Using Current Evidence to Drive Clinical Practice in Adult Dysphagia

WSHA Conference 2015
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Evidence based practice

"Evidence-based medicine is the integration of best research evidence with clinical expertise and patient values."

- EBP requires us to use best available evidence to make decisions about care that will be effective and efficacious
- ASHA practice surveys highlighted common challenges to accessing EBP
- ASHA's National Center for Evidence-Based Practice in Communication Disorders (N-cep) partnered with the VA to initiate Evidence Based Systematic Reviews
- The information is out there:
  - Evidence maps (http://www.asha.org/practice-portal)

Daggett et al (2001), Wheeler-Hegland (2009), ASHA site

Why it matters

- Current health care climate
  - ‘Do better, not more’
  - Goal of increase from current 20% to 50% value based payment system by 2018/ Bundled payment system
- Data from 2003: estimated health care cost of 4.4 billion annually for pneumonia
- Average length of stay for aspiration PNE when a patient is on thin liquids is 4 days, honey thick is 18 days at average cost of $12,000.
- Estimated cost of $200/month for thickened liquids
- MBS/FEES cost about $375 MBS/$325 FEES, about $500 for mobile units
- Loss of revenue is about $500/day for a SNF if a pt is hospitalized

Aspiration and Risk and Stroke

- By 2030, it is expected that an additional 4 million people will suffer from stroke, a 21.9% increase in prevalence compared to 2013
- Post stroke dysphagia 16.5-64% incidence, with aspiration estimated in approx 22-49% of post stroke patients
  - Up to 50% of stroke patients with dysphagia will develop aspiration PNE
  - PNE risk is 7 times higher for stroke patients who aspirate vs those who do not
  - Dysphagia is one of the major causes of mortality in the first year post stroke
- Dysphagia increases risk of dehydration and malnutrition (approx 48% of patients post-stroke), and associated with decreased quality of life
- Dysphagia associated higher mortality, disability, longer LOS, increased r/o infection, higher percentage of institutionalization, and increased r/o readmission


Aspiration and Risk

- A 2001 study estimated 15 million Americans with dysphagia and approximately 600,000 new cases/year
- Pneumonia is the 5th leading cause of infectious death 65 and older, 3rd for 85 and older
- Second most common type nosocomial infection in hospital (2nd to UTI)
- Mortality rate of 20-50%, with rates as high as 80% reported in literature
- Aspiration PNE results in death for 5-15% of patients who have dysphagia caused by neurological disease.
  - An estimated 80% of neurological oropharyngeal dysphagia is not diagnosed or treated
- Incidence rate of dysphagia in LTC is reported at 50-75%
  - Incidence rate based on diagnosis
    - Multiple sclerosis 10-46%
    - Alzheimer’s dementia 52-86%
    - Parkinson’s disease 66%
    - Huntington’s disease 86%
    - ALS 14%
  - Aspiration PNE 13-48% of all infections in LTC
- Aspiration PNE is the most common cause of mortality in pts with PEG
  - Several studies have shown higher rates of PNE in pts with non-oral feeding than oral feeders

Santo, C.M., Cichero, I.A. (2014), Marik and Elywar 2001, Langmore et al 2018

Aspiration and Risk

Risk factors for Dysphagia
- Feeding respiratory rate of 20+
- Greater risk if not the logical exhale, swallow, inhalation pattern
- Decreased tongue-root pressure (particularly if lower than 300mmHg + increased risk)
- Decreased anterior eye movement

Risk factors for developing aspiration PNE
- Difficulty swallowing foods/fluids
- Dependence for oral feeding
- Dependence for oral care
- Number of decayed teeth
- Multiple medical diagnoses
- Number of medications, particularly sedatives
- Colonization of the oropharynx
- Low serum albumin, with decreased nutrition being decline in immune system
- Decreased cough reflex
- Smoking
- Tube feeding


Dysphagia and dementia

- 2004: 24 million worldwide with dementia; By 2030, estimated to be 42.3 million
  - North America highest burden, with 450 million patients
  - Dysphagia is a common complication, more frequently seen in NH
  - As many as 75% of NH in US have some form of dysphagia
  - Dysphagia increases (a) weight loss, dehydration and malnutrition
  - Malnutrition estimated 20-60% of NH
  - Co-occurrence of dysphagia and malnutrition is estimated to be up to 28% in NH
  - Dysphagia can result early from issues with cognition, vision, sensation, weakness, agnosia apraxia
  - The great feeding tube debate
    - Ruo et al 2003 study showed mortality of 64% following PEG placement, with median survival of 56 days s/p placement in NH
    - Peck et al 1993 found 56% of NH with PEG developed aspiration PNE vs 10% of orally fed residents over 6 month assessment period
    - Multiple studies have been done comparing survival rates of NH with advanced dementia and dysphagia who have PEG vs oral feeding with no significant difference
  - Medication effects
    - Positive
      - ACE inhibitors and increased dehydration (50% in FTO to improve behavior/PO meds
    - Negative
      - Anticholinergics

