TREATMENT FOR ORAL AND PHARYNGEAL DYSPHAGIA; WHAT PRINCIPLES AND EVIDENCE SUPPORT IT?

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Goals for this session

• Discuss principles of neuroplasticity, motor learning and neuromuscular treatment related to dysphagia
• Review some basics re: reading research
• Differentiate postural, compensatory and rehabilitative techniques for pharyngeal dysphagia
• State the role outcomes data play in planning treatment
• Determine appropriate strategies for various oral and pharyngeal deficits
• Discuss evidence for specific techniques and the limitations in current evidence

Why understand related principles?

• Swallowing involves series of highly coordinated, volitional and reflexive sensorimotor movements in mouth, larynx, and pharynx
  – Coordination between respiratory and swallowing functions in upper aerodigestive tract
• To manage some a complex disorder, the SLP must understand underlying physiology and related principles

Without the understanding, how does the SLP answer:

• Can the impaired physiology actually be changed?
• Is it possible an exercise could cause more harm than good?
• How frequently should an exercise be practiced?
• How many repetitions of the exercise are needed to obtain a benefit?
• Should the practice be spaced out or massed together?
• At what point in recovery will dysphagia intervention be most beneficial?

Neural plasticity

• Brain’s ability to change, to alter neuronal systems in response to changes in input
• Swallowing therapy intends to achieve a behavioral change (e.g. more efficient movement of the bolus), but also a change in underlying neural pathways
Do changes in pathways happen?

• “Swallow neural substrates can undergo plastic changes as a function of experience, and...
• These swallowing neuroplastic changes may be associated with modulated swallowing behavior”
  – Martin 2009 p. 219

Does it always happen?

• Changes in neural pathways may result in behavioral change
• Only sometimes does behavioral change indicate neural plasticity occur (Robbins et al 2008)

Ten principles of neural plasticity

• Overview
• Two good articles to read:
  – Robbins et al 2008 “Swallowing and Dysphagia Rehabilitation: Translating Principles of Neural Plasticity into Clinically Oriented Evidence”
  – Kleim & Jones 2008 “Principles of Experience-Dependent Neural Plasticity: Implications for Rehabilitation After Brain Damage”

Use it or lose it

• If certain function is not used, behavioral response may degrade
  – A sport played in high school?
  – Dancing lessons?
  – Foreign language?
• What does this imply for patients we make NPO?

Use it and improve it

• Function can be improved through use
  – Especially if the activity involves not just practicing, but practicing designed to improve performance of the activity
    • Use of a coach for sports?
    • Instructor for dance or language lessons?
• What is implication for swallowing?
  – Just repetitive swallowing?
  – Or swallowing with instruction for improved performance?

Plasticity is related to specific skill being practiced

• Practicing one skill will not necessarily result in change to a different area of the brain
  – Would practicing tap make a person a better ballet dancer?
  – Practicing a tennis forehand improve golf swing?
• Would practicing bringing spoon to lips result in improved cup to lips? (and a change in different areas of the brain)
Repetition matters

- In order to change neural substrates, practice must be extensive and continue for a period of time
  - Anyone take piano lessons as a child?
- How extensive does swallowing “exercise” need to be?
- How many repetitions?
- Over what length of time?
- One of the criticisms of NMES… is it just the “repetition” that results in change?

Intensity matters

- In order to achieve neural change, activity must force the body beyond the typical level of activity in order to achieve neuromuscular adaptation (Pollock et al 1998)
  - No pain, no gain?
- Body building…. Light weights or heavy weights?
- Swallowing: Burkhead (2007) suggests we should have patient work to point of fatigue rather than specific # reps or sets

Time matters

- Long periods of training and continuous training (rather than intermittent) may result in maximal neural change (Fisher & Sullivan 2001)
- Going to the gym for ten minutes a day? An hour a day?
- Going for a few days and then skipping weeks?
- Swallowing – at what point in recovery can patient benefit from long periods of continuous training?

Salience matters

- Movement being practiced has to be important, functional and related to the behavior being trained
  - Basketball player at the foul line… what’s more important to practice….
  - Bouncing the ball before shooting?
  - The movement of the shoulders and wrist during the shot?
- Swallowing –If goal is to improve ability to move bolus posteriorly would practicing tongue lateralization be salient?

Salience … specificity

- Specificity- movement being trained should be close to the movement needed during the functional target task
  - E.g. Training on isotonic endurance task did not increase endurance on an isometric endurance task (Clark 2012)
    - Isotonic
    - Isometric

Age Matters

- Younger brain is more adaptive and plastic
  - Neural plasticity does occur across the lifespan, though response decreased with age (Kramer et al 2004; Sawaki et al 2003)
    - Whew!!
  - Swallowing therapy – does this affect our prognosis?
Transference

- Plasticity in response to training one behavior can enhance acquisition of similar behaviors
  - Roller skating and roller blading ... and ice skating?
- Would training tongue lateralization to clear the sulci enhance acquisition of tongue lateralization to place food on chewing surface

Interference

- Plasticity within a given neural structure can impede that structure from other more beneficial plasticity
- Skiing vs. snowboarding: facing straight ahead vs. sideways; moving legs vs. moving whole body
- A patient might learn a maladaptive compensation which could impede them using the same neural circuitry to learn appropriate behavior
  - Garcia et al 2004

Interference example

- Patient changed mechanics of swallow
- Interfered with typical bolus flow
- Used abnormal tongue base seal with bolus still in oral cavity
- Resulted in nasal backflow

- Authors stressed importance of carefully monitoring behaviors taught
- They observed this on repeat VFSS, and could not tell clinically

Motor control and motor learning

- Humbert & German 2013
- “New Directions for Understanding Neural Control in Swallowing” Dysphagia 28 (1) 1-10

Sensory feedback

- Sensory feedback is important for learning a motor movement, predicting the accuracy of the movement and making corrections to the movement

Top-down, Bottom-up

- Swallowing involves top down (cortical control) and bottom-up peripheral input processing
  - Chewing and unexpectedly encounter something hard
  - Sip of coffee much hotter than expected
Continuum

- Swallowing movements occur on a continuum of reflexive to volitional

Feed-back and feed-forward

- Motor learning involves feed-back and feed-forward control loops as the individual adapts motor movements

Neuromuscular treatments for speech and swallowing

- Heather Clark
- Limited empirical evidence to support use of NMTs
- Clinicians may also lack the foundational information needed to judge the theoretical soundness of unstudied treatment strategies.

Clark and NMTs

- Much of the work on neuromuscular treatment is derived from work of physical therapists
  - Large muscles in the limbs
  - Differ from muscle fiber types in small muscles of lips, tongue, cheek, soft palate
- Beyond scope of this course to review all of the information

So why understand how muscles function?

- May think you are working on one muscle when you are really working on another (that is perhaps on top of the one you are hoping to target)
- You might be providing a treatment that is not beneficial to the type of muscle you are targeting
  - E.g. strength training may not be indicated for a particular disease

Evidence-based practice

- ASHA has placed an emphasis on EBP
- Multiple documents exist to provide information to the clinician
- EBP Documents and Reports
  - 2006 Work Plan: Focused Initiative on Evidence-Based Practice
  - Position Statement: Evidence-Based Practice in Communication Disorders
  - Report of the Evidence-Based Practice Coordinating Committee
  - Research and Scientific Affairs Committee Statement
- Excerpts to follow
Evidence-based Practice

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

The goal of EBP is the integration of:

• (a) clinical expertise, (b) best current evidence, and (c) client values to provide high-quality services reflecting the interests, values, needs, and choices of the individuals we serve

EBP is client/patient/family centered

• A clinician’s task is to interpret best current evidence from systematic research in relation to an individual client/patient, including that individual’s preferences, environment, culture, and values regarding health and well-being.

Goal of EBP

• Providing optimal clinical service to that client/patient on an individual basis.
• Because EBP is a continuing process, it is a dynamic integration of ever-evolving clinical expertise and external evidence in day-to-day practice.

What is the BIG challenge for the clinician?

• Clinical expertise?
• Taking client values into account?
• Reading and interpreting best current evidence, which changes on an almost daily basis!

Understanding Research in Speech-Language Pathology

Basics for Clinicians
With thanks to Daniel J. Croake, MM/MS, CCC-SLP
Take a sip of caffeine while we refresh our ability to:

• Understand components of the research paper
  — We will focus on the methods and reporting of the methods (Statistics)
• Help you draw conclusions (on your own) about the research findings

Importance of research

• Improving human health requires research
  — Bench to bedside
• It’s not all in a textbook
  — Rapid pace of new information
• Evidence Based Practice (EBP) (Sackett et al., 1996)
• ASHA says so....

Barriers to reading research

• Lack of time (O’Connor & Pettigrew, 2009)

• Anecdotal
  — I don’t understand it
  — It’s never practical
  — It’s written for other researchers
  — It’s boring
  — I just want to treat my patients

Clinical question

• When should we begin tx post stroke?
• Post stroke patients in state of hypoperfusion
  — Low levels of oxygen and glucose
  — High levels of Glutamate (excitotoxic)
• How long does this period last?
• Is it wise to start therapy right away?
• What about hyperperfusion?? (Ca2+)

OK... So research matters

• How do I understand what I’m reading?
• Can’t I just read the abstract and results?
• I don’t understand the methods section
• I don’t understand statistics
• Is it going to tell me anything I don’t already know?

Isn’t it all in the abstract?

• A qualified NO!
• Abstracts are limited to 250 words or less
• Details and problems with the study cannot be described in a short paragraph
Research Article Formats

- Remember: IMRaD
- Introduction
- Methods
- Results
- and
- Discussion

Introduction

- Introduction: The Lit Review
  - Lays out the known literature and establishes rationale for the study.
  - You don’t know where you’re going if you don’t know where you’ve been...
  - Some of the questions you may ask yourself later may be mentioned in the introduction.

Methods

- A specific listing of the:
  - WHAT?
  - HOW?
- A study is only as good as it’s methodology. The conclusions are COMPLETELY dependent on the methods.
  - *Methods of the greatest value must be simple reliable, and readily understood by non-statisticians* – SJ Pocock (1982)

Results

- What did they find?
  - The numerical data is found in this section
  - Along with the dreaded STATISTICS
  - The individual data IS important
  - The numbers are important

Discussion/Conclusions

- This is what the AUTHORS conclude from the data and analysis
  - This may not be what YOU conclude if you’ve read the rest of the paper
- Limitations and Future Directions
  - These need to be mentioned
  - Be suspicious if there are no limitations

Critical Appraisal

- How do I critically appraise an article?
- Use an appraisal checklist for the vitals!
  - There are many to chose from
  - Different for different types of studies
  - Centre for Evidence Based Medicine [http://www.cebm.net](http://www.cebm.net)
  - It takes practice
  - It gets easier!
The “So What” Factor

• In the end you should ask—SO WHAT?
  “The ‘So What?’ factor is, quite simply, the most important test that any scientist can put his or her work to, before starting, during execution, and following completion prior to presentation and/or publication. It is the ultimate judge of the worthiness of any scientific (or other) endeavour, and is too often failed by the studies that are currently being presented at conferences and/or published in the peer Reviewed literature.” - Peter M. Chapman

• AKA – THE LAUGH TEST!

Why statistics?

• Statistical Methods minimize the chance of drawing incorrect conclusions from either good or bad data.
• Statistics is unique among academic disciplines in that statistical thought is needed at every stage of virtually all research investigations, including:
  – Planning the study
  – Selecting the sample
  – Managing the data
  – Interpreting the results

Why statistics?

• Regardless of data quality (good/bad) it is possible that ineffective treatments appear to be effective
  WHY?
  – Placebo effect
  – Disease remission
  – Faulty diagnosis
  – Relief of symptoms vs. cure
  – Chance
  – Small benefit (statistically but not clinically relevant)

Will the next generation of clinicians be better at this?

• Beginning September 1, 2014
• “SLP’s will need to demonstrate knowledge in statistics in order to earn clinical certification
• Standard IV-A
• Demonstrate statistical knowledge given alignment with EBP
• 2014 standards: www.asha.org/Certification/2014-Speech-Language-Pathology-Certification-Standards

Why Statistics?

• Ultimately...
  – To look at variability in the data
  – Variability is what tells us why two or more things are close to being the same, or why they’re different
  – We can only study a sample of a population of interest
  – To give unbiased account of what we observe

Basic Statistical Concepts

• Hypothesis: The question we are attempting to answer
  – Null: (Ho) The opposite of what we hope to be true. We try to DISPROVE the null hypothesis by conducting the study
  – Alternative: (Ha) What we are “hoping” to find. We hope to reject the null hypothesis in favor of the alternative
    • Ho = There is no difference in the treatments
    • Ha = There is a difference in the treatments
Note on Hypotheses

- We NEVER prove something to