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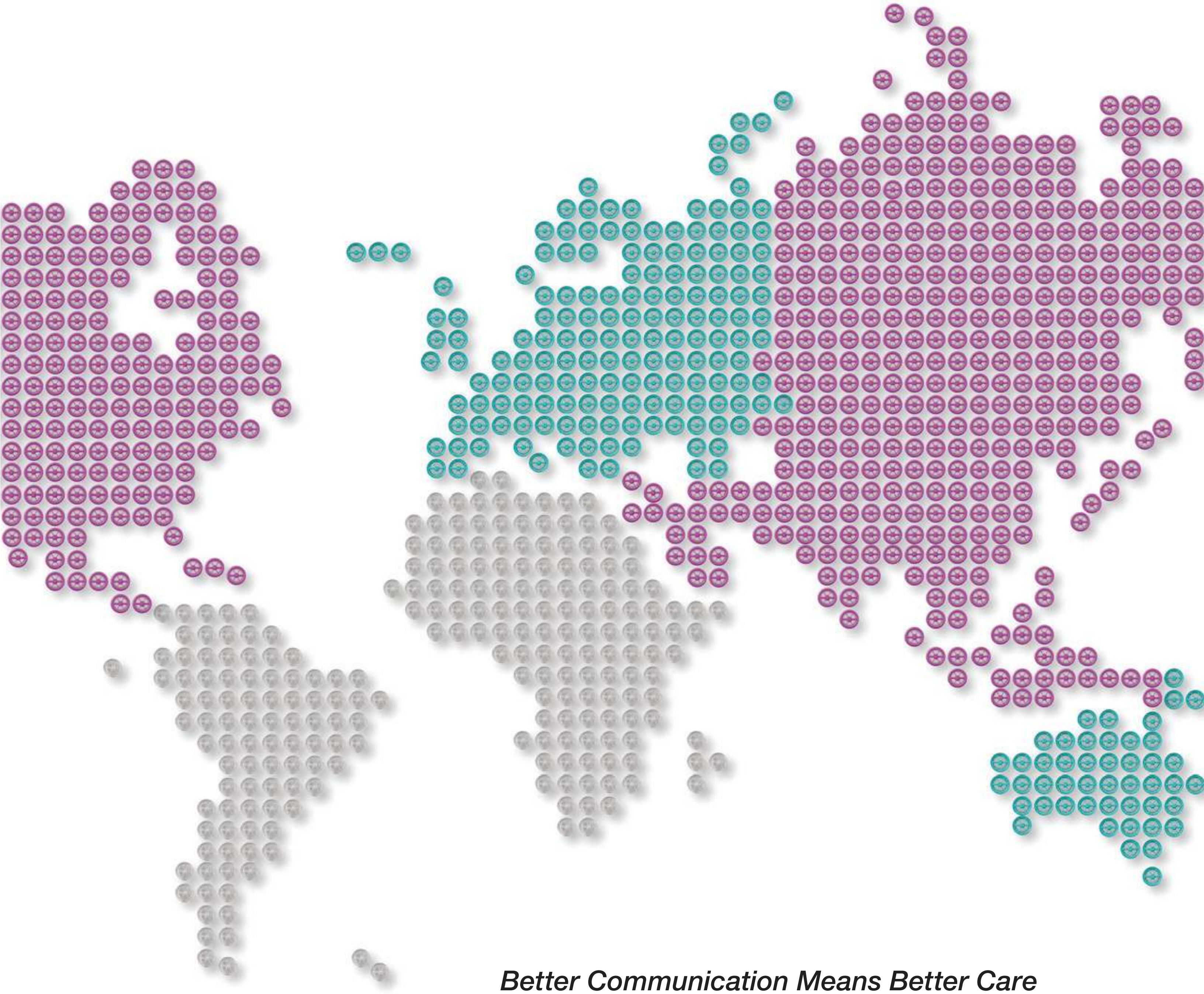

Better Communication Means Better Care

Volume 2, Issue 1

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

International Perspectives on 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 the use of the PMV.

In each edition, you will find key elements:

- Editor's Commentary – An overview of the publication's theme topic or question
- Healthcare Practitioners' Perspectives – Articles by Physicians, Respiratory Therapists and Speech-Language Pathologists on clinical issues
- Peer-Reviewed Published Research Studies – Top studies with summaries of each featured article
- Research Bibliography – A bibliography of the top articles on the publication's theme
- Clinical Take-Home Boxes – Relevant clinical information for healthcare practitioners
- Hot Topic Box – Key clinical questions that have been hot topics from our tech calls or clinicians

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Financial Disclosure

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About the Cover:

In keeping with the international theme, this issue's cover is comprised of images of Passy Muir® Valves (PMV® 2001, PMV® 2000, and PMV® 007), arranged to represent a map of the world.

For this issue, the primary focus is: *International Perspectives on 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 a myriad of other factors. Because an acceptable, consistent standard of care does not exist internationally, this issue focuses on providing the perspectives of professionals from around the globe. Because of the complex nature of care for these patients, having an awareness of research findings and medical practices from multiple resources and other healthcare professionals is imperative for best practice. The broader the experience and knowledge that is considered, the stronger the outcomes and plans of care.

A primary means for closing the system is to use the Passy Muir Tracheostomy and 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 cords and upper airway. Research has shown that this redirection of airflow assists with improving secretion management, increasing sensory awareness, improving swallowing, and restoring natural physiologic PEEP (positive end expiratory pressure), among other benefits.

The participating authors in this issue address considerations for prolonged weaning from mechanical ventilation, phrenic nerve stimulation, team management of patient care, and the role of the speech-language pathologists. The authors of the various articles hail from England/UK, Switzerland, and the United States, bringing a broad range of experiences. One emphasis that each author brings to the forefront is that team management is a key element when working with patients following tracheostomy and mechanical ventilation. A takeaway from this issue is that each team member provides a significant role in assisting with the plan of care and the progression of care with this patient population. It also addresses troubleshooting various difficulties such as poor diaphragm function, dysphagia, and respiratory complications from disease.

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.

Impacting Patient Care and Ethical Considerations

Kristin King, PhD, CCC-SLP

Ethical considerations are constantly evolving as medical care changes and advances. Because of the ever-changing state of medical care, being aware of the current research must be maintained at an international level as researchers from around the globe contribute to the standard of care for patients with tracheostomy and mechanical ventilation. However, a challenge to healthcare professionals is clarifying their role in the decision process for medical care and determining appropriate interventions for patients. The ethical standards that should be addressed in practice go beyond individualized, personal professions; they also incorporate the rights of patients and the consideration of a patient's ability to access communication and to participate in their medical care. The efficiency and efficacy of the communication method provided is a primary aspect to patient care.

The articles in this issue provide support for both team management and early intervention with patients following tracheostomy to provide best practice. In the article by Hans Schwegler and Bischof, he follows the care of one patient over a year and provides perspectives on team management and complex problem solving with unique patient issues. The complexities of managing this patient population become evident through this patient case study. Each article provides a perspective on advances which are occurring in care management, from advanced treatment interventions to such practices as phrenic nerve stimulation.

However, as advances are made in medical care, an examination of ethical standards emerges on many levels to meet the demands of proper patient care and professional practice. Ethics in medical healthcare include the consideration of bioethics that deal with decisions related to both old and new practices in healthcare. An evolution of traditional ethical standards is being observed because standards for new issues are created – and then challenged and revised. The conversation is often sparked by new developments in patient care and it is constantly evolving. Kummer and Turner (2011) discussed that because the practice of medicine and medical speech-language pathology affects the health, well-being, and quality of life of individuals served, adherence to a code of ethical conduct is critically important in the healthcare environment.

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One question that arises to challenge healthcare professionals on the medical front is what role each team member has in the decision process when determining appropriate interventions for patients with tracheostomy and mechanical ventilation. When patients are in the intensive care unit of a medical facility, one patient population to manage are those who are intubated, requiring mechanical ventilation to support their respiratory function. However, a dilemma arises with the decision of whether or not to pursue a tracheostomy tube and the timing of that placement. Desai and Chakrabarti's article in this issue addresses the question of prolonged mechanical ventilation and the complications that arise. They walk the reader through the team concept and the members of a multidisciplinary team. While historically, Speech-Language Pathologists (SLPs) would not be involved at this level of care (prior to a patient's ability to access communication and swallowing), because of the negative impact of intubation on swallowing and communication and the research which shows the significant benefits of early intervention – SLPs have a role in this decision process which Desai and Chakrabarti explore. This earlier intervention leads to the direct care of the patient with a tracheostomy and many questions arise as to the Scope of Practice of an SLP of working with these patients and the ethics behind conducting tasks that some see as more medical in nature versus "speech."

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Another aspect regarding the care of patients in the critical and acute settings is their ability to participate in their medical care and to make decisions, both of which are a basic human right. When a patient is intubated, they have lost their voice. However, various regulations, such as the ADA (American Disabilities Act), require that a patient have access to the least restrictive means of communication and access to participation in their medical care. “The ADA applies to all hospital programs and services… Wherever patients … are interacting with hospital staff, the hospital is obligated to provide effective communication… Effective communication is particularly critical in healthcare settings where miscommunication may lead to misdiagnosis and improper or delayed medical treatment.” While in the United States, the ADA provides support for access to communication, internationally; each country has their own system to address patients’ rights. The research that has best illustrated the impact that a loss of voice has on multiple aspects of a patient’s life is shared within the research article summaries.

