TRACHEOSTOMY *and* VENTILATOR DEPENDENCE IN ADULTS *and* CHILDREN

Learning Through Case Studies

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CASE STUDY 4–3. ADULT WITH RESPIRATORY FAILURE

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INTRODUCTION

Medical speech-language pathologists (SLPs) working in acute-care facilities are frequently consulted on clinical cases of persons recovering from critical illness and respiratory failure. Many of these patients are medically complex and require careful interdisciplinary teamwork as they rehabilitate. A frequent consequence of respiratory failure is the need for prolonged mechanical ventilation and placement of a tracheostomy tube. In this chapter, we present the case of a 59-year-old person with a history of myasthenia gravis who was admitted with critical illness secondary to sepsis and recurrent acute-on-chronic hypercarbic respiratory failure.

CASE PRESENTATION

Prior to this patient's admission to our medical intensive care unit (ICU) with respiratory failure, they were receiving a course of inpatient rehabilitation. This patient had developed acquired debility and weakness following multiple hospital admissions over a 1- to 2-month period (original admission was in August) due to sepsis secondary to infected knee hardware. Over the course of these hospitalizations, they developed secondary infections including *Clostridioides difficile* and recurrent acute-on-chronic hypercarbic respiratory failure. Subsequently, they experienced progressive functional decline due to debility, and they were admitted for inpatient rehabilitation. Speech-language pathology services were not consulted while they were in the inpatient rehabilitation unit at the hospital for September.

The patient's rehabilitation course was relatively uneventful until the end of September. During that time, they developed increased somnolence, weakness, increased left ptosis, disconjugate eye movement, family reported difficulty swallowing pills, and increased shortness of breath necessitating an increase to 3 to 4 L of O_2 to maintain O_2 saturations greater than 90%. Therapies were interrupted by increased lethargy, abdominal discomfort, diarrhea, and drowsiness. The decision was made to transfer to the medicine floor for monitoring and management. Eventually, the patient's deteriorating mental status and respiratory function required transfer to the medical ICU. It was thought that the patient's respiratory decompensation may have been related to a "myasthenic crisis" as their pyridostigmine was held for 3 days due to the presence of a *C difficile* infection. Unfortunately, the patient's respiratory status worsened, requiring bilevel positive airway pressure (BiPAP) support to improve their oxygenation. It should be noted that the patient's negative inspiratory force measured earlier in the day was between –40 and –60 cm H_2O but later dropped to –25 cm H_2O which also suggested reduced respiratory function and suspicion for myasthenic crisis. Their chest x-ray showed confluent densities in both lung bases that were thought to be due to a combination of pleural fluid and airspace disease, most likely secondary to congestive heart failure.

Per critical care medicine progress notes, in the ICU, the patient responded well to noninvasive mechanical ventilatory support

(BiPAP) ventilation. Their arterial blood gas was 7.21 (normal pH values = 7.35–7.45) with PCO_2 of 62 mm Hg (normal values = 35–45 mm Hg), values considered close to the patient's baseline. The patient was also hypotensive on their arrival to the ICU, requiring management with vasopressors, from which they were able to eventually wean. After stabilization in the ICU, the patient was transferred to the general medical floors. On October 1, the patient had their first plasmapheresis since September 10, and a CONDITION C was called, which is a pre-code to CONDITION A (cardiac or respiratory arrest), transferring the patient back to the medical ICU.

