certified Speech-Language Pathologist. She specializes in the assessment and treatment of swallowing disorders in adults in both the inpatient and outpatient setting. She has a special interest in the head and neck cancer population. She currently practices in Kansas City, MO.



Meredith Oakey Ashford, MS, CCC-SLP

Meredith Oakey Ashford, M.S., CCC-SLP has over ten years of experience in adult acute care at Vanderbilt University Medical Center in Nashville, Tennessee. In addition to clinical practice, she is also a co-instructor of the Dysphagia course at Vanderbilt University and the lead SLP in the interdisciplinary Geriatrics and Palliative Care teams.

Cheryl Tansley, MS, CCC-SLP

Cheryl Tansley, MS, CCC-SLP received her BS and MS at Worcester State University and has 18 years' experience in adult-based settings. Currently, she works at Gaylord Hospital in CT, a long term acute care hospital. Cheryl is a key member of the tracheostomy and ventilator team and focuses on improving patient outcomes for swallowing and decannulation.

Cheryl Wagoner, MS, CCC-SLP, BCS-S

Cheryl Wagoner is the Inpatient Therapy Director for the Specialty Hospitals at Madonna Rehabilitation Hospitals. She was a staff SLP with Madonna Rehabilitation Hospital on the Long Term Acute Care Hospital (LTACH) unit for 14 years where she gained extensive experience working with medically complex adults with tracheostomy tubes and mechanical ventilation.

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