Freeman-Sanderson et al. (2016) found that patients who were intubated or on mechanical ventilation without a means to voice had a higher incidence of depression and anxiety. The findings from this study indicated that patients with return of voice, by using a no-leak speaking valve, had decreased anxiety, improved mood, and shorter lengths of stay in the ICU. Another consideration to early voicing is that the AMA (2016) stated that is a fundamental requirement both by law and ethics for patients to have access to informed consent. Patients have the right to receive information and ask questions about recommended treatments, so that they can make well-considered decisions about care.

> *Several authors have reported that decreased access to communication also may partially explain why pain continues to be frequently undiagnosed and mismanaged.*

Another aspect of care that is covered within the research article summaries and by Schwegler and Bischof is how poor access to communication or a lack of voice impacts a patient’s ability to notify and interact with medical staff effectively as it relates to their direct care. It also has been reported that patients who cannot communicate are in more pain. Not only is there a link to the degree of pain, but it has been reported that difficulty communicating with healthcare practitioners remains a significant barrier to accessing pain relief (Limaye & Katz, 2006; Wiltshire, Cronin, Sarto, & Brown, 2006). Several authors have reported that decreased access to communication also may partially explain why pain continues to be frequently undiagnosed and mismanaged (Limaye & Katz, 2006; Wiltshire, Cronin, Sarto, & Brown, 2006). Due to the private and subjective nature of pain, it is necessary to communicate about the pain and the level of its impact, if others are to be aware of its presence and nature. It also has been shown that adverse events are three times more likely to occur when communication between medical professionals is not correct and efficient. In United States medical facilities, review of and adherence to standards is often overseen by JCAHO (Joint Commission: Accreditation, Healthcare, Certification). Meeting JCAHO’s goal is not the only reason to encourage patients to have a voice in their care though: patients who are actively involved in their care often have better outcomes (Metules & Bauer, 2006).

The contributing authors to this issue all share some aspect of patient care that is not only related to a patient’s right to communicate and to participate in their medical care but also the importance of a multidisciplinary team for best practice. It is a universal consideration for the care of patients with tracheostomy and, therefore, knowing the international perspective assists with developing evidence-based practice and meeting ethical standards related to the rights of patients.

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Understanding the Management of Patients Undergoing Prolonged Weaning from Mechanical Ventilation: Perspectives from a Speech-Language Pathologist and a Respiratory Physician

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Patients presenting with respiratory failure are now surviving with the help of medical advances, including tracheostomy tubes and mechanical ventilation. The care of patients on mechanical ventilation has changed significantly over recent decades. Since the 1950s, there has been a shift from devices delivering negative-pressure mechanical ventilation to invasive positive pressure ventilation modes. Frequently, ventilation is delivered via tracheostomy tubes and permits prolonged mechanical respiratory support for most individuals with respiratory failure. The presence of the tracheostomy tube accomplishes multiple airway management goals; establishing a patent airway, as well as providing a connection to assisted ventilation (Robert & Argaud, 2007).

A uniform and broadly accepted definition of the term "weaning" is crucial to avoid confusion and is an essential prerequisite for interpreting the literature and guiding clinical decision-making. Weaning from mechanical ventilation is defined as "the process of withdrawing ventilator support" (Navalesi et al., 2014). It is commonly accepted that the process of weaning starts with the first spontaneous breathing trial (SBT), during which the patient is allowed to breathe for a relatively brief period of time (30–120 min) through a T-tube, or with low levels of either CPAP (2–5 cmH_2O) or pressure support (≤ 8cmH_2O). When the SBT is successful, the patient is considered weaned and ready to be extubated, provided that the natural airway is not at risk for obstruction.

A recently proposed and largely accepted classification based on the difficulty and duration of the weaning process includes: (1) simple weaning, i.e., the patient passes the initial SBT and is successfully extubated at the first attempt; (2) difficult weaning, i.e., up to three SBT or 7 days from the first SBT are necessary to withdraw mechanical ventilation and extubate the patient; (3) prolonged weaning, i.e., more than three SBTs or 7 days from the first SBT are required (Boles et al., 2007).

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The variability of the potential influences on weaning success has created awareness that the process is facilitated by a "best practice" of collaborative multidisciplinary care. O'Bryan et al. (2002) described weaning protocols for a system of long-term acute care hospitals that included a consistent approach and protocol to weaning, the participation of rehabilitation services, and early and aggressive intervention as well as nutritional support. There is evidence that implementing standardized weaning protocols may reduce the duration of mechanical ventilation and length of stay in the Intensive Care Unit (ICU) patients (Blackwood et al., 2011). However, it is important that when applied specifically to the subset of patients with weaning difficulty, the use of "weaning protocols" are tailored to the individual patient, reflecting a holistic, multidisciplinary assessment, including consideration for the underlying cause and aggravating factors contributing to prolonged mechanical ventilation.

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In the ICU, the majority of patients can be successfully liberated from mechanical ventilation without difficulty (Cohen & Booth 1994). However, up to 50% of the time a patient spends on the ventilator may be involved in the process of weaning from mechanical ventilation and approximately 14% of patients receiving mechanical ventilation undergo a "prolonged weaning" process (Esteban et al., 1994; Funk et al., 2010).

The Burden of Prolonged Weaning

A report from the UK revealed that 8% of ICU patients had "weaning delay" (defined as the need for ventilatory support for more than 2 weeks in the absence of any non-respiratory factor preventing weaning) and 7% had so-called "weaning failure" (if this state persisted for 3 weeks or more) (NHS Modernisation Agency, 2002). While for approximately 70% of patients, the weaning process is simple and successful; for the remaining 30%, the initial attempt fails, making the weaning difficult and worsening prognosis. ICU mortality has been reported to be as high as 25% in these patients, with about half progressing to prolonged weaning (Navalesi et al., 2014). Furthermore, patients with prolonged weaning account for 6% of all ventilated patients but consume 37% of ICU resources (Warren et al., 2003). From an economic perspective, US annual costs for mechanical ventilation are estimated to be 27 billion dollars, corresponding to more than 10% of all hospital costs. Each year, about 300,000 people receive prolonged mechanical ventilation in ICU's in the US, and this number might double within the next decade, with costs increasing up 50 billion dollars (Zilberburg, 2008). Therefore, prolonged weaning carries not only a medical but also a significant social and economic burden.

The Role of Specialized Weaning Units and Multidisciplinary Teams

The appropriateness of the ICU environment for long-term management of patients undergoing prolonged weaning may be questioned by the detrimental consequences on the psychological and cognitive function of these patients, coupled with a paucity of ICU beds failing to adequately address demand. An otherwise stable patient who remains on mechanical ventilation may be considered for transfer to a specialized weaning unit (SWU). Though there is not a precise definition, SWU can be considered as highly specialized and protected environments for patients requiring mechanical ventilation despite resolution of the acute disorder. The philosophy of such units lies in the delivery of holistic care from a truly multidisciplinary team encompassing a variety of specialties, including skilled nursing staff, physiotherapists (a designation used outside the US; within the US, the team would have respiratory therapists and physical therapists), physicians, speech-language pathologists, dieticians, psychologists, mental health services, social workers and palliative care.

Such an approach to "difficult weaning" would include an appreciation of the existence of underlying medical and psychological problems that may be contributing to weaning delay in each patient that may have been unrecognized in a busy ICU setting. These include the presence of chronic hypoventilation (failure to breathe rapidly enough or deeply enough), parenchymal lung disease (a group of lung diseases affecting the interstitium (the tissue and space around the air sacs of the lungs), neuromuscular conditions, cardiac disease, electrolyte abnormalities, nutritional deficiencies, inadequate muscle mass, and significant critical illness neuropathy. The tenets of care in specialized weaning units aim to focus on privacy, sleep quality, utilization of weaning protocols tailored to the individual patient, and optimizing comorbid medical conditions in an environment away from an acute ICU with the absence of invasive monitoring or multi-organ support (NHS Modernisation Agency, 2002).

To highlight the benefits of such an approach, a prospective study of 262 patients receiving prolonged invasive mechanical ventilation admitted to one such specialized unit in the UK over an 8-year period reported a successful outcome from weaning (i.e. liberation from invasive ventilation) in 64% of the patients (Mifsud Bonnici et al., 2016). Of those who were successfully weaned, 62% of those participants discharged were alive 12 months post discharge. Other observational studies report that 34–60% of patients in specialized weaning units can be weaned successfully from ventilatory support and suggest successful weaning can occur up to three months after admission to these SWU's, without adversely affecting long-term mortality (Boles et al., 2007).

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Initial Strategies for Patients Undergoing Prolonged Weaning

A preferred initial strategy is to maintain mechanical ventilation completely at nighttime; therefore, ensuring the patient has adequate "rest" during this period whilst aiming for either progressive ventilatory independence or a gradual reduction in the level of ventilator support in the daytime, depending on the individual patient. This initial approach is supplemented by regular detailed review of the patient's swallow and bulbar function. When possible, progressive periods of tracheostomy cuff deflation during the daytime and allowing the patient to talk through speech devices, such as the Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve, are utilized. Allowing the patient to talk, regaining the sensation of taste and resuming oral, nutritional intake as early as feasible during the weaning process, carries significant physical and psychological benefits. The tracheostomy may also be downsized permitting the introduction of Non-Invasive Ventilation (NIV) early in the weaning process, if deemed safe and appropriate; still enabling the patient to receive ventilation by tracheostomy, if required. It is also imperative to ensure that aggressive secretion management occurs in patients, if successful liberation from tracheostomy ventilation is to occur.