Initial Speech-Language Pathology Consult (October)

The patient was initially evaluated by the SLP in early October while they were in the medical ICU. At the time of the assessment, they had weaned from BiPAP to 4 L of oxygen support via nasal cannula and appeared stable from a medical and respiratory standpoint. The patient had a large hiatal hernia, and placement of a nasogastric tube was challenging. Critical care medicine requested the opinion of speech-language pathology to determine potential risks associated with returning the patient to oral intake following their complicated ICU course. At the time of the initial SLP clinical evaluation of swallowing, the patient was on nil per os (NPO) status and complaining of an "upset stomach." The patient's spouse was also present. During the evaluation, the patient was described as awake but anxious and oriented to person and place. They exhibited reduced head/neck and trunk control impacting positioning. On clinical assessment of the muscles of the head and neck, the patient demonstrated symmetric movement patterns with subjective reduction in range of motion and tone. They demonstrated vocal asthenia, thought to be associated with reduced breath support. During assessment of swallowing with conservative amounts of water via teaspoon (approximately 4–5 ml), the patient exhibited symptoms of respiratory-swallow incoordination characterized by poor lip closure and blowing off liquids away from the mouth during attempts at oral acceptance of the bolus. Weak, nonproductive coughing was elicited when attempting to drink thin liquids from a straw, which was consistent with possible aspiration and warranted further instrumental investigation of swallowing physiology. The etiology of the patient's suspected oropharyngeal dysphagia was thought to be due to a combination of acute deconditioning and respiratory insufficiency combined with neurogenic weakness associated with myasthenia gravis. The SLP provided education regarding the results and recommendations of the examination to the patient and their family. It was recommended that the patient continue to remain NPO and receive short-term supplemental nonoral hydration and nutrition.

Following the SLP clinical evaluation of swallowing on in early October, the patient's respiratory status deteriorated again. Despite the use of noninvasive mechanical ventilation (BiPAP and high-flow nasal cannula), the patient was unable to maintain adequate self-ventilation, and they were intubated one evening in early October. After failing extubation on a few days later, they were reintubated and then underwent placement of a tracheostomy tube (Shiley flex, size 7.5, cuffed tracheostomy tube) and a percutaneous endoscopic gastrostomy feeding tube in mid-October.

Speech-Language Pathology Re-Consultation (mid October)

The patient's medical condition stabilized, and SLP services were reconsulted in mid to

late October to evaluate for use of a one-way speaking valve in-line with the ventilatory circuitry. The patient was seen in the morning with respiratory therapy, nursing, and the patient's daughter while on a spontaneous breathing trial (continuous positive airway pressure [CPAP]). An additional medical goal for the day was to trial an aerosol tracheostomy mask (ATM) in the afternoon. At the time of the evaluation, the patient had been tolerating CPAP ventilation mode with pressure support of 5 cm H_2O, 40% (fraction of inspired oxygen) FiO_2, and a positive end-expiratory pressure (PEEP) of 5 cm H_2O. Respiratory rate (RR) and pulse oximetry oxygen saturation (SaO_2) readings were within acceptable ranges (RR = 18–20, SaO_2 = 95%–96%). The medical goals for the day related to speech and breathing were explained to the patient by the evaluating SLP and RT. Both oral and endotracheal suctioning were completed by the RT prior to cuff deflation. The tracheostomy cuff was slowly taken down over the course of several minutes by the evaluating SLP. "Leak" speech was detected and audible at both partial and full cuff deflation indicating that pulmonary air was able to pass around the outer diameter of the tracheostomy tube and through the glottis. There was no immediate change in breathing patterns or change in respiratory vital sign stability following full cuff deflation, and the patient progressed to in-line placement of a Passy-Muir® Tracheostomy & Ventilator Swallowing and Speaking Valve (PMV 007).

The PMV was placed between the t-piece and inspiratory/expiratory connector tubing using an adapter. Immediate phonation was demonstrated with placement of the PMV, and the patient did not report perceived difficulty with breathing. No change in clinical status, breathing patterns, or respiratory vitals were demonstrated across 25 min of observed time using the PMV. The patient was able to produce connected speech adequately for short intelligible responses to family/staff questions; however, the evaluating SLP observed reduced vocal loudness and accessory respiratory muscle recruitment during speech. Perceptual voice ratings of Grade 2 (mild dysphonia), roughness 1 (subjectively within normal limits), breathiness 1 (to a slight degree), asthenia 2 (to a medium degree), strain 1 (to a slight degree) on the GRBAS scale were made by the SLP during evaluation (Hirano, 1981). Overall, the patient demonstrated successful ability to maintain respiratory stability and produce functional speech using an in-line speaking valve for 25 min. The patient was encouraged to also use the speaking valve during spontaneous breathing trials. Clinical reassessment of swallowing was deferred by the SLP and critical care physician due to the presence of an ileus.