Disch et al 2013, Hanson and Klahn 2013
Neuroplasticity

Swallow Work Group explored principles of neuroplasticity as it relates to swallowing response (response NOT reflex)

Principles of neuroplasticity
1. Use it or lose it
2. Use it and improve it
3. Plasticity is experience specific
4. Repetition matters
5. Intensity matters
6. Time matters
7. Salience matters
8. Age matters
9. Transference
10. Interference

Neuroplasticity

- Physiologic components of deglutition
  - Lip closure
  - Tongue control/hold position
  - Bolus prep/maturation
  - Bolus transport/lingual motion
  - Initiation of pharyngeal swallow
  - Soft palate elevation/retraction
  - Laryngeal elevation
  - Anterior hyoid excursion
  - Laryngeal closure
  - Pharyngeal stripping wave
  - Pharyngeal contraction
  - Pharyngoesophageal segment (UES) opening
  - Tongue base retraction
  - Esophageal clearance

Penetration Aspiration Scale

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
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| 1     | Contrast does not enter the airway.  
| 2     | Contrast enters the airway, remains above the vocal folds; no residue.  
| 3     | Contrast remains above the vocal folds; visible residue remains.  
| 4     | Contrast contacts vocal folds; no residue.  
| 5     | Contrast contacts vocal folds; visible residue remains.  
| 6     | Contrast passes the glottis; no subglottic residue visible.  
| 7     | Contrast passes the glottis; visible subglottic residue despite patient response.  
| 8     | Contrast passes the glottis; visible subglottic residue; absent patient response.  

Current research

- There is still much that is unknown
  - Ideal frequency, intensity, duration
  - Limited randomized controlled studies
- In general, dysphagia treatment falls into
  - Compensation
  - Behavioral treatment
  - Diet modifications
Compensation

• Postures and maneuvers
  – Postures are intended to change bolus flow to protect the airway and/or improve oral/pharyngeal clearance
  – Maneuvers are associated with increased cortical involvement (Martin, Logemann, Shaker, Dodds 1993; Boden, Hallgren, Witt 2006) and ‘place aspects of the pharyngeal swallow under voluntary control’ (Marik and Kaplan 2003)

Compensation- Effortful Swallow

• EFFORTFUL SWALLOW (Huckabee and Steel 2006; Hind, Nicosia, Roecker, Carnes, Robbins 2001; Fukusaka et al 2013; Yeates, Steele, Pelletier 2010; Lazarus, Logemann, Gibbons 1993; Bulow, Olsson, Ekberg 2001; and Huckabee, Butler, Barclay, Jit 2005; Wheeler-Hegland 2009)
  – Increases neuromuscular drive/ submental muscle activation
  – Increases lingualpalatal and pharyngeal swallowing pressure
  – Increases tongue base movement and subsequent vallecular clearance
  – Improves contact of tongue base to posterior pharyngeal wall
  – Associated with improved airway protection &/or prolonged elevation of hyolaryngeal complex
  – Increases muscle activity in floor of mouth
  – Decreases pressure in UES
  – Increases duration of lingual, pharyngeal and UES relaxation contraction pressure
  – Being studied both in terms of compensation and rehabilitation

Compensation- Effortful Swallow

• Fukusaka T. et al 2013 ‘Effect of the effortful swallow and the Mendelsohn maneuver on tongue pressure production against the hard palate’
  – Study of oral pressure at 5 points during Mendelsohn, effortful swallow vs water sip.
  – Found higher oral pressure and longer duration of pressure against palate with maneuvers
  – Supported research by Huckabee emphasizing instruction for tongue to palate during effortful swallow

• Clark and Shelton 2014 ‘Training Effects of the Effortful Swallow under 3 ex conditions’
  – Examined use of ES + Theradip swallow trainer vs ES+ lingual elevation vs ES sole.
  – 40 participants (mostly females, healthy, mean age of 23)
  – Instructed to perform 3 sets x 10 for 4 weeks of assigned exercise
  – What they found (pressure measured with IPR)
    – Across all groups, swallow pressures for effortful swallows were higher than for non-effortful swallows prior to training
    – Higher pressures were seen with larger diameter straws vs prediction of increased pressures with increased resistance (smaller straws)
    – Increase in anterior lingualpalatal pressure after training with effortful swallow, with no real difference between the groups