Non-Invasive Ventilation

The application of NIV in subjects with weaning difficulty has been shown in the literature to represent a useful strategy (Burns et al., 2013; Girault et al., 2011). Ferrer et al. (2003) investigated the use of NIV in weaning by randomizing 43 participants undergoing invasive mechanical ventilation who had failed a 2-hour T-piece trial for 3 consecutive days to either extubating and NIV or a "conventional" weaning plan consisting of continued daily weaning attempts. Liberation from invasive ventilation and 90-day survival were both greater in the NIV arm, where there was a significantly decreased incidence of nosocomial pneumonia and septic shock. A randomized controlled trial conducted in 13 ICUs comprised of 208 participants with chronic hypercapnic respiratory failure (respiratory failure with increased arterial carbon dioxide levels), who had failed an SBT, found that the group who was extubated to NIV had a significantly reduced occurrence of acute respiratory failure post-extubation compared to those extubated to oxygen therapy or those who continued a weaning strategy using Intermittent Mandatory Ventilation (IMV) (Girault et al., 2011). The results from these studies suggest that NIV represents a useful tool in the management of patients undergoing a prolonged weaning process.

High Flow Nasal Oxygen Therapy

Another technique that has a potentially useful application in the weaning process is that of High Flow Nasal Oxygen Therapy (HFNOT). HFNOT aims to derive greater physiological benefit by delivering heated and humidified oxygen therapy through a nasal cannula at higher flow rates (up to 60 liters/minute) when compared to standard oxygen delivery devices (Spoletini et al., 2015). This results in greater washout of the upper airway dead space facilitating removal of carbon dioxide. It also results in delivery of a small degree of Positive End Expiratory Pressure (PEEP), allowing alveolar recruitment, thus aiming to reduce the work of breathing as well as maintaining patient comfort through the delivery of warm humidified gas. At present, there is a paucity of high-quality evidence examining the utility of HFNOT in subjects undergoing prolonged weaning despite some data pointing to improvements in oxygenation with HFNOT in this cohort (Corley et al., 2017). In a multi-center study comparing 604 extubated patients deemed at high risk of re-intubation randomized to either HFNOT or NIV post-extubation, no significant differences were noted in the rate of re-intubation or in-hospital mortality (Hernandez et al., 2016). Whilst such data is encouraging, further research is needed in this area to identify those subgroups of patients with weaning difficulty who may benefit from the use of HFNOT as a tool in the liberation from mechanical ventilation.

Management of Comorbidities

Adequate management of comorbidity also is integral to the management of patients with weaning difficulties. For example, it is important that healthcare professionals pay attention to fluid overload and to the optimization of cardiac function during the weaning process. A weaning strategy that includes fluid management driven by serum B-type natriuretic peptide (BNP) levels has been shown to confer superior outcomes in terms of duration of weaning and time to successful extubation when compared to a more conventional approach with no significant differences in terms of incidence of electrolyte abnormalities and renal failure between the two groups. A potential mechanism postulated to explain the beneficial outcomes reported of such a biomarker based approach may lie in the reduction of Ventilator Associated Pneumonia (VAP) as pulmonary edema may affect the alveolar bacterial clearance (Mekonto Dessap et al., 2014).

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Role of Allied Health Professionals and Trach Teams

The role of Physical Therapy and Occupational Therapy at an early stage in the management of patients aiming to be liberated from mechanical ventilation cannot be over-emphasized. Early physical and occupational therapy is feasible from the onset of mechanical ventilation, despite high illness acuity and presence of life support devices. Adverse events are uncommon, even in this high-risk group (Pohlman et al., 2010). This includes multiple domains such as early mobilization and transferring, attention to posture and balance, maintenance of muscle mass, peripheral muscle training, airway secretion management, and respiratory muscle training (Ambrosino et al., 2012). To emphasize the importance of rehabilitation, the "real world" service review reported that 48.1% of patients admitted to a specialist weaning unit in the UK were discharged to the referring hospital for on-going rehabilitation needs (Mifsud Bonnici et al., 2015).

Another area of utmost importance in the management of subjects with weaning difficulty is the role of Clinical Psychology and Mental Health services. The impact of prolonged mechanical ventilation and the events leading to the ICU admission may carry a significant burden both on patients and family members in terms of depression, anxiety, and other mental health issues and this may be overlooked by healthcare professionals in a busy ICU environment. In a seminal study, depressive disorders were found to be present in 42% of patients undergoing weaning difficulty and were associated both with weaning failure and an elevated mortality rate (Jubran et al., 2010b). These issues may persist even after the weaning period; highlighting the importance of creating a structured holistic follow-up program for patients following discharge from the hospital. Beyond healthcare professionals simply recognizing such conditions, it is worth appreciating that such a traumatic experience may greatly alter the patient's perception of the environment around them, their progress during the process of being liberated from the ventilator, medical interventions and actions of healthcare professionals caring for them. Nutritional status is integral in the weaning process. Patients with tracheostomy who are dependent on ventilators, and who have decreased nutritional intake, may experience protein–calorie malnutrition, which reduces respiratory muscle strength and function. Registered Dieticians play an integral part in the nutritional management of such patients. Through special enteral feeding formulas and oral supplements, dieticians can address hypoalbuminemia (low level of albumin in the body) and heal and prevent pressure ulcers, while maintaining optimal support for weaning. When an oral diet is recommended, Speech-Language Pathologists and Registered Dieticians work closely together to maximize caloric intake, modifying consistencies as needed to achieve appropriate nutrition and hydration in the safest and most effective manner.

Placement of a tracheostomy tube may be necessary for patients in the ICU with respiratory failure. In fact, the incidence of tracheostomy seems to be increasing out of proportion to the increased need for mechanical ventilation. This has led some hospitals to develop specialized tracheostomy teams to standardize and deliver specialized patient care to reduce perioperative tracheostomy-related complications; typically delivered by multiple providers, including the primary physician, resident, mid-level providers, consulting surgeon, nurse, Respiratory Therapist, and Speech-Language Pathologist. Multidisciplinary tracheostomy and wean teams have been successful in improving patient outcomes. One study showed that the addition of a post-tracheostomy care bundle to a multidisciplinary tracheostomy service significantly improved rates of decannulation and tolerance of oral diet (Mah et al., 2016). Standardized care provided by a specialized multidisciplinary tracheostomy team also was associated with fewer tracheostomy-related complications and an increase in the use of speaking valves (Mah et al., 2016).

Role of the Speech-Language Pathologist (SLP) in Patients Undergoing Prolonged Weaning

Speech-Language Pathologists (SLPs) address the communication and swallowing needs of the tracheostomized and ventilator-dependent population throughout the course of the patient's recovery. Adults who are tracheotomy and ventilator dependent or who are undergoing prolonged weaning are some of the most challenging patients in the caseload of an SLP. Airway issues influence many aspects of patient care, including swallowing. The medical issues for patients with these complex cases greatly affect their rehabilitation. Physicians, SLPs, and other members of the multidisciplinary team must work together in their management, especially to understand the influence of pulmonary physiology on swallowing and swallowing dysfunction. Often, these tracheostomized and ventilator dependent patients have long-term alternative feeding methods placed early in their acute medical course. Without SLP intervention, these patients may never return to an oral diet. Communication and swallowing management can greatly enhance the quality of life for these long-term mechanically ventilated individuals.

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Swallowing

Deglutition and respiration are shared systems. Remediation of swallowing function can assist in the weaning and decannulation process by restoring airflow to the upper airway and addressing airway protection deficits. The entire medical team must have an appreciation for the timing of swallowing management with other medical interventions, such as weaning, and make appropriate adjustments to the patient's plan of care. For those individuals where weaning from mechanical ventilation is not possible, the ability to take even a small amount of oral intake can greatly improve their quality of life (Dikeman & Kazandjian, 2000). The clinical literature does not support a direct, causal relationship between tracheostomy, mechanical ventilation, and swallowing impairment; however, the clinical course of these medically fragile patients typically includes a disruption of swallowing function (Donzelli et al., 2005). Many of these patients receive feeding tubes simultaneously with the tracheotomy, without a swallow assessment. This may result in the patient's long-term non-oral status, influencing an important aspect of quality of life. For some individuals, the events that led to respiratory failure and the need for mechanical ventilation may create dysphagia or exacerbate dysphagia that is already present. In addition, the presence of dysphagia may affect the individual's ability to wean from ventilation. The consequences of pulmonary aspiration may be more significant for patients already in an immuno-compromised state, who are often malnourished, have multiple medical issues, and are receiving polypharmacy (Langmore, 1996).

Communication

This is a key issue for ventilated patients, who find the inability to speak distressing (Dikeman et al., 2000). Difficulties with communication in the tracheostomy patient population have been associated with social withdrawal, leading to depression, lack of motivation to participate in care (Leder, 1990; Freeman-Sanderson et al., 2016), poor sleep, and increased anxiety and stress levels (Egbers, 2014; Freeman-Sanderson et al., 2016) which have both short-term and long-term impacts on patient outcomes in ICU and post ICU stays. By demonstrating the potential physiological benefits on top of the already known and more obvious psychological benefits, speaking valves present an excellent way to improve patient care in the ICU.

Use of Speaking Valves

The inability to communicate during periods of mechanical ventilation (MV) can significantly increase psycho-emotional distress (Egbers et al., 2014) and has been associated with depression and post-traumatic stress disorder (Jubran et al., 2010a). One-way speaking valves can be used to restore verbal communication for patients who require MV. The Passy Muir® Valve is the only bias-closed position valve that can be used during MV. The Passy Muir Valve opens during inspiration and closes at the end of inspiration, re-directing exhalation through the vocal cords and out through the mouth and nose, which allows for verbal communication. The restoration of airflow, sensation, and positive airway pressure to the aerodigestive tract returns the upper airway to a more normal physiologic condition and may also have other clinical benefits for the patient who requires tracheostomy and MV. Speaking valves can be used in-line with mechanical ventilation but use of these requires deflation of the tracheostomy cuff.