Speech-Language Pathology Therapy Session (late October)

The SLP followed up for a treatment session. The patient continued to improve and make progress toward ventilator weaning, spending part of the day off the mechanical ventilation. The patient was reassessed without mechanical ventilation support and demonstrated the ability to maintain respiratory stability using a PMV while receiving 50% FiO_2 via ATM for 20 min. Conservative assessment of swallowing potential was completed across administration of 10 ice chips. Given continued respiratory stability and lack of overt symptoms of airway compromise with limited volumes of ice chips, an instrumental FEES was recommended.

Fiberoptic Endoscopic Evaluation of Swallowing (late October)

The patient underwent an instrumental assessment of swallowing function via FEES with

the SLP. The FEES examination was completed in conjunction with RT in the medical ICU. At the time of the FEES examination, the patient had a Shiley cuffed, flex tracheostomy size 7.5 and was being mechanically ventilated on CPAP mode with a PEEP of 5, pressure support setting of 10, and 50% FiO_2. The scope was inserted prior to cuff deflation and placement of the PMV in order to assess the impact of these interventions on secretion management and swallowing. Copious thin, clear, frothy secretions were pooled within the pharynx and within the laryngeal vestibule, where passive aspiration of secretions was demonstrated (Figure 4–1). The patient's tracheostomy cuff was deflated, and tracheal suctioning was completed. When airflow was restored around the tube and deflated cuff, they were able to orally expectorate a large amount of mucus. Fortunately, secretion management was not an obstacle for the remainder of the study. Once fully visible, the larynx was described as edematous, especially the arytenoids, which limited the amount of space in the pyriform sinuses. Posterior pharyngeal wall medialization and base of tongue retraction appeared to be reduced. Arytenoid adduction and true vocal fold abduction appeared to be intact, but true vocal fold adduction appeared to be reduced.

The patient was challenged with multiple trials of a variety of viscosities and volumes in

