

Early Intervention for the Ventilated ICU Patient: Use it or Lose it!

Lori Burkhead Morgan, PhD, CCC-SLP



Disclosures

- ▶ Lori Burkhead Morgan, PhD, CCC-SLP
 - Disclosure: *Financial* -Received an honorarium from Passy-Muir Inc. for this presentation.
 - Nonfinancial* -No relevant nonfinancial relationship exists.

Disclosures

- ▶ Passy-Muir, Inc. has developed and patented a licensed technology trademarked as the Passy-Muir® Tracheostomy and Ventilator Swallowing and Speaking Valve. This presentation will focus primarily on the biased-closed position Passy-Muir Valve and will include little to no information on other speaking valves.

Purpose of this talk

- ▶ Elucidate the impact of critical illness on the neuromuscular system and how this can impact swallowing & communication
- ▶ Identify rationale and simple interventions that can facilitate communication & swallowing

Identifying the problems



Major culprits in the ICU patient-alt

- ▶ Systemic inflammatory response syndrome
- ▶ Critical illness myopathy
- ▶ Critical illness polyneuropathy



Systemic Inflammatory Response Syndrome (SIRS)

- ▶ HR > 90 bpm
- ▶ Body temperature, 36 or >38°C
- ▶ WBC count, 4000cells/mm3
- ▶ SIRS + infection = sepsis

SIRS

- ▶ Occurs in adults and children
- ▶ Up to 50% of ICU patients on vent have SIRS
- ▶ 50-70% of those patients develop diffuse myopathy and polyneuropathy

SIRS

- ▶ Results in
 - Muscle weakness
 - Difficulty weaning from the ventilator

Critical Illness Myopathy (CIM) & Polyneuropathy (CIP)

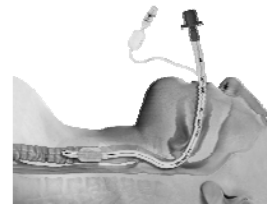
- ▶ Usually co-occurring
- ▶ Presents as ventilator weaning difficulty
- ▶ Seen in 25-63% of patients on vent >1 week
- ▶ Sensorimotor with motor predominance
- ▶ Limbs & respiratory muscle affected most
- ▶ Cranial nerves usually spared

Critical Illness Myopathy (CIM)

- ▶ Diffuse weakness
- ▶ Diagnosed with EMG studies & biopsy
- ▶ Type II muscle atrophy or undergo necrosis

“Offenders” specifically impacting communication & swallowing

- ▶ Deconditioning
- ▶ Endotracheal intubation
- ▶ Tracheostomy
- ▶ Ventilator dependency



Deconditioning Negatively Impacts Structure & Function

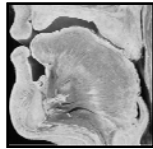
- ▶ Muscle atrophy
- ▶ Reduced force-generating capacity
 - A.K.A., "strength"
- ▶ Lower endurance

Skeletal Muscle Composition

- ▶ Type I ← Slow-twitch, fatigue resistant
- ▶ Type II ← Fast-twitch, fatigable
 - IIa ← Adaptable, more efficient Type II fiber
 - IIb ← Best force generation, but inefficient
- ▶ Whole muscle contains blend with a predominance of one type

Oropharyngeal Muscle Composition

- ▶ Type II is predominant
- ▶ Type I, IIa, IIb and hybrid fibers
- ▶ Unique architecture
 - Regional differences in proportion & diameter of fibers
 - Complex arrangement



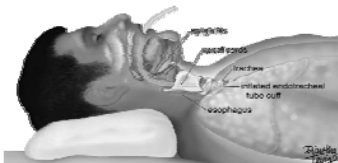
Kent, 2004.

What about communication & swallowing in the ICU?