It is not uncommon, however, for the SLP to meet resistance when requesting cuff deflation. There is still the misconception that the cuff prevents aspiration. There is also a fear that adequate ventilation cannot be achieved. The SLP can provide education and evidence to alleviate these concerns. It has been demonstrated that ventilation and stable respiratory parameters can be achieved with the cuff fully deflated and with placement of a Passy Muir Valve. Most recently, clinicians in a cardiothoracic ICU were able to reveal that deflating the cuff and using the Passy Muir Valve increased end expiratory lung impedance, therefore serving as a lung recruitment intervention (Sutt & Fraser, 2015). Due to these findings, use of Passy Muir Valves with ventilator patients increased from 0% to 70% and is now the standard of care in that ICU.

> *It has been demonstrated that ventilation and stable respiratory parameters can be achieved with the cuff fully deflated and with placement of a Passy Muir® Valve.*

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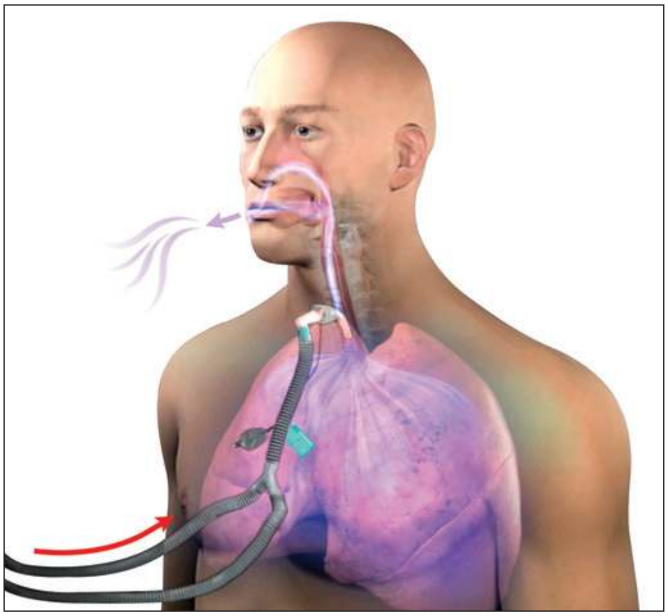
The SLP must work closely with the Respiratory Care Practitioner (RCP) and Respiratory Therapists (RTs) to understand how particular ventilator settings and the level of patient control of breathing may impact the patient's ability to synchronize breathing and swallowing. Using the Passy Muir Valve in-line may require ventilator adjustments to assure patient comfort, safety, adequate ventilation and ability of the patient to perform speech and swallow tasks. These adjustments are made by the RCP/RT trained in such procedures under the guidance of the physician. For the ventilated patient, the team determines the roles of the RCP and SLP as related to cuff deflation and placement of the Valve in-line with the ventilator circuitry. The RCP typically is responsible for procedures such as downsizing the tracheostomy tube and adjustments to the ventilator settings as stipulated in the facility's Policy and Procedures.

Therefore, the SLP-RCP team is presented with a unique opportunity to co-treat patients who require tracheostomy ventilation to provide not only a way to communicate, but also to restore airflow and engage the glottis, restore positive pressure to the aerodigestive tract, and address rehabilitation of the aerodigestive system as needed. This therapy may enhance weaning and rehabilitation by promoting safer swallowing to reduce aspiration, improved swallow and cough (Pitts, et al., 2009), reducing respiratory infections, promoting alveolar recruitment (Sutt et al., 2015,) and by enhancing early mobilization efforts (Mah et al., 2016).

Conclusion

In summary, prolonged weaning from mechanical ventilation constitutes a significant burden in terms of morbidity and mortality in the ICU. Successful liberation of such patients from mechanical ventilation lies in availing a multidisciplinary approach to care in any setting, developing specialist weaning units, and following standard weaning protocols. When working with patients who are being weaned from mechanical ventilation, clinicians must appreciate the interaction between respiration, swallowing, and communication systems. Impairment in these systems is closely linked; and in conjunction with other comorbidities of chronic illness, such as recurrent infections and decreased nutrition, the ventilator weaning process is often challenging. Multidisciplinary teams must work together to facilitate patient recovery and liberation from mechanical ventilation.



No-leak Valve in-line with mechancial ventilation

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Clinical Take Home

Tracheostomy Tube Cuff: Purpose and Practice through Team Managment

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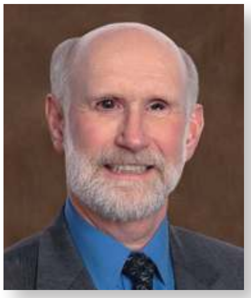

Care of patients with tracheostomy has become a frequent topic of discussion in the medical industry and publications. Due to this focus, details related to the care plan of such patients are of concern and must be considered. This brief discussion highlights one aspect of patient care which has been noted to be of importance, the safety and efficacy of cuff deflation, especially when using a bias-closed position, no-leak Valve.

Purpose of a Cuff

The purpose of the inflated tracheostomy tube cuff is to direct airflow through the tracheostomy tube. This is typically during mechanical ventilation when the ventilator circuit must be closed to control and monitor ventilation for the ventilator patient, who frequently has a more seriously compromised system than patients not on a ventilator. The inflated cuff also may be important in cases of gross emesis or reflux when gross aspiration is present, to limit the penetration of aspirated material into the lower airway. The definition of aspiration is when any food, liquid, or other matter passes below the vocal folds. Therefore, the cuff cannot prevent aspiration as it is located below the vocal folds (see Figure 1). When neither mechanical ventilation or a risk of gross aspiration is present, the cuff should be deflated. Another consideration is to change the patient to a cuffless tracheostomy tube.

> *The definition of aspiration is when any food, liquid, or other matter passes below the vocal folds. Therefore, the cuff cannot prevent aspiration as it is located below the vocal folds.*

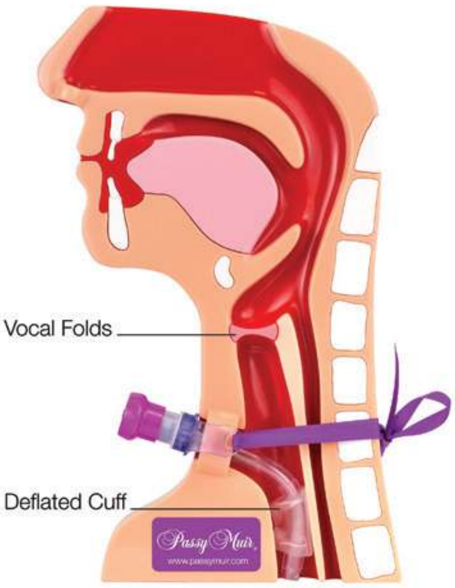

Figure 1:

Inflated Cuff Considerations

The inflated cuff should be avoided whenever possible because it has the potential to cause multiple complications, such as:

1) Increased risk of tracheal injury, including mucosal injury, stenosis, granulomas, and more;
2) Diminished ability to use the upper airway, leading to disuse atrophy over time; and
3) Restriction of laryngeal movement (laryngeal tethering) which may impact swallowing negatively.

Cuff Deflation

Deflating the tracheostomy tube cuff, when appropriate, has been shown to have multiple patient benefits, including:

1) Reducing the risk of potential tracheal mucosal damage;
2) Returning the patient to a more normal physiology, including closing the system through the use of a bias-closed position, no-leak Valve;
3) Restoring speech and improving communication;
4) Allowing for the possible improvement of the swallow;
5) Potentially lowering the risk of aspiration;
6) Allowing rehabilitation to begin as early as possible; and
7) Decreasing the time to decannulation.

Cuff deflation is a recognized important step in the care plan for a patient with a tracheostomy (Speed & Harding, 2013). The benefits of cuff deflation can be safely and effectively extended to a patient with mechanical ventilation, when appropriate assessment and patient selection is performed (Sutt, Caruana, Dunster, Cornwell, Anstey, & Fraser, 2016). This early cuff deflation may decrease delays in the rehabilitation process, and potentially avoids the negative consequences related to the inflated cuff. The earlier that a patient has their cuff deflated, the earlier the patient may be weaned or decanulated. When decannulation is not a possible goal, cuff deflation may still accommodate the benefits outlined above on a long-term basis.

It has been demonstrated that a team of appropriately trained professionals armed with evidence-based guidelines significantly improves care and reduces negative outcomes for the patient with tracheostomy (de Mestral, 2011; Speed & Harding, 2013). A team approach assists with continuous monitoring and patient care plan management. As with any medical procedure or device, thorough education is important in achieving the desired outcomes. Providing the education, and competency verification necessary, is the duty of the organization providing healthcare services.

It is the responsibility of healthcare professionals to provide the best possible care to their patients. Proper cuff management, including cuff deflation, contributes significantly to the best practice plan of care for the patient with a tracheostomy. The safety and efficacy of the plan depends largely on the education and competency of the team caring for these individuals, as well as a commitment from the healthcare facility to a multidisciplinary tracheostomy team approach for patient care.

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Case Study: Management of Complications Following SCI and the Role of SLPs on a Multidisciplinary Team

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On a splendid, early summer's day in June 2016, Mr. Walter had the urge to get on his mountain bike after having dinner with his wife and four school-age children. Like every evening, Mr. Walter promised to tell a bedtime story to the two younger children when he returned. So, they waited excitedly for the made-up adventures of the heroes, which Mr. Walter created from his imagination.