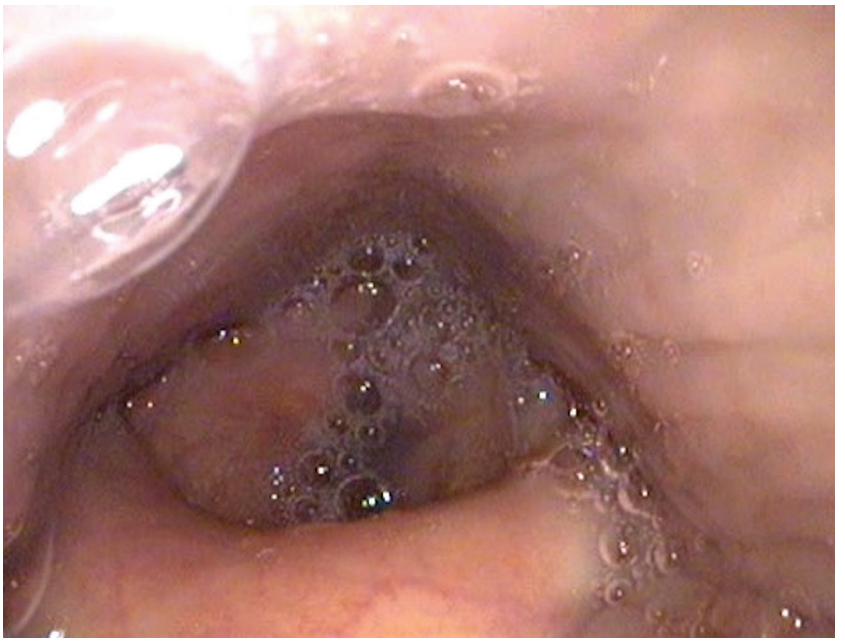

Figure 4–1. Initial fiberoptic endoscopic evaluation of swallowing (FEES) image assessment of secretions. This image demonstrates the initial FEES image captured prior to swallowing trials or cuff deflation or manipulation of ventilator settings (mode). Note the copious volume of thin, clear, frothy secretions that are pooled within the pharynx and within the laryngeal vestibule, where passive aspiration of secretions was demonstrated. The patient has a 7.5 Shiley flex, cuffed tracheostomy tube with the cuff inflated on mechanical ventilation on continuous positive airway pressure, positive end-expiratory pressure = 5, pressure support of 10 and a FiO_2 = 50%.

three conditions: (a) CPAP ventilation, cuff down, no PMV; (b) CPAP ventilation, cuff down, PMV (aqua-high resistance) in place; and (c) 40% FiO_2 ATM, cuff down, PMV (purple-2001) in place.

Both asymptomatic and sensate aspiration events were demonstrated before the swallow due to mistimed airway closure, and after the swallow from overflow of residue from postswallow residue accumulation within the pyriform sinus and lateral channels (Figures 4–2 and 4–3). Airway protection at the height of the pharyngeal swallow (i.e., laryngeal vestibule and true vocal fold closure) was functionally improved by increasing the viscosity of the bolus, limiting the volume of the bolus, and cueing the patient to swallow multiple times per bolus. Based on the frequency and depth penetration and aspiration events, airway protection was also improved by the use of a one-way speaking valve, particularly when used off of pressure support mechanical ventilation (Figures 4–4 and 4–5).

Primary nonoral means of nutrition and hydration was recommended following this patient's initial FEES study. The presence and perceived severity of the patient's dysphagia in conjunction with factors including acute deconditioning, impaired endurance, respiratory compromise, and impaired posture

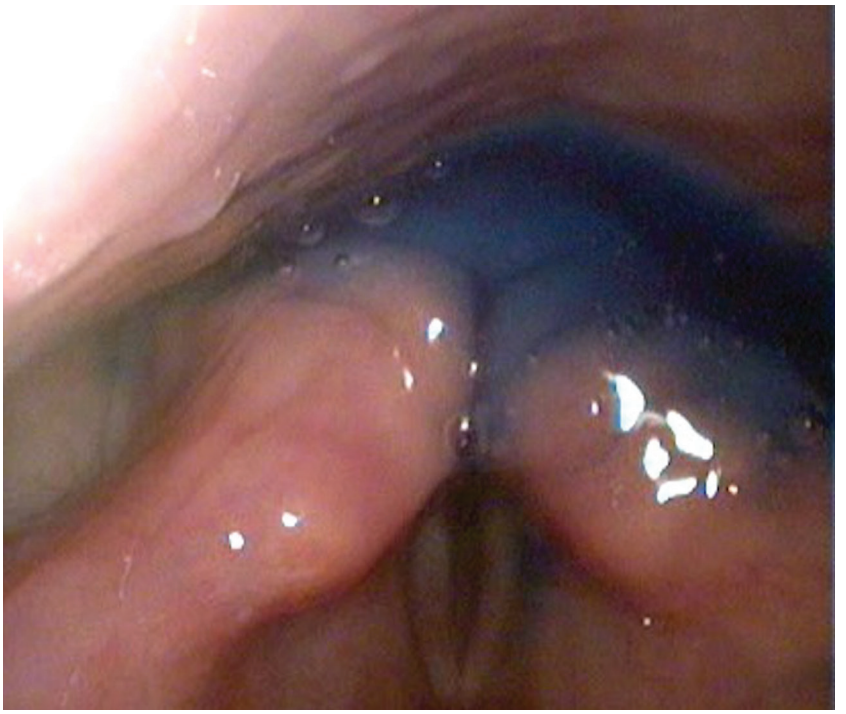

Figure 4–2. Fiberoptic endoscopic evaluation of swallowing (FEES) image following swallowing trial of thin liquids. This image was taken during the FEES exam following the presentation of a teaspoon of thin liquid while the patient was on mechanical ventilation on continuous positive airway pressure, positive end-expiratory pressure = 5, pressure support = 10 with the tracheostomy cuff deflated and without the Passy-Muir Valve in place. The penetration-aspiration scale score was judged to be an "8," silent aspiration without immediate ejection.

were cited by the evaluating SLP as factors contributing to their clinical decision-making process.