- ▶ Intubation
- ▶ Tracheostomy
- ▶ Ventilator dependency
- ▶ NPO

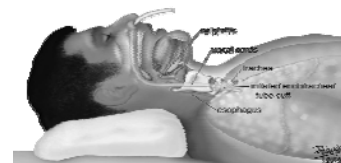
Endotracheal Intubation

- ▶ Bypasses use of upper airway
 - Disuse atrophy
 - Desensitization
- ▶ Trauma to mucosa, particularly larynx
- ▶ Cuff over inflation is common

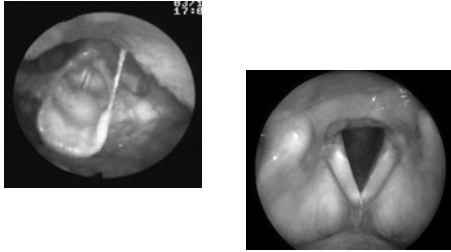


Nasotracheal Intubation

- ▶ Because mouth is "available" patients are sometimes erroneously given ice chips, liquid, food, meds.
- ▶ Do not encourage mouthing to communicate
- ▶ Same complications as ETT



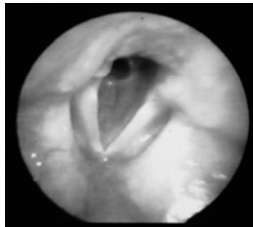
Normal Larynx (for reference)



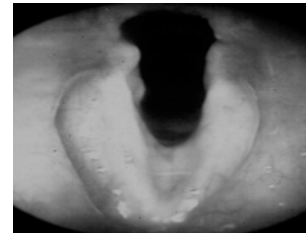
Granuloma



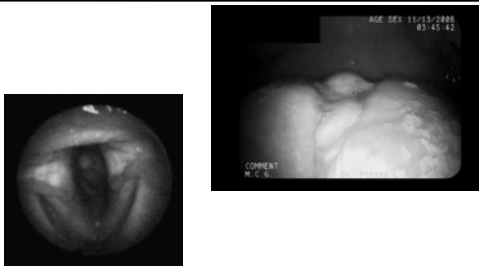
Subglottic Stenosis



Glottic & subglottic trauma



Post-Intubation Ulceration



What contributes to structural deficits?

- ▶ Prolonged intubation (>2 weeks)
- ▶ Can happen quickly, not just in long-term intubation
 - Whited (1984); Colice (1992); De Larminat et al (1995)
- ▶ Trauma due to movement/friction

Incidence & Prevalence

- ▶ Laryngotracheal injury in 95% (39/41) of previously intubated patients.¹
- ▶ Dysphagia as high as 56% (27/48), with nearly half those patients aspirating silently
 - Ajemian, Nirmul, Anderson, Zirlen, & Kwasnik (2001)²

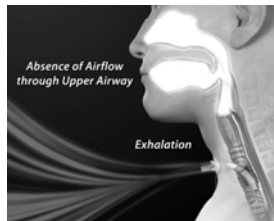
1. Stauffer, Olson, & Petty (1981)
2. Ajemian, Nirmul, Anderson, Zirlen, & Kwasnik (2001)

What can you do to minimize intubation complication?

- ▶ Don't over-inflate cuff
- ▶ Secure tube to minimize movement
- ▶ Minimize patient movement
 - Education
 - Sedation as necessary
 - Discourage "mouthing"
- ▶ Convert to tracheostomy and Passy-Muir Valve placement sooner!

Airflow Changes with tracheostomy

- ▶ Airflow bypasses upper airway
- ▶ Deflated cuff and/or fenestration can facilitate some upper airway airflow



Impact of Tracheostomy on Voice, Cough & Swallow

- ▶ Larynx & upper airway are not involved in inspiration or expiration
 - Aphonia
 - Desensitization
 - No subglottic air pressure
 - Can disrupt swallow function
 - Higher likelihood for silent aspiration
 - Cannot cough to clear oropharynx or nasopharynx

What does research tell us about tracheostomy & swallowing?



Tracheostomy negatively impacts swallowing & laryngeal function...