Mr. Walter was an avid biker and, despite being almost 50 years old, he was in exceptionally good physical condition. He loved being physically active on weekends or after a stressful day at work, breathing fresh air on forest trails, disconnecting for a while, and recharging his batteries through bike riding. Biking was his passion.

Life Changes in an Instant

WAS – because today he can only climb on his mountain bike in his thoughts, and he can only dream of challenging inclines and rapid descents. That summer day put a sudden end to his chosen sport. He had just finished his favorite bike track and was on his way home. He barely managed to avoid the cat that suddenly crossed his path. In fractions of a second, he collided with the curb and sustained a violent fall, going head first into the hard ground - completely changing his life and that of his family.

He realized immediately that something damaging had happened. For a few seconds, he was still halfway aware of the people who rushed to his help, but then it all went black.

This was followed by an approximately two-week gap in his memory.

At the scene of the accident, Mr. Walter required resuscitation and intubation. Initially, he was artificially ventilated [CPR] by the bystanders and the emergency physicians who fortunately arrived quickly. In the acute care clinic, where he was admitted as an emergency patient, the diagnosis showed a spinal cord injury (SCI) with complete tetraplegia (quadriplegia) sub C1 (ASIA A - complete) and, consequently, a complete failure of the respiratory muscles.

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A few days after the accident, while he was still intubated and analgosedated (administration of an analgesic along with sedation), he was transported to the Swiss Paraplegic Centre (Schweizer Paraplegiker-Zentrum, hereinafter abbreviated as SPC Nottwil) for further intensive-care treatment and subsequent rehabilitation.

In light of the diagnosis and severity of the cervical spine injury, Mr. Walter was surgically tracheotomized on the second day at SPC Nottwil to prevent negative effects resulting from excessive intubation, to initiate the recovery process, and to push him towards being more actively involved in rehabilitation (Barker, J., Martino, R., Reichardt, B., Hickey, E.J., & Ralph-Edwards, A. 2009; Brown, C.V., Hejl, K., Mandaville, A.D., Chaney, P.E., Stevenson, G., & Smith, C. 2011; Durbin, 2010; Durbin, C.G., Jr., Perkins, M.P., & Moores, L.K. 2010; Flaatten, H., Gjerde, S., Heimdal, J. H., & Aardal, S. 2006; Michels, G., Motzko, M., Weinert, M., Bruckner, M., Pfister, R., & Guntinas-Lichius, O. 2014; Scheel, R., Pisegna, J.M., McNally, E., Noordzij, J.P., & Langmore, S.E. 2015; Skoretz, S.A., Flowers, H.L., & Martino, R. 2010; Skoretz, S.A., Yau, T.M., Ivanov, J., Granton, J.T., & Martino, R. 2014). The following days were

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marked by the reduction of the analgosedation, his slow awakening, and gradual return from his dark memory gap.

The high level of complete tetraplegia suggested that Mr. Walter would remain permanently dependent on artificial respiration.

Role of Speech Therapists

One of our tasks as speech therapists at SPC Nottwil is to help the ventilated patients regain their verbal communication skills as quickly as possible. We were, therefore, involved early-on in the intensive care unit to begin the work with the Passy Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve (PMV® 007). As we worked with this patient, we provided education to explain in detail why his work with the Passy Muir® Valve (PMV®) is necessary with regard to verbal communication, as well as for the upcoming swallow-function rehabilitation. We also discussed other considerations related to tracheal suctioning, the initial air flow through the upper airway, and the possibility of insufficient exhalation, which can occur if the tracheostomy tube is too large or if there is existing stenosis. This education was provided to prepare the patient for the planned interventions and to diminish possible negative reactions he may have to change.

Even with patients who are not able to follow these explanations cognitively, we attempt treatment with the PMV 007 under strict monitoring. Often this may trigger swallowing movements and phonation. We can observe if there are any reflex reactions such as hawking or coughing, often seen secondary to secretions. Providing stimulation to the upper trachea, larynx, and pharynx with the exhaled airstream is extremely important to maintain sensitivity and awareness. Patients need this sensitivity, especially regarding swallowing. If it is absent due to an underlying neurological disease or due to a tracheostomy tube that has been cuffed too long, the risk of silent aspiration is higher, which in turn prolongs swallowing rehabilitation (Burkhead, 2011; Heidler, 2007, 2011; Heidler, Bidu, Friedrich, & Völler, 2011; Prigent et al., 2012).

On the fourth day after the tracheostomy, Mr. Walter's respiratory situation was stable and the PEEP (positive end-expiratory pressure) on the ventilator was reduced so that the PMV 007 could be used for the first time for speech therapy. Typically, PEEP is at 8 cmH_2O or lower before Valve use with this patient population. The session began with informing the patient about the planned procedure. First, oral suctioning was performed, then the cuff was deflated on the tracheostomy tube with simultaneous tracheal suctioning. It was evident that air could be exhaled through the upper respiratory tract. With the inserted PMV 007, his first attempts at articulation were still hesitant. The Philadelphia Collar (neck brace used with SCI), lingering sedatives, and some loss of air at the tracheostoma site around the tracheostomy tube, made speaking difficult for him, and his voice remained aphonic (without voice) in this first attempt.

Initially, Mr. Walter had a nasogastric tube which was replaced with a PEG tube after a few days in the ICU. The speech therapists also were instrumental in evaluating and managing Mr. Walter's swallowing status. It had been observed that Mr. Walter had severe dysphagia as determined during the clinical diagnostic assessment. During the clinical, Mr. Walter could not swallow his own saliva. Due to the severity of his swallowing impairment, it was expected that Mr. Walter would have a prolonged swallow function rehabilitation secondary to his injury.

Because Mr. Walter began to exhibit a stable respiratory condition, he was transferred to the rehabilitation department approximately one week after entering SPC Nottwil. The daily logopedic (speech therapy) exercises focused on functional dysphagia therapy with the PMV 007 on the ventilator. These interventions for swallowing were continued after his transfer to the rehabilitation department.

Importance of Verbal Communication

With the support of the respiratory care team, including specialized nurses, two ventilation profiles with different pre-set parameters were programmed into the ventilator. The patient's ventilator allowed for adjustments to be pre-set in profiles for specific uses by the family and staff. The first profile included the parameters for no valve use and cuff inflated. In the second profile, the parameters allowed use of the PMV 007 and the deflated cuff, which were more comfortable for the patient. By simply switching from profile one to the second profile, which allowed for PMV 007 use, the nurses and therapists could help Mr. Walter speak. After a few days, Mr. Walter shared a brief statement about his experiences while he was unable to speak. He shared:

"I have never been misunderstood as much as during the days when I could not speak. Since I can speak again, I can express my needs much better to the nursing staff. This is much better for both sides. My ability to speak is also very important for the loved ones who come to visit me. Before that, I just had to lie there like a mute fish. Now I can tell them what I think and how I feel. This is very important for them and for me."

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These statements clearly show the importance of verbal communication in an extreme situation, like the one experienced by Mr. Walter. A review of the research literature also suggests that patients with an inability to speak find it extremely stressful and frustrating (Egbers, Bultsma, Middelkamp, & Boerma, 2014; Ford & Martin-Harris, 2016; Freeman-Sanderson, Togher, Elkins, & Phipps, 2016a, 2016b; Massery, Hagins, Stafford, Moerchen, & Hodges, 2013; Sutt, Anstey, Caruana, Cornwell, & Fraser, 2017; Sutt, Cornwell, Mullany, Kinneally, & Fraser, 2015; Sutt & Fraser, 2015). The research findings support that when given the opportunity to speak, patients participate more actively in rehabilitation and feel better mentally, which results in faster progress. This ultimately illustrates how liberating it can be for those affected and how important the earliest possible implementation of a speaking valve is, even during respiratory service.

Addressing Dysphagia

In the first Fiberoptic Endoscopic Evaluation of Swallowing (FEES) study at one month post-injury, Mr. Walter's suspected aspiration of saliva was confirmed. Therefore, the time he could stay on the PMV 007 was limited. His poor secretion management was so severe that the team felt it would be detrimental to his medical state to have his cuff deflated all day. Because of the severity, in the beginning, the PMV 007 was used only in therapy and, beginning a few days later, also with the nurses.

The gradual advances in functional dysphagia therapy resulted in more efficient saliva swallowing in the next few weeks, allowing PMV 007 use and thereby communicative capabilities to be expanded. Most of the therapy was based on the Funktionelle Dysphagietherapie (FDT) (Bartolome & Schröter-Morasch, 2018). Therapy included strength training exercises like the Masako maneuver or Mendelsohn maneuver, while swallowing training also included manipulation of the consistency of food and the use of compensatory procedures (strategies).

While practicing swallowing with small amounts of boluses, small signs of aspiration could initially be seen during tracheal suctioning. Consequently, a cautious and slow approach to dysphagia therapy was indicated. However, Mr. Walter was very motivated to practice swallowing intensively to reach one of his goals of eating again. The cleaning techniques during the swallow function training had to be continuously supported, as the severe paraplegia also caused failure of the expiratory muscles. Without support, coughing was virtually impossible, reaching a value of less than 50 L/min measured by the peak flow meter (Bach & Saporito, 1996; Torres-Castro, et al., 2014).