Compensation- Supraglottic Swallow

• Supraglottic designed to protect airway by forcing closure of true vocal folds, super supraglottic involves additional ‘bearing down’ to begin closure at false folds by forcing arytenoids forward to base of epiglottis
• Wheeler-Hegland 2009
  – Supraglottic swallow
    – Changes timing of UES opening, changes duration and timing of hyoid excursion, induces VF closure/laryngeal closure and changes timing of tongue base retraction
  – Super supraglottic swallow
    – Increased UES relaxation pressure
    – Increased duration of hyolaryngeal movement
    – Changes timing of UES opening and onset of VF closure (earlier in swallow)
  – The cough associated at the end of this maneuver has not been investigated
**Compensation- Supraglottic Swallow**

**SUPRAGLOTTIC SWALLOW/ SUPER SUPRAGLOTTIC SWALLOW**
- Chaudhuri et al 2002 identified abnormal cardiac findings in approx 87% of participants (with h/o stroke both with and without h/o CAD) and therefore may be contraindicated for stroke and cardiac patients.
- Fujiwara, et al 2014 ‘Effect of Supraglottic and Super-supraglottic swallows on Tongue Pressure Production against hard palate’
  - 19 healthy adults 17-40 whose tongue pressure was measured with tongue pressure sensor sheet on palate during normal swallow, supraglottic swallow and super-supraglottic swallow.
  - What they found
    - Duration of tongue pressure on anterior-median of hard palate longer with SS and SSS
    - Increased magnitude of pressure on posterior palate with S5 and all points with SSS

**Compensation- Chin Tuck**

**CHIN TUCK**
  - Pushes tongue base and epiglottis closer to posterior pharyngeal wall
  - Increases size of vallecular space
  - Increases epiglottic inversion for improved airway protection
  - Increases pharyngeal contraction
  - Changes relationship of pharyngeal structures
  - Increases airway protection by narrowing of laryngeal entrance
  - Decreases distance from hyoid to larynx
- According to numerous studies (Logemann et al 2008, Robbins 2008, Nagaya et al 2004) chin tuck eliminates aspiration in up to 50% of neurologically involved patient and is correctly executed in as few as 60% of the same group of patients.
- Some studies (Bulow et al 1999, Castell et al 1994) reported decreased pharyngeal peak pressure/contraction during chin tuck and suggest that swallowing may be worse for patients using chin tuck who have weak pharyngeal contraction.

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**Compensation- Chin Tuck**

**CHIN TUCK**
- Jong, Jung, Kyoung, Seung 2014 ‘Chin Tuck for Prevention of Aspiration: Effectiveness and Appropriate Posture’
  - Retrospective of 97 patients (heterogeneous diagnoses) who aspirated and used chin tuck during MBS
  - Chin tuck eliminated aspiration in 16/97 (17%) of patients
  - Chin tuck resulted in decline in scores of PENNAP scale (improved safety) on 20/97 (21%)
  - Chin tuck was most effective in cases where there was no PS residue
  - Chin tuck shortened oral transit time, pharyngeal delay time and pharyngeal transit time
  - Chin tuck reposition angle was greater in the effective group
  - Study with 60 healthy adults 26-79 with comparison of neutral vs ‘chin-down’ vs ‘true chin tuck’
  - Chin tuck reduced the anterior/posterior distance in epiglottis (which would presumably assist in TBR) and reduced A/P distance of laryngeal vestibule (i.e. improved airway closure).
  - Chin tuck reduced hyoid horizontal movement and may presumably reduce UES movement
  - No effect with chin-down

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**Compensation- Chin Tuck**

**CHIN TUCK**
- **When to use:**
  - Decreased TBR
  - Delayed pharyngeal swallow onset
  - Poor oral control, resulting of loss of bolus posteriorly into pharynx
  - Poor airway closure
- **When NOT to use:**
  - Decreased pharyngeal contraction
  - Poor oral control (Logemann 1993)
  - Poor A/P transit
  - Poor labial seal
  - Pyriform Sinus residue as it can CAUSE aspiration with PS residue
- Due to:
  - Reduced pharyngeal peak pressure (Bulow et al 1999)
  - Increased laryngeal effort (Inoue et al 2011)
  - Increased duration of UES relaxation (Bulow et al 2001)
  - Decreased VC movement
Compensation/Exercise- Mendelsohn

MENDELSON MANEUVER
- Designed to increase hyolaryngeal excursion and duration of UES opening to decrease pharyngeal residue and increase swallow safety.
- 2002 pilot study from Lazarus et al also suggested increased pharyngeal pressure generated from increased tongue base to posterior wall contact, resulting in improved bolus clearance.
- Traditionally used as compensatory strategy. Being investigated as a rehab exercise to target submental musculature