- ▶ Bonanno, P. Swallowing Dysfunction After Tracheostomy. *Annals of Surgery*, 1971. 74(1): 29-33.
- ▶ Cameron JL, Reynolds J, Zuidema GD. Aspiration in patients with tracheostomies. *Surg Gynecol Obstet* 1972; 136: 68-70.
- ▶ Sasaki CT, Suzuki M, Horiuchi M, Kirchner JA. The effect of tracheostomy on the laryngeal closure reflex. *Laryngoscope* 1977; 87: 1428-1433.
- ▶ Stauffer JL, Olson DE, Petty TL. Complications and consequences of endotracheal intubation and tracheostomy. A prospective study of 150 critically ill adult patients. *Am J Med* 1981; 70: 65-76.
- ▶ Buchwalter JA, Sasaki CT. Effect of tracheotomy on laryngeal function. *Otolaryngol Clin North Am* 1984; 17:41-48.
- ▶ Nash M. Swallowing problems in the tracheotomized patient. *Otolaryngol Clin North Am* 1988; 21: 701-709.
- ▶ Muz J, Mathog RH, Nelson, Jones. Aspiration in patients with head and neck cancer and tracheostomy. *American Journal of Otolaryngology* 1989; 10: 282-286.
- ▶ Elpern EH, Scott MG, Petro L, Reis MG. Pulmonary aspiration in mechanically ventilated patients with tracheostomies. *Chest* 1994; 105 (2): 563-566.
- ▶ Shaker R, Milbrath M, Ren J, Campbell B, Toohill R, & Hogan W. Deglutitive aspiration in patients with tracheostomy: effect of tracheostomy on the duration of vocal cord closure. *Gastroenterology* 1995; 108: 1357-1360.

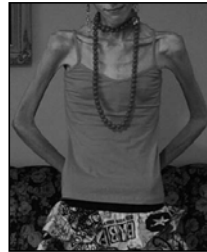
Trach occlusion to reduce/eliminate aspiration & impact swallow physiology...

- Dettelbach, MA, Gross, RD, Mahlmann, J, & Eibling, DE, & Zajac, DJ. The effects of the Passy-Muir valve on aspiration in patients with tracheostomy. *Head & Neck* 1995; 17: 297-302.
- Eibling, DE, Gross, RD. Subglottic air pressure: a key component of swallowing efficiency. *Annals of Otolaryngology, Rhinology, & Laryngology* 1996; 105: 253-258.
- Sachler, RJ, Hamlet, SL, Choi, J, & Fleming, S. Scintigraphic quantification of aspiration reduction with the Passy-Muir valve. *Laryngoscope* 1996; 106: 231-234.
- Logemann JA, Pauloski BR, Colangelo L. Light digital occlusion of the tracheostomy tube: a pilot study of effects on aspiration and biomechanics of the swallow. *Head & Neck* 1998; Jan;20(1):32-7.
- Abraham, SS, Wolf, EL. Swallowing physiology of toddlers with long-term tracheostomies: a preliminary study. *Dysphagia* 2000; 15: 206-212.
- Gross, RD, Mahlman J, Grayhack JP. Physiologic effects of open and closed tracheostomy tubes on the pharyngeal swallow. *Annals of Otolaryngology, Rhinology, & Laryngology* Feb 2003; 112 (2): 143-152.
- Suiter, et al. Effects of cuff deflation and one-way tracheostomy speaking valve placement on swallow physiology. *Dysphagia* 2003; 18(4): 284-92.
- Ding R, Logemann JA. Swallow physiology in patients with trach cuff inflated or deflated: a retrospective study. *Head & Neck* 2005; 27: 809-813.

Muscle response to deconditioning & conditioning

Deconditioned:

Muscle-wasting, cachexia



Conditioned:

John Burkhead – World record bench press, 515 lbs.