The loss of air next to the tracheostomy tube through the surgically created tracheostoma, unfortunately, affected his speech abilities. Several strategies were tried to improve speech, including careful positioning of the head, tracheostomy tube and breathing tube position, and slight manual pressure against the tracheostomy tube shield to reduce air loss. As is often the case, Mr. Walter's problem of air loss through the tracheostoma also was not improved by tightening the trach ties of tracheostomy tube around the neck. This method did not improve the tracheostoma seal, but instead caused the tracheostomy tube to be pulled upwards more vigorously, increasing air leakage below the tube through the stoma. Prolonged upward movement of the tracheostomy tube also increases the risk of the tracheostoma enlarging and consequently increasing the problem of air loss. We initially hoped for a spontaneous reduction of the tracheostoma size.

Phrenic Nerve Stimulation as a Therapy

Due to the foreseeable permanent ventilation requirement, the possibility of using a phrenic nerve stimulator (Ducko, 2011) was discussed with the patient and his family in September. Initial investigations showed that the diaphragm could be stimulated bilaterally via the phrenic nerve. A purpose of the phrenic nerve stimulator is to allow ventilation to be maintained temporarily or permanently via a small pulse generator, eliminating the need to be permanently dependent on a relatively large ventilation unit that must be managed and transported around the facility all the time. Simpler handling of ventilation, through use of the stimulator, would provide Mr. Walter the prospect of more freedom of movement in everyday life.

After extensive discussions with Mr. Walter and his wife, he opted for this type of ventilation as an additional option. The surgery to implant the phrenic nerve stimulator was performed in November, almost exactly five months after his accident. About two weeks after the surgery, the phrenic nerve stimulation was initiated by the respiratory care team, and the stimulation time was gradually accelerated.

Of course, a careful and empathetic approach was necessary. Mr. Walter first had to gain the confidence that his ability to breathe could also function effectively

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with the stimulator. Through a long and carefully managed process, the appropriate settings had to be determined by the medical team, including the respiratory care team as a primary contributor. Throughout this process, the ventilation times on the stimulator were gradually extended. Eventually, towards the end of his rehabilitation (one year after the accident), Mr. Walter was primarily ventilated with the stimulator during the day.

Troubleshooting Changes in Swallowing and Respiration

To accelerate Mr. Walter's use of the ventilator with the stimulator took much more time than initially considered. Ultimately, the extended time was due to circumstances that were initially undetermined by the entire care team. Shortly before the diaphragm stimulator surgery, it was observed that when eating on the ventilator, food penetration into the nasopharynx with food leakage through the nose, was observed when using the PMV 007 in-line. As the oral diet was progressed to soft consistencies, increasingly larger food items were frequently blown out through the nose, even when the settings on the ventilator were not changed. Up to this point, such problems had not occurred.

Coordination of breathing and swallowing is known to be different when eating on the ventilator (as well as under conditions on the stimulator, as will be discussed momentarily) compared to spontaneous breathing conditions. In spontaneous breathing, the person freely chooses the time of swallowing and swallow apnea (period without breath). In the controlled ventilation form, as was necessary for Mr. Walter, the breathing rhythm was predetermined by the machine. Thus, he had to add his swallowing at a suitable time in the ventilation cycle, preferably after the end of the inspiration phase, so that the subsequent exhalation helped to keep possible food residues (which had been endoscopically confirmed) away from the respiratory tract as much as possible. This coordination of breathing and swallowing required some concentration during eating, but Mr. Walter eventually mastered it.

In addition to the nasal penetrations mentioned above, the first and more frequent occurrences of difficulty during this same period were those in which exhalation was suddenly blocked while using the PMV 007, which increased stress levels. This phenomenon was inexplicable. Initially, it was found that a way to unblock the upper airway was to use active, manual, forward displacement of the lower jaw. Eventually, a rolled-up cloth positioned under the neck in a lying position proved to be an effective measure to eliminate the respiratory blockages.

In the search for causes of the nasal penetration and expiratory blockage, the available studies from radiology were evaluated. These images were made while Mr. Walter was in rehabilitation. Review of the radiology images finally identified the issue. They revealed an increasing displacement of the cervical spine. This increased the velopharyngeal distance and led to a narrowing of the exhalatory path at the base of the tongue. The narrowed conditions at the tongue base area caused the sudden respiratory blockages during exhalation while using the PMV 007. Due to the increased distance to the upper portion of the posterior wall of the pharynx, another complication had developed in that the velum could no longer fulfill its task of preventing food from entering the nose when swallowing. Eating was becoming increasingly unpleasant, tedious, and burdensome for Mr. Walter.

These circumstances accelerated the decision to undergo surgery to stiffen and stabilize the cervical spine that was urgently needed for head control during mobilized wheelchair times. Prior to these negative circumstances with eating and breathing, Mr. Walter had not been able finalize his decision about surgery. Since it was believed that the surgery to correct the position of the cervical vertebrae also may eliminate the penetration of food into the nasopharynx and the expiratory blockage, Mr. Walter finally agreed to have this surgery performed. In May 2017, 11 months after the accident, a dorsal C0-C5 spinal fusion (Spondylodesis) was performed. The time that elapsed before these issues were finally addressed also illustrates the complexity of the interlinked relationships between respiration, swallowing, and physiologic function of the upper airways. The potential significant impact had not known before the team provided comprehensive assessment of multiple areas.

After the surgery, the desired outcome was achieved. The nasal penetration disappeared, as did the exhalation blockage. Mobilization in the wheelchair was made much easier with the stabilized head posture.

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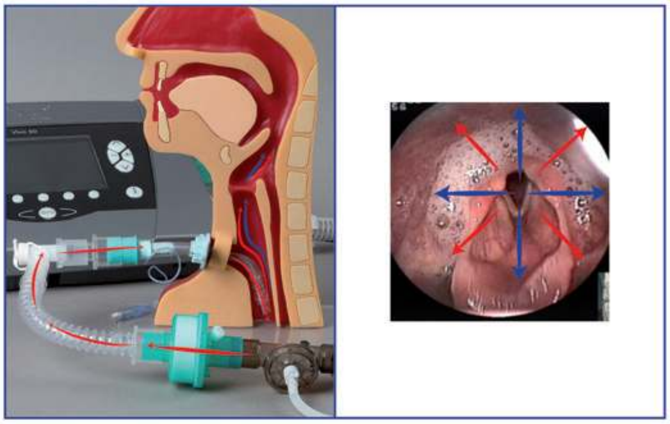
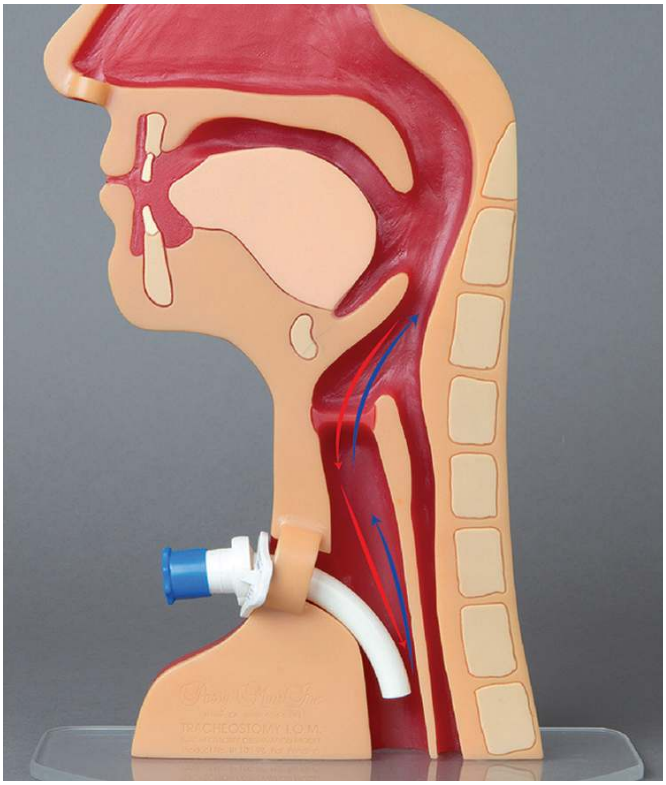
Since the implementation and extension of ventilation times on the diaphragm stimulator were successful, speech therapists also had to evaluate whether swallowing while using the stimulator was sufficiently safe to do so during meals. While using the PMV 007, the ventilator creates an airflow through the larynx from the bottom to the top during the inspiratory and expiratory phases. Although this continuous airflow does not completely prevent penetration and aspiration, it does potentially counteract them. They would have to flow against the continuous airflow through the larynx into the deep respiratory tract.



Airflow during inspiration (red) and expiration (blue) with invasive ventilation using the PMV 007.

When eating with the diaphragm stimulator in place, this continuous airflow from the bottom up through the larynx is non-existent. Inspiration is no longer associated with positive pressure as on the ventilator, but with negative pressure as in spontaneous breathing. If the Valve is used, most of the inspiration will flow into the lungs via the tracheostomy tube. If the tracheostomy tube is closed, inspiration flows physiologically over the larynx from top to bottom. If there is a problem with residual food while eating or residual salivation, this change to the physiological airflow increases the risk of aspiration into the deep respiratory tract.

Because of this potential problem with residual food particles, the Valve was used for Mr. Walter during initial attempts to eat with the stimulator. Even though the tracheostomy tube was closed increasingly during stimulator times, this was only done between meals. Mr. Walter shared that he enjoyed the occlusion of the tracheostomy tube because it enabled him to better smell the various odors around him. He shared that having the ability to smell odors in the environment provided some reminders of what he had previously perceived during his bike tours [rides].



Airflow with closed tracheostomy tube

One of the aspects monitored during his use of the PMV 007 trials was his blood gas. During these times, blood gas analysis showed no increase in CO_2 for Mr. Walter.