Compensation/Exercise- Mendelsohn

MENDELSON MANEUVER
- McCallough and Kim 2013
  - 2 part study with 17 participants with stroke and continued dysphagia (6-22 mos post)
  - Treatment was 2x/day for approx 45min targeting at least 10 and optimally 40 swallows using Mendelson with at least 2 sec sustained but targeting 3:4. Biofeedback provided.
  - Results after 2 week treat = statistically sig increased hyoid movement both anterior and superior; increased duration of UES opening, though not statistically significant.
  - Gains greater after 20 sessions vs 10, and on treatment vs non-treatment weeks, suggesting ongoing gains could have been seen with longer treatment duration
  - Improved swallow function (measured by PAS) and improved overall diet measured on 7 point scale (DOSS)
  - Maintenance of minimally altered diet for 9-11 follow up.
- Wheeler-Hegland 2009
  - Increased peak pharyngeal pressure and duration of pharyngeal contraction
  - Increased UES peak contraction and duration of UES opening
  - Improved bolus transit time

Compensation- Head Turn

HEAD TURN/ROTATION
- To direct bolus laterally. Also been shown to open UES by pulling on cricopharyngeal muscle and subsequently helping with decreasing residue in pyriform sinuses.
  - Studies have been primarily on normals
  - Trial of 10 healthy participants with measure of pressure via manometry, comparing degree of rotation via novel technique cervical range of motion (CROM) inclinometer
  - Decrease in UES pressure with both 45 and 90 degree head turn
- Wheeler-Hegland 2009
  - Increased pharyngeal pressure at I/o valleculae and PS on rotated side
  - Increased A/P opening of UES

Exercise

Martin 2009- review of evidence on neuroplasticity related to swallow function
- Concluded that much of the available literature is based on hind function, but there are differences in oral/oropharyngeal musculature (e.g. co-activation of paired mide line muscles vs lateralization contralateral/ipsilateral contributions of gross motor
- Basic principle in literature (i.e. Burkhart LM, Sapenca CM, Rosenbek JC. 2007) is that exercise must push the neuromuscular system beyond normal level of activity for change (the INTENSITY principle of neuroplasticity)
- Review of the basics
  - 55 muscles/6 CN
- Skeletal muscles are made up of type I (slow twitch/endorance) and type II (fast twitch/larger and more force based)
  - Oral/pharyngeal/laryngeal muscles also have “hybrid” type between the 2
- Recent TMS studies have shown some R hemi-dominance of swallow function, particularly in mylohyoid
- Sensory input drives cortical change
- Exercises target both cortical reorganization and “hypertrophy” of muscles

Exercise - Shaker

**SHAKER Exercise**

- **The original studies**
  - Kahrilas et al., 1988; Logemann et al., 2000; Ferrajoli et al., 2000; Shaker et al., 2002; Goyal 1984; Craig et al., 2006; Shaker et al., 1993 – Easterling et al., 2005; Magan et al., 2009
  - Primarily for decreased UES opening, with goal of increasing strength of suprahyoid muscle (digastric, mylohyoid, geniohyoid) to pull larynx up and forward (superior anterior to open UES and improve swallow)
  - Shaker R, et al. 2002
    - 27 patients (23 male, 4 female) with a variety of diagnoses
    - 6-week/3-day-of-the-week protocol (2 isometric, 3 isokinetic) repeated
    - Significant increase in the anterior-posterior diameter of the UES/reduction of PS residue
    - Improved anterior excursion of the larynx during swallow
    - Significant increase in the functional outcome assessment measure of swallowing
    - All participants demonstrated aspiration post swallow before and none after exercise program
    - All participants NPO prior, all on oral diet after (30 regular/wide, 5 mushy soft/wide, 2 mushy soft/NTU)

Exercise - Shaker

**SHAKER - The new research**

  - 3x/day (slow twitch force based) to provide resistance targeting suprahyoid muscle (digastric, mylohyoid, and anterior digastric)
  - Surface EMGs measured significantly greater with CTR vs Shaker and greater difference in measures from rest to peak with CTR
  - Easterling et al. (2012) jaw opening exercise for insufficient opening of upper esophageal sphincter
    - Exercise with ‘chin tucks’ (isometric force based)
    - PS to open jaw as much as possible and hold for 10 seconds
    - Significant increase in opening between CTR vs Shaker
  - Significant improvement in opening in both groups with use of chin tucks