Deconditioning

- | | |
|---|--|
| <ul style="list-style-type: none"> ▶ PERIPHERAL ▶ Atrophy <ul style="list-style-type: none"> ◦ Loss in cross sectional area <ul style="list-style-type: none"> • Decreased size • Force-generating capacity ("strength") ▶ Fiber-type shift <ul style="list-style-type: none"> • More easily fatigued ▶ Sarcopenia <ul style="list-style-type: none"> ◦ Age-related reduction in muscle fibers ◦ Preferentially affects Type II | <ul style="list-style-type: none"> ▶ CENTRAL ▶ Decreased neural activation ("drive") ▶ Decrease in number of motor units ▶ Remodeling of motor units |
|---|--|

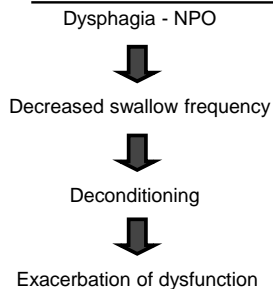


Deconditioning

- ▶ Muscle atrophy & deconditioning
 - 4-6 wks bed rest (young, healthy) = ~40% decrease in strength¹
 - Ill & elderly even more susceptible²

1. Bloomfield, 1997
2. Urso et al, 2006.

"Vicious Loops" in Dysphagia?



- ▶ Murray et al, 1996
 - Swallow frequency/min:
 - Normals = 3
 - Dysphagia, - asp = 1.16
 - Dysphagia, + asp = .71

But we CAN do something....



Conditioning

- ▶ PERIPHERAL
 - ▶ Hypertrophy
 - Increased cross sectional area
 - Increased force-generating capacity
 - ▶ Fiber type shift
 - Increased endurance
- ▶ CENTRAL
 - ▶ Increased neural activation (“drive”)
 - ▶ Increased number of motor units

4-8 wks.



6-12 wks.

Plasticity

- ▶ Cortical reorganization
- ▶ Blood flow changes
- ▶ Peripheral muscle changes

Barbay et al, 2006; Gobbo & O'Mara, 2005; Kleim et al, 2003; Nudo, 2003, 2005, 2007; Nudo & Friel, 1999

Now that we've identified the culprits and their impact on communication & swallowing what can we do about it?



Therapeutic Exercise: When, What, How?



“Our patients are too sick”

- ▶ If you do nothing you will improve nothing.
- ▶ Function may only get worse as you “wait” for the patient to “get better.”
- ▶ Remember the concept of “vicious loops.”

Lessons from Physical Therapy

- ▶ Early intervention
- ▶ ROM and facilitation are precursors to rehabilitating functional movement.



Exercise: When?

- ▶ The sooner the better
 - Muscle atrophy & deconditioning
 - 4-6 weeks bedrest = ~40% decrease in strength¹
 - Ill & elderly even more susceptible²

1. Bloomfield, 1997
2. Urso et al, 2006

First things first....

- ▶ Restore the system to the most “normal” condition as possible
- ▶ Passy-Muir Valve use (in-line ventilator use or trach alone)



Passy-Muir Valve

- ▶ Only valve FDA indicated for use on/off vent
- ▶ Only valve indicated in research to impact swallow as well as voice
- ▶ Original intent was to be used in-line with vent



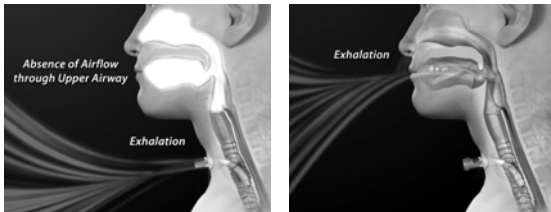
David Muir, inventor of the Passy-Muir Valve
(Ventilator dependent due to Duchenne Muscular Dystrophy)

Physiologic Impact of the Passy-Muir Valve

- ▶ Airflow
- ▶ Oxygenation
- ▶ Sensation
- ▶ Cough, secretion management
- ▶ Subglottic air pressure

Airflow Changes with Passy-Muir Valve

- ▶ Still inspire through tracheostomy
- ▶ Exhale through glottis & upper airway



Oxygenation with Passy-Muir Valve

- ▶ Facilitates end-expiratory pressure which increases alveolar surface area.
 - Instrumental in gas exchange across blood/gas barrier.



Changes in Sensation with Passy-Muir Valve

- Airflow over mucosa promotes sensation
 - Glottis
 - Voicing
 - Protective cough
 - Mouth
 - Taste
 - Swallowing
 - Pharynx
 - Clear secretions
 - Swallowing
 - Nasal Passages
 - Clear secretions
 - Smell

Changes in Cough with Passy-Muir Valve

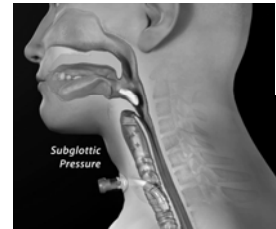
- ▶ Cough
 - Improved sensitivity to cough in response to noxious stimuli (secretions, aspirate)
 - More forceful due to subglottic air pressure
 - Now able to clear oropharyngeal secretions with cough

Changes in Secretion Management with the Passy-Muir Valve

- ▶ With more forceful, effective cough, less suctioning may be required
- ▶ Sensing/clearing secretions in upper airway
- ▶ Able to blow nose

Restoration of Subglottic Air Pressure with the Passy-Muir Valve

- ▶ Important for voice production, cough, and swallow.



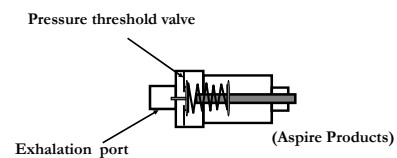
Passy-Muir a "SPEAKING" Valve and so much more!

- ▶ Unique design mimics a "more normal" system and physiology
 - Voicing
 - Pulmonary functions
 - Swallowing



Exercise: What?

- ▶ Expiratory muscle strength training (EMST)¹
 - Patients exhale against > 60% MEP
 - Suprahyoid complex activation, similar to swallow
 - May also increase strength of protective cough



1. Sapienza 2004; Kim & Sapienza, 2005

EMST

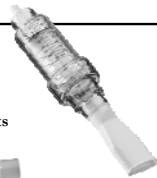
Phillips Respironics

- ▶ Provides resistive strength training to intercostals as well as suprahyoids
- ▶ 5 sets of 5 breaths, 3-5x per day, 3-5 days per week
- ▶ Progressively increase weekly as necessary to insure pt is exhaling against >60% of maximal expiratory pressure/effort
- ▶ Monitor vitals
- ▶ Use caution in patients with increased intracranial pressure
- ▶ Other precautions-see manufacturer warnings

Aspire Products



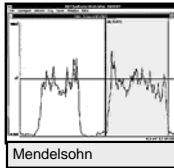
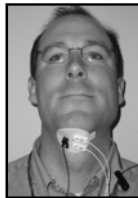
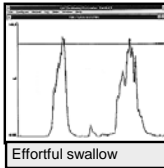
PN Medical



MD order required

- ▶ Both Passy-Muir Valves and EMST devices are prescription devices, requiring MD orders
- ▶ A Speech Pathologist and/or Respiratory therapist will evaluate appropriateness of use and prescribe usage protocol

Sampling of Other Treatment Tools



Thank you for your attention.



Presenter



Lori Burkhead-Morgan, PhD, CCC-SLP

Questions can be directed to Julie Kobak at jkobak@passy-muir.com

Additional Educational Opportunities

- ▶ Self-study webinars available on demand
 - Getting Started
 - Ventilator Application
 - Swallowing
 - Pediatric
 - Special Populations
- ▶ Live group webinars
- ▶ www.passy-muir.com
- ▶ Passy-Muir Inc. is an approved provider of continuing education through ASHA, AARC, and California Board of Nursing Credit