Resolving the Stoma Issue

Unfortunately, the problem with the loss of air via the surgically created tracheostoma did not resolve itself, as no shrinking of the stoma occurred. Consequently, speech remained difficult for a long time and depended on the patient's posture and positioning of the tracheostomy tube. Several alternative tracheostomy tube models had been trialed during his course of rehabilitation but did not provide a satisfactory solution. At times, various medical staff, including nursing, had to be present for Mr. Walter's daily telephone conversations with his family to ensure sufficient voice volume while sealing the leak. Not only was this exhausting; it also affected the privacy of the patient negatively.

Therefore, a tracheostoma epithesis (functional prosthesis) was created in collaboration with an epithesis company. We were careful to use as little material as possible in the stoma around the tracheostomy tube to prevent further dilatation. Although this did not result in a perfect seal, his speech ultimately functioned with significantly less air leakage, resulting in stronger and louder voiced speech.

continued next page

Progress at One Year

At the end of the one-year rehabilitation period, Mr. Walter was able to eat normal food, no longer needing any artificial nutrition or tube feeds. He continued to use his Valve during meals to provide for the best swallow function whether on the ventilator or the stimulator. The Valve was used during meals because occlusion of the tracheostomy tube has been shown to decrease residue in the pharynx during meals. Since liquids still proved to be an aspiration hazard, some of the fluids were administered via his PEG tube. With optimal posture, small boluses, and concentrated drinking, he also was able to consume some of his liquids orally.

Current Status

In August 2017, Mr. Walter moved to a nursing home near his residence. This was preceded by the respiratory care team providing intensive training to the nurses on-site. The team also provides ongoing support to the nursing home staff for questions or problems regarding respiratory ventilation.

During a short, repeat rehabilitation at SPC Nottwil in early 2018, Mr. Walter underwent another FEES study to evaluate his swallowing. Unfortunately, the findings were not significantly improved, and the continued use of the Valve with meals was recommended. Caution was still required for drinking. The PEG tube is therefore still in situ.

In a conversation with Mr. Walter, he shared that his two younger children now enjoy his fantasy stories again, just as much as he enjoys them himself.

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Hot Topic Box:

High Flow Oxygen Therapy and the PMV®

Lynn Godwin, BSRT, RRT

A frequent question that has arisen from clinicians is: What is High Flow Oxygen Therapy, and should I be using it with my patients who have a Passy Muir® Valve (PMV®)? This article begins to address the considerations by providing information on both devices and the current state of the science. First, High Flow Oxygen Therapy (HFOT) is an oxygen delivery system which provides heated humidity with high flow levels of oxygen (O_2). Traditional oxygen delivery systems do not exceed 16 L/min while HFOT can deliver up to 60 L/min and as high as 100% oxygen (Lindenauer, et al., 2014; Gotera, Díaz Lobato, Pinto, & Winck, 2013). HFOT is typically used with patients following acute respiratory failure; however, it has proven to be successful in decreasing the Work of Breathing (WOB) in chronic conditions, such as Chronic Obstructive Pulmonary Disease (COPD) and end-stage cancers as well (Gotera et al., 2013).

The HFOT system essentially creates an oxygen reservoir within the patient's airway, decreasing the patient's WOB due to the available O_2 during inhalation (Dysart, Miller, Wolfson, & Shaffer, 2009). In addition, the high turbulent flow flushes the anatomical dead space, removing the remaining exhaled air, thereby, rapidly clearing carbon dioxide (CO_2) (Dewan & Bell, 1994). The heated humidification component provides warm moisture to the airway, preventing drying of the mucous membranes, while at the same time assisting with decreasing the viscosity of mucous in the airways (Dysart, et al., 2009).

In addition to these benefits, the increasing use of HFOT is partially attributed to the comfort of the patient interfaces. The nasal cannula interface is more comfortable for the patient than wearing facial mask O_2 delivery systems (Dysart, et al., 2009). The patients who benefit from HFOT include both the adult and pediatric patient. It also can be provided to tracheostomy patients to provide support for respiratory function.

Studies have shown that HFOT produces a Positive End Expiratory Pressure (PEEP) effect within the lungs, improving lung recruitment and thus improving oxygenation, as well as decreasing the risk for atelectasis (Gotera, et al., 2013). Use of the Passy Muir Tracheostomy & Ventilator Swallowing and Speaking Valve® (PMV®) also has been shown to assist with lung recruitment, diaphragm function, and improved ventilation of the alveoli (Sutt, Caruana, Dunster, Cornwell, & Fraser, 2015). Some facilities have reported using the HFOT with tracheostomy in conjunction with a PMV because of the potential for lung recruitment to be further enhanced with the restoration of more natural physiological PEEP with use of the Valve. The potential dual benefit from using both the HFOT and the PMV provide some support for using these two options together as an intervention.

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Since studies also have shown that HFOT may reduce exercise-induced dyspnea allowing for patients' endurance levels to be increased (Dewan & Bell, 1994), and because the PMV restores a patient to a closed system with exhalation through the upper airway, increased thoracic pressures are possible which may further improve postural control and stability when the two devices are used together. This in turn may provide a stronger, more stable core for physical movements and interventions. Both HFOT and the PMV also have been shown to improve secretion management. Because both devices have been shown to have effects that benefit a patient on several levels, healthcare professionals are looking more toward using them together. The facilities that are doing so report positive effects; however, research is needed to investigate the premise of multiple benefits from using HFOT with the PMV in appropriate patient populations.

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Articles Representing International Research on Tracheostomy, Mechanical Ventilation and Passy Muir® Valves

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Impact of the Speaking Valve on the Use of Medications:

Kinneally, T. (2018). Do speaking valves reduce sedative drug use in ICU? A retrospective data analysis. *Australian Critical Care, 31*(2), 131–132.

It has been reported by patients that the inability to communicate effectively with healthcare professionals has led to misunderstandings as to their needs, causing increased administration of pain medications and other factors negatively impacting their care. Kinneally reports that use of a tracheostomy tube, instead of an endotracheal tube, enables less use of sedation. This article reports that early use of speaking valves (SV) has become common practice in his ICU. By using SVs earlier during patient care in the ICU, Kinneally reports that the return of verbal communication has been observed to improve patient care and has increased patient and family engagement. He also describes how this appears to be associated with reduced agitation. Because of these changes in patient access to communication, Kinneally reports that the use of sedatives and pain medications has been reduced significantly. Overall, less sedatives are being used when patients have access to their voice, communication, and interaction in their care. These findings suggest that early intervention of SV use with patients in the ICU will improve overall care by reducing the need for pain and sedating medications.

Use of Speaking Valves and Impact on Length of Stay:

Alabdah, M., Lynch, J., & McGrath, B. (2018). Reduction in hospital length of stay via tracheostomy quality improvement collaborative. *British Journal of Anaesthesia, 120*(5), e25 – e 26. DOI: https://doi.org/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) project to improve the care of patients, and 20 facilities within this project also have GTC resources. The GTC analyzed data comparing the global GTC data on tracheostomy care to those facilities with GTC resources while participating in the Improving Tracheostomy Care (ITC) project. 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.

Quality of Life Considerations:

Freeman-Sanderson, A.L., Togher, L., Elkins, M.R., & Kenny, B. (2018). Quality of life improves for tracheostomy patients with return of voice: A mixed methods evaluation of the patient experience across the care continuum. *Intensive and Critical Care Nursing, 46*, 10-16. doi:10.1016/j.iccn.2018.02.004.

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Freeman-Sanderson, A.L., Togher, L., Elkins, M.R., & Phipps, P.R. (2016). Return of voice for ventilated tracheostomy patients in ICU: A randomized, controlled trial of early-targeted intercention. *Critical Care Medicine, 44*(6), 1075-1081. doi:10.1097/ccm.0000000000001610

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This group of publications investigated the use of a Passy Muir Valve® in the Intensive Care Units (ICU). The premise behind the undertaking of these studies was to examine the effects of targeted early communication intervention for the restoration of voice in tracheostomy patients with mechanical ventilation in the ICU. Freeman-Sanderson et al. discuss the negative impact of cuffed tracheostomy tubes for prolonged mechanical ventilation on the ability to voice – in actuality – prolonged voicelessness. After establishing randomized trials to investigate the effect of providing early intervention for cuff deflation and use of the Passy Muir Valve in-line with mechanical ventilation, the initial studies report benefits when addressing these concerns early in patient care. These studies report a compilation of findings, from restoring voice earlier during patient care to the positive impact of voice restoration on mood, outlook, and sense of recovery.

Sutt et al. investigated the impact of early use of the Valve in-line with mechanical ventilation on communication and on duration of ventilation time. The authors reported that while the patients achieved earlier communication, they did not observe an impact on ventilation time or time to decannulation.

These studies provide support for early intervention and the need to provide patients with the access to their voice for participation in their medical care and for socialization with family and caregivers. The authors advocate that early intervention and restoration of voice in the ICU may improve the experience of patients in the ICU following tracheostomy and improve psychosocial functions.