Exercise - Lingual Exercises

**LINGUAL EXERCISE**

- In general, target improved lingual strength for improved OTT and oral clearance.
  - Tongue is a muscular hydrotat, composed of all muscle and not centered around a joint with both intrinsic and extrinsic musculature
  - Anterior lingual muscles are primarily type II (fast twitch/force based) so those associated with strength that are easily fatigued and posterior lingual musculature are composed of more than 50% type I muscle fibers (slow twitch/ endurance)
  - 2003 study of normals by Lazarus et al showed significant increase in max lingual strength (compared to no exercise group) measured by IOP, either with use of tongue blade or IOP
    - Ex 30 mm/s/day, 3x/week to 5 month lingual lateralization left/right, elevation and protrusion
  - Clark, 2012
    - Phase 1 Study of 25 normals randomized to one of 5 groups (including one no treatment) targeting endurance, strength, power, or speed
    - Specificity of training for endurance, strength and power groups
    - Needs further assessment with dysphagic population but suggests we may need to be more specific with exercises
Exercise- Lingual Exercises

LINGUAL EXERCISE
- Robbins et al 2007
  - 10 patients s/p stroke (mix of 6 acute and 4 chronic)
  - 10 reps x 3/day x 3 days/week x 8 weeks x 2 placements via IDPI [anterior and posterior] as prescribed by American College of Sports Medicine for strength training.
  - Exercise at 60% of baseline 1 rep maximum x 1 week, then 80% max for additional 7 weeks. Max recalculated EDW.
  - Significant increase in 1 rep max, with greatest gain in initial 4 weeks, decreased oral/pharyngeal residue with greatest reduction in pharyngeal residue, improved swallow safety as measure by decreased score on PES (greatest from 4.8 weeks), decreased DT, increased pharyngeal response duration (from beginning to end of hyoid movement) indicating prolonged airway closure/protection, improved SWAL-QOL scores.
  - Transferance from isometric exercise program to dynamic swallow function

Exercise- Lingual Exercises

LINGUAL EXERCISE (MOST exercise program)
- Juan, Hind, Jones, McCulloch, Gangnon, & Robbins, J. 2012 (Case study)
  - Treatment protocol included 8 weeks of tx, 5 weeks ‘detraining’ and 9 weeks of maintenance combined with UES dilation post treatment (after maintenance period)
  - Treatment targeting anterior and posterior tongue 10 reps each, 3/day for 3 days/week
  - ‘Detraining’ = no swallowing exercise, Maintenance = pushing tongue hard against palate without device 10 reps, 3/day, 1x/week
  - Following 8 week treatment period
    - Progression to general oral diet with <15 lb weight gain
    - Increased isometric lingual pressure of greater than 166Pa, 8.8% gain in lingual volume, Increased pharyngeal pressure and UES opening
    - Decreased pharyngeal wall residue
    - Decreased pressure and UES opening after 5 weeks detraining
    - Pressure returned to initial post treatment levels after maintenance training

Exercise- General Exercises

LINGUAL EXERCISE- McNeill Dysphagia Therapy Program
  - According to published literature, the McNeill Dysphagia Therapy Program focuses on progressive strengthening and coordination of swallowing in the context of functional swallow activities and the development of movement patterns and refinement of the coordination of the muscular components of the swallowing process. The McNeill Dysphagia Therapy Program uses the act of swallowing as an exercise incorporating a single swallowing technique (food swallowing) and a specific hierarchy of feeding tasks, which challenge a patient’s swallowing system.
  - Initial case control study in 2003 showed patients treated with the McNeill Dysphagia Therapy Program were 14 times more likely to improve their swallowing ability compared to a matched control group. A 80% success rate with improved oral intake and 76% success rate for removal of feeding tubes (per brokanc)
  - Current study N=6, chronic dysphagia s/p w/o successful prior treatment
  - 12/day, 5/week (8 weeks) in program nightly between sessions
  - Subjects were taught a strategy (i.e. swallow food with a single swallow, with licker consistency and volume well balanced for success and increased load. Were we based on success criteria from tx
  - Results:
    - Increased scores on three assessment of swallowing ability (MASA) with average increase of 27 points
    - Functional Oral Inhalation Test (FOIT) improved for all participants and was maintained for 83% in 3m follow up
    - UDS patient perception score improved from 20-68.5 and were maintained at 6 months
    - UDS patient perception score improved from 20-68.5 and were maintained at 6 months
    - Also physiologic improvement in biomechanics, swallow pressure and OES measurements

Exercise- General Exercises
**Exercise - EMST**

- EMST (expiratory muscle strength training)
  - Addresses expiratory pressure for improved cough and subsequent airway clearance
  - Variable frequency in literature but generally positive results
    - Wheeler et al 2007 - used sEMG during saliva and water swallows following EMST
    - Wheelon-Heglund et al 2008 compared EMST vs normal swallow, Mendelsohn, and effortful swallows in normals
      - Both showed increased motor recruitment of submental muscles
    - Smeltzer et al 1996 3 sets x 15 reps, 2x/day x 3 mo with MS patients resulting in improved PEmax for improved cough
    - Troche et al 2009 and Pitts et al 2009 - 5 sets x 5 reps 5 days/week
      - x 4 weeks in PD pts resulted in decreased PAK, increased hyolaryngeal excursion and improved SWAL-QOL scores