The recommended rehabilitation plan of care included oral stimulus items of ice chips, single sips of water, bites of applesauce, bites of pudding for swallow reconditioning and retraining, as well as ongoing PMV trials guided by SLP and RT. Specifically, the evaluating SLP recommended the patient should be encouraged to wear the purple PMV when on ATM and use aqua PMV in-line when the CPAP mode is on vent.

The patient was transferred to a long-term acute-care (LTAC) rehabilitation facility in late October where they underwent additional rehabilitation for communication and swallowing deficits following a prolonged and complicated medical course in the medical ICU. Twelve days after the patient's admission to inpatient LTAC, they underwent a MBSS while on ATM with the purple low-profile PMV in place. During the repeat instrumental assessment, improved swallowing physiology was demonstrated, with an overall reduction in both the presence of residue and the instance of bolus misdirection toward the airway (penetration/aspiration). The patient was able to successfully return to unrestricted oral intake after that examination.

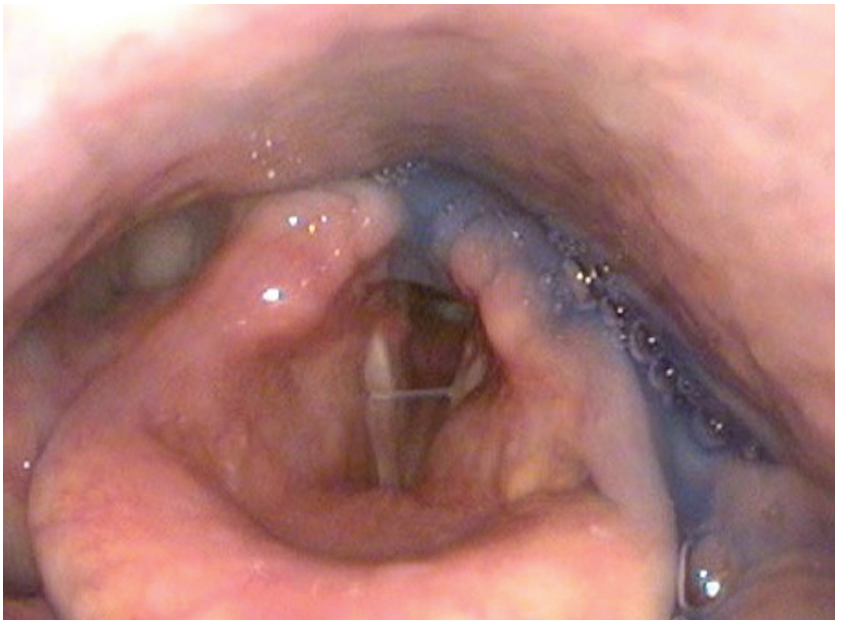

Figure 4–3. Fiberoptic endoscopic evaluation of swallowing (FEES) image following trials of thin liquids with trach cuff down and in-line Passy-Muir Valve (PMV). This image was taken during the FEES exam following the presentation of a teaspoon of thin liquids while the patient was on mechanical ventilation on continuous positive airway pressure, positive end-expiratory pressure = 5, pressure support = 10 with the tracheostomy cuff deflated and with the PMV in-line. The penetration-aspiration scale score was judged to be "3", laryngeal penetration above the glottic plane or true vocal folds without ejection. No gross aspiration was appreciated during this trial. Note the slight improvement in post-swallow residue.