Impact of the PMV® In-Line with Mechanical Ventilation on Lung Recruitment:

Sutt, A.L., Antsey, C., Caruana, L.R., Cornwell, P.L., & Fraser, J. (2017). Ventilation distribution and lung recruitment with speaking valve use in tracheostomised patient weaning from mechanical ventilation in intensive care. *Journal of Critical Care, 40*. doi: 10.1016/j.jcrc.2017.04.001

Sutt, A., Caruana, L.R., Dunster, K.R., Cornwell, P.L., Anstey, C.M., & Fraser, J. F. (2016). Speaking valves in tracheostomised ICU patients weaning off mechanical ventilation - do they facilitate lung recruitment? *Critical Care, 20*(1), 91. doi:10.1186/s13054-016-1249-x

Sutt, A., Caruana, L.R., Dunster, K. R., Cornwell, P.L., & Fraser, J.F. (2015). Improved lung recruitment and diaphragm mobility with an in-line speaking valve in tracheostomised mechanically ventilated patients – An observational study. *Australian Critical Care, 28*(1), 45. doi:10.1016/j.aucc.2014.10.021

Sutt, A., Cornwell, P.L, Caruna, L.R., Dunster, K.R., & Fraser, J.F. (2015). Speaking valves in mechanically ventilated ICU patients- Improved communication and improved lung recruitment. *American Journal of Respiratory Critical Care Medicine, 191*, A3162.

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Sutt and colleagues have published a collection of studies that investigated the impact of a Passy Muir Valve in-line with mechanical ventilation on lung recruitment. The premise behind these studies was to answer the question if deflating the cuff and placing a Valve in-line would cause the lungs to de-recruit? The initial findings reported in 2015 and 2016 demonstrated that with placement of the Valve in-line with mechanical ventilation improvement in lung recruitment was observed. These studies were conducted by using Electrical Impedance Tomography (EIT) to measure lung volumes and muscle activity while using the Valve in-line. EIT readings indicated improved lung recruitment and possible improved use of the diaphragm. The authors also reported increased verbal communication. The 2017 study in the Journal of Critical Care provided a secondary analysis of the data from the earlier studies. This analysis demonstrated that the lung recruitment occurred across all lung sections and that hyperinflation did not occur. These findings support the early use of Valves in-line to provide not only earlier access to communication and other psychological benefits, but also to provide increased lung and alveolar recruitment. The authors did not report any adverse events with early use of the Valve in-line.

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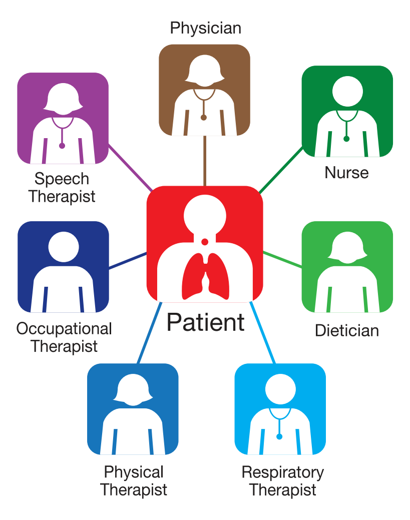
Multidisciplinary Team Considerations:

Santos, A., Harper, D., Gandy, S., and Buchanan, B. (2018). 1214: The positive impact of multidisciplinary tracheostomy team in the care of post-tracheostomy patients. *Critical Care Medicine, 46* (1), 591.doi: 10.1097/01.ccm.0000529218.20247.15

Santos et al. investigated the impact of a multidisciplinary team on outcomes following tracheostomy. Their team was developed to include surgeons, intensivists, nurses, respiratory therapists, and speech-language pathologists. The purpose of the team was to develop a systematic way to wean patients from mechanical ventilation, introduce and expedite speaking valve use, facilitate weaning and decannulation, provide better transitions from ICU care to the floor, and improve education of patient, family, and caregiver. They followed the impact of the team on 102 patients with tracheostomy. The findings from the study indicated that the patients had decreased ICU length of stay and hospital length of stay, expedited weaning from ventilator, earlier use of the Passy Muir Valve, earlier initiation of oral diet, earlier decannulation, and fewer tracheostomy related adverse events or critical issues. These findings suggest that a multidisciplinary team is essential for improved care of patients with tracheostomy.

Multidisciplinary Team Considerations | Kristin King, PhD, CCC-SLP



Working with patients following tracheostomy and with mechanical ventilation takes a multidisciplinary team (MDT) approach to ascertain that the needs of the patient are well met. Because of the complex nature of working with these patients, having the involvement of different disciplines provides perspective on various aspects of care. Typically, these patients are followed by both the respiratory therapist (RT) and the speech-language pathologist (SLP). However, many other healthcare professionals should be involved with the patient following tracheostomy and with use of the Passy Muir® Valve. To initiate an MDT approach, it takes multiple healthcare professionals, including the physician, nursing, dieticians, physical therapists, occupational therapists, and the patient at the center of it all. In a study conducted by Fröhlich, Boksberger, Barfuss-Schneider, Liem, & Petry (2017), they investigated best practice for early intervention with use of the Passy Muir Valve as a standard of care in the ICU following tracheostomy and mechanical ventilation. Their findings demonstrated that patients improved with voicing and swallowing more quickly than those without MDT intervention. However, since the authors were able to follow the patients over a period of time that included up to 51 trials with the PMV®, they also reported how the implementation of a team approach had a positive impact on the potential for adverse events, with none occurring. The researchers attributed this to the multidisciplinary team approach and suggested the findings support the idea that two professionals should be at the bedside to provide assessment and intervention with the PMV in-line with mechanical ventilation. Santos, Harper, Gandy, & Buchanan (2018) also investigated the impact of team management on the post-tracheostomy care of patients. Their findings concur with Frohlich, et al (2017) and suggest that having the involvement of an MDT allows the patient to progress faster in multiple areas. The parameters addressed in their study were time in the ICU, total hospital days, days to Valve use, days to verbal communication, oral intake, and decannulation. The group receiving team management were found to have improved care in all areas measured. Patients who received the Valve with the MDT did so earlier in their care and had restored voicing, communication, and the ability to participate in their care. The positive impact of an MDT on the care of patients and the ability to achieve earlier voicing cannot be overstated in its clinical significance.

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Irene Bischof graduated from the University of Applied Sciences and Arts Northwestern Switzerland with her Bachelor of Arts in Speech and Language Therapy (SLP) in 2015. Since that time, she has been working as an SLP at the Swiss Paraplegic Centre (SPC) in Nottwil. Her clinical experience pertains primarily to the management of dysphagia, and patients with tracheostomy tubes and mechanical ventilation. Additionally, she has been a board member of the Deutschschweizer Logopädinnen-und Logopädenverband, DLV (German-Swiss Association of Speech and Language Therapists) since 2016.

Biswajit Chakrabarti, MD, FRCP

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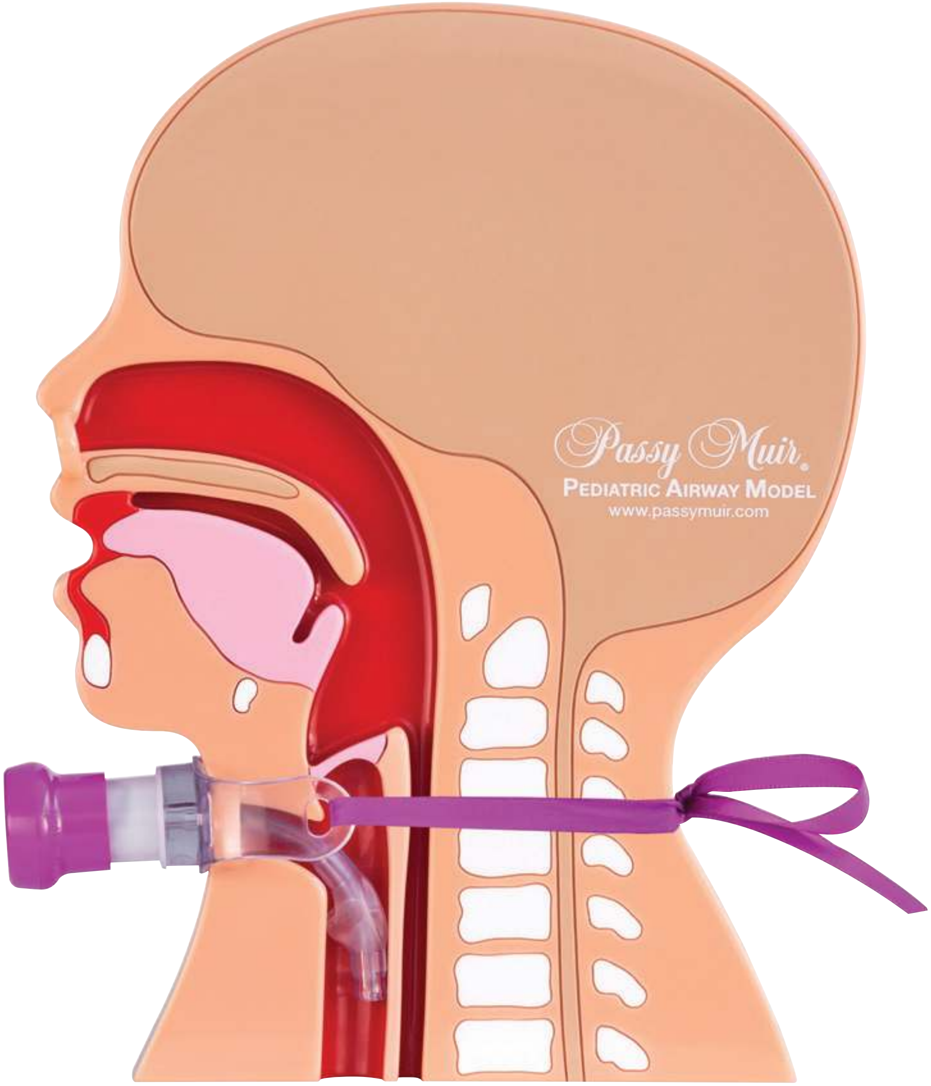

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