**NMES General**

- How muscles are impacted
  - Electrodes are transcutaneous
    - Skin, adipose tissue, then platysma
    - Omohyoid and sternohyoid are deeper than platysma but superficial to thyrohyoid
    - Omohyoid and sternohyoid depress hyoid
    - Thyrohyoid elevates
    - Submental placement targets mylohyoid, genioglossus, and anterior body of digastric (deeper than platysma) which are elevators when the mandible is fixed.
    - Thyrohyoid placement (usually right at level of thyroid notch) targets laryngeal elevation
  - If the submental muscles are activated (raising hyoid) without simultaneous elevation of thyrohyoid (raising larynx), then the laryngeal vestibule opening is increased and theoretically would increased r/o airway compromise

**NMES General**

  - 10 healthy participants with paired electrodes diagonally across thyroid and submental with stim at sensory level (50Hz, 2.3mA) while water was introduced to superior pharynx, with swallowing measured via EMG + microphone for detection of ‘swallow sounds’.
  - Swallowing increased during stim and the effect immediately stopped with cessation of stim
  - Found a difference in threshold for sensory, motor and pain, with sensory at lowest level, then motor and finally pain

**NMES- Pro**

- Ralph, et al 2013 'Effect of surface sensory and motor electrical stimulation on chronic poststroke oropharyngeal dysfunction’
  - 20 Patients with h/o CVA and chronic oropharyngeal dysphagia (at least 3 mo post with score of 3 or higher on PAK)
  - Randomized to sensory (75% motor threshold thyrohyoid placement) or motor (motor threshold suprahyoid/submental placement) x 1 stim/1 hour/day for 10 days of treatment (with VitalStim device)
  - Sensory placement at thyrohyoid notch to stimulate paraglottus and increase afferent drive and promote cortical plasticity.
  - Motor placement in submental position to induce muscular contraction and improve hyoid motion and laryngeal protection.
  - What they found
    - Motor group showed decreased pharyngeal residue, improved vertical and anterior hyoid movement and corresponded laryngeal vestibule closure
    - Significant improvement in swallow safety for both groups with 4% 7% decrease in unsafe swallows’ penetration or aspiration in sensory group and 6% decrease in motor group, but motor-MS scores only reduced in sensory group
    - Significant decrease in oral residue in both.
  - Conclude that ‘impaired airway protection can be treated at sensory level’ and ‘improvement in larynx transfer should be treated at motor level’
NMES- Pro

• Blumenfeld, et al 2006 'Transcutaneous electrical stimulation versus traditional dysphagia therapy: A nonconcurrent cohort study'
  - Chart review of 40 LTAC patients with 'dysphagia and aspiration', variable diagnoses undergoing NMES vs traditional treatment (exercise, maneuvers and diet texture trials)
  - Exercise sessions completed for 30 minutes for both groups, variable treatment periods 'based on patient need/goals'
  - Scores on swallow severity scale (0-6 scale) were significantly better with NMES group vs traditional group

NMES- Pro

  - 25 patients with MS and either had aspiration or pharyngeal residue on FEES or self reported swallowing problems (coughing or globus feeling)
  - NMES at 30Hz for 20 min sessions 2x/week x 3 week for 6 total sessions with 2 paired electrode placements (submental and between hyoid and thyroid).
  - Pts instructed to swallow when they felt the ramp up, for targeted total of 60 swallows/session (1 swallow every 20 seconds)
  - What they found (from 17 subjects who were able to complete pre and post testing)
    • 10/17 had improved swallow score on Dysphagia severity scale, 7/10 unchanged
    • 8/17 had improved score on INSS with water bolus
    • 7/17 declined in INSS on jugbolus
    • 7/17 showed decreased pooling in either valleculae (1/7) or pyriforms (6/7)

NMES- Con

• Humbert , et al 2006
  - Tested 50 submental and laryngeal placements of bilateral surface electrical stim (VitalStim) on 29 healthy volunteers ages 20-60 to assess hyoid and laryngeal movement
  - Utilized maximum tolerated stimulation levels which ranged from 3-25mA depending on placement
  - Stim to laryngeal regions resulted in significant hyoid/laryngeal decent
  - Stim to suprahypoid areas resulted in hyoid depression
  - Only placement not resulting in decent was submental only, though this also did not result in elevation but neutral positioning.
  - Healthy participants were not able to overcome the hyoid or laryngeal depression when completing liquid swallows during stim (compared to movement with stim at rest)

• Power et al 2006 looked at stim intraorally on the faucial pillars while assessing cortical excitability and found stim at 3Hz inhibited corticobulbar activity and delayed swallow onset while .2Hz enhanced cortical activity

NMES-Con

• Kim and Han 2009 'Effect of surface electrical stimulation of suprahypoid muscles on hyolaryngeal movement'
  - Comparison of hyolaryngeal movement and trajectory during 5mL liquid swallows in NMES with suprathyoid placement (4 electrodes/2 placements bilaterally at edge of hyoid and mandible )
  - 12 healthy normals
  - Stim was maximal tolerable intensity (10-15mA) at 70Hz for 1 sec
  - A head splint with Vivan attachments was used to secure the electrodes closer to the skin bc they found that electrodes alone were not enough to penetrate soft tissue in initial trials
  - Elevation and anterior excursion were much less (about 10% less average) in electrical stim vs water swallow and about 24% of the epiglottic movement induced by a liquid swallow
  - Trajectory was similar, but significantly less in electrical stim group

• Rajani, et al 2012 'The effect of surface electrical stimulation on swallowing dysfunction in Parkinson patients'
  - Immediate effects of NMES measured via NMES on 10 patients with PD compared to 10 age-matched healthy peers
  - They measured multiple temporal and spatial variables, with limited effect: the only statistically significant changes were in horizontal hyoid movements and an increased duration of laryngeal ventricular opening which the authors felt would be of little benefit for improved swallow function.
NMES-Neutral

  - 25 patients s/p hemispheric stroke (at least 3 mos post)
    - Traditional vs NMES
    - NMES with VitalStim position 3B (bilateral at level of thyroid notch) 60 min sessions, 5x/week x 3 weeks
    - Traditional 60 min, 5x/week x 3 weeks of traditional exercise program as designed by SLP (nonspecific)
    - No statistical difference in NMES vs Traditional on VAS (a subjective swallow assessment), Actual Nutrition Scale, Oral Motor Function test or MBS
  - Suggested that NMES showed promise, but no solid evidence of efficacy and implementation should be considered experimental

NMES-neutral

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    - NMES with VitalStim position 3B (bilateral at level of thyroid notch) 60 min sessions, 5x/week x 3 weeks
    - Traditional 60 min, 5x/week x 3 weeks of traditional exercise program as designed by SLP (nonspecific)
    - No statistical difference in NMES vs Traditional on VAS (a subjective swallow assessment), Actual Nutrition Scale, Oral Motor Function test or MBS
  - 120 patients s/p stroke who had at least 48 hours of stable vital signs after dx of hemispheric infarct or hemorrhage
    - Assigned to VitalStim, conventional (defined as ‘basic training’ which appeared to refer to a swallow exercise program and ‘direct food intake training’) or VitalStim + conventional
    - Results measured via sEMG of hyoid, SSA (Standardized Swallow Assessment), MBS, and SWAL-QOL
  - There was no difference in the VitalStim vs conventional therapy (suggesting that either treatment is equally effective), but statistically significant difference in the VitalStim + conventional compared with either in isolation

NMES-neutral

  - 8 participants age 25-78 with chronic dysphagia s/p 6mo to 20 years, with mean of 2 years on a severely restricted diet
    - Utilized electrode placement recommended by VitalStim, with 2 paired placements, one submental and the second at the thyroid (targeting mylohyoid and thyrohyoid muscles)
    - E-stim at sensory level (below max threshold) and at motor level (maximal tolerated)
    - During stim at rest, the hyoid was depressed 5-10 mm/ no laryngeal movement
    - At sensory threshold levels there was no change on PenAsp scale, but improvement on NIH SSS (swallow safety scale) which measures residue in addition to penetration and aspiration
    - At motor levels, there was not an anticipated increase in penetration or aspiration during liquid swallows

NMES-neutral

  - 20 pts s/p stroke(at least 1mo post), 18 completed full program (n=9 of each group)
    - 2 groups RCT
      - Effortful swallow with infrahyoid motor electrical stim (experimental)
      - Effortful swallow with infrahyoid sensory electrical stim (control)
    - Vitalstim used @80Hz 700us
    - Control intensity was adjusted until ‘tingling was felt’, experimental until ‘muscle contraction was visible’
    - 3 sets x 20 min /week x 4 weeks with effortful saliva or small water q 10s
    - For experimental group, significant increase in vertical movement of larynx but no statistically significantly change in hyoid movement, UES opening, anterior movement or scores on PAS
    - No statistically significant changes in control group
**NMES-Neutral**

- Kiger et al. 2006
  - Compared VitalStim vs traditional therapy (consisting of oral motor ex, compensatory strategies, and TTS) via dietary status and FEES or MBS
  - VitalStim group participated in 1-13 treatment sessions vs traditional group with 1-6 sessions
  - No statistically significant difference between the groups
- Tan et al. 2013 meta-analysis concluded that NMES may be more effective than traditional treatments in the non-stroke population, but of equal effectiveness in the stroke population

**NMES**

**Conclusion**

- Variability in treatment protocols
  - 20 min sessions to 60 min sessions
  - 10-80Hz
  - Variable amplitudes (2-25mA)
  - Variable placement of electrodes
- Limited research including follow ups to assess maintenance of gains
- No clear evidence on what diagnoses and levels of severity are candidates
- More expensive than traditional dysphagia treatment
- FDA clearance does not equal efficacy
- Third party payers do not see as efficacious and thus cannot be billed as a stand alone treatment

- Miller, et al. (2013) 'Electrical Stimulation in treatment of pharyngolaryngeal dysfunctions’
  - Systematic review with conclusion that ‘in combination with traditional therapy methods, NMES offers better and faster therapy effects, particularly with respect to providing ‘submental support, enhancement of infrapharyngeal resistance or to support sensory input’.

**Diet Modifications**

  - Overall, huge variability in consistencies (i.e. 4 identified liquids in US, 5 in Japan)
  - Differences in corn starch vs xanthan gum thickeners in residue
  - Thicken liquid
    - Reduce penetration/aspiration
      - Increased duration of swallow events (OTT, PTT, UES opening)
    - Increase risk of post swallow residue
    - Increased overall residue (80% of NTL, 44% thin liquid swallows)

**Diet Modifications**

- Steele, et al. (2014) ‘Variations in tongue-palate swallowing pressures when swallowing Xanthan gum-thickened liquids’
  - Xanthan gum is relatively new and introduced d/t amylase resistance (preventing dilution with saliva), low yield stress with subsequent better flow, slippery and more cohesive with less residue than corn-starch thickeners
  - 78 healthy adults, with older and younger cohorts
  - Tongue pressure measured with Kay swallow lab
  - Higher tongue palatal pressure noted during NTL/HTL swallows compared to thin liquid swallows, but still below 40% of max isometric capacity so below taxing capacity
  - Implications for recommendations with patients with dysphagia and reduced lingual strength
- Preliminary study by Domer et al. (Not yet published- with data in the Dysphagia Research Society annual report) showed survival rate of 100% with animals on thin and xanthan gum vs 12.5% on cornstarch thickened liquids
Diet Modifications

- Logemann et al 2008
  - Portion of protocol 201 that looked at immediate aspiration elimination using chin down, HTL, HTL (n=142)
  - honey thick liquids most effective in eliminating aspiration, followed by nectar, then chin tuck
  - patient preference was for chin tuck, then nectar, then honey
- Robbins, et al 2009
  - Participants from 1st part of study who either aspirated on all 3 conditions or did equally well and did not aspirate on any of the three conditions (n=115)
  - 52/115 developed pseudomembranous (10%), 21 died (4%)
  - PNE 16/259 (6%) in chin down group, 6/133 (4.5%) in HTL group, 12/122 (10%) of HTL group
  - DEATH 12/259 (4.6%) chin down, 4/133 (3%) HTL, 5/122 (5%) HTL
  - Of the group for which all 3 interventions worked equally well, there were 10 cases of PNE on 3 mo follow-up. None of the patients for which all 3 is worked who were randomly assigned to HTL developed PNE
  - Hospitalization for PNE with chin tuck of average of 4 days vs 18 for HTL

- Sensory issues related to chemo/RT with higher r/o silent aspiration
- Some evidence of decrease in aspiration with use of thickened liquids but not consistent
- Lack of evidence to support use of thickened liquids as a compensatory measure to eliminate aspiration in HNC
  - Several studies have found that thicker food and liquids are safer for reducing penetration and aspiration in patients with vocal fold paralysis, nonprogressive brain disease and neurodegenerative disease
  - Increased volume decreases safety.

Resources

- If you have trouble finding the time to keep up with all of the research coming out, you are not alone, but there are some great resources to help keep you up to date:
  - ASHA
    - SIG 13
    - Practice Portal
  - Dysphagia café
    - http://www.dysphagia-cafe.com/
    - http://swallowingdisorderfoundation.com
    - http://www.swallowstudy.com/
    - http://www.nature.com/gimo/index.html
  - FB
    - Adult Rehab Speech therapy
    - Medical SLP Forum
    - SLP Medical Research Group