Figure 4–4. Fiberoptic endoscopic evaluation of swallowing (FEES) image following teaspoon of thin liquids on aerosol trach mask, Passy-Muir Valve (PMV) in place. This image was taken during the FEES exam following the presentation of a teaspoon of thin liquids while the patient was on 40% FiO_2 aerosol tracheostomy mask with the tracheostomy cuff deflated and with the PMV in-line. The penetration-aspiration scale score was judged to be "1" without laryngeal penetration or aspiration.

CONCLUSION

This case study represents the complexity and careful clinical decision-making necessary for successfully managing dysphagia in patients who are tracheostomized and ventilator dependent in the ICU. The SLP clinical decision-making process in this case was not straightforward, and multiple patient-specific factors were integrated with multidisciplinary care at every step. Clinical evaluation of swallowing was limited to conservative volumes of water (neutral pH liquid) during time points in which the patient demonstrated respiratory stability. Instrumental assessment was completed in a proactive manner once the patient demonstrated more consistent medical and respiratory stability following tracheostomy, and oral intake was assessed under all conditions during which the patient might realistically request to eat or drink. Specific conditions under which swallowing was improved were identified: off positive-pressure ventilation, tracheostomy cuff down, and purple PMV in place. The patient's overall level of debility and reduced endurance led the evaluating SLP to make more conservative recommendations regarding advancement back to oral intake. This patient was still considered at a higher risk for respiratory and medical decompensation if a significant aspiration or choking event were to occur. Additionally, their immune response was presumed to be depressed in the context of steroid use and plasmapheresis that were used to treat myasthenia gravis. For these

Figure 4–5. Fiberoptic endoscopic evaluation of swallowing (FEES) image following straw sip of thin liquids on aerosol tracheostomy mask, Passy-Muir Valve (PMV) in place. This image was taken during the FEES exam following the presentation of a teaspoon of thin liquids while the patient was on 40% FiO_2 aerosol tracheostomy mask with the tracheostomy cuff deflated and with the PMV in-line. The penetration-aspiration scale score was judged to be "3" with laryngeal penetration above the glottic plane or true vocal folds without immediate ejection but no gross aspiration.

reasons, cautious and well-supervised reintegration of oral intake was recommended in conjunction with longer durations of PMV use and time spent off of the ventilator. This approach appears to have been effective given that the patient demonstrated physiological improvement based on reported penetration/aspiration and residue patterns reported on their follow-up MBSS.

Management of voice and swallowing changes associated with critical illness, tracheostomy, and mechanical ventilation continues to be guided primarily by critical theory-based decision-making, with little existing empirical evidence to guide medical teams and clinicians. It is our hope that cases such as this one, where proactive SLP intervention appears to have been effective, PMV will help contribute to a growing body of evidence promoting early therapeutic assessment and intervention for these patients (Freeman-Sanderson et al., 2016; Kowalski et al., 2017; Rodrigues et al., 2015).

REFERENCES

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 intervention. *Critical Care Medicine*, *44*(6), 1075–1081. https://doi.org/10.1097/CCM.0000000000001610

Hirano, M. (1981). *Clinical examination of voice*. Springer-Verlag.

Kowalski, S., El-Gabalawy, R., Macaulay, K., Thorkelsson, R., Robertson, A., Bshouty, Z., & Girling, L. (2017). Weaning from mechanical ventilation using tracheostomy cuff deflation and a one-way speaking valve: A historical-cohort series. *Canadian Journal of Anesthesia/Journal Canadien d'anesthésie*, *64*(12), 1286–1288. https://doi.org/10.1007/s12630-017-0964-3

Rodrigues, K. A., Machado, F. R., Chiari, B. M., Rosseti, H. B., Lorenzon, P., & Gonçalves, M. I. R. (2015). Swallowing rehabilitation of dysphagic tracheostomized patients under mechanical ventilation in intensive care units: A feasibility study. *Revista Brasileira de Terapia Intensiva*, *27*(1), 64–71. https://doi.org/10.5935/0103-507X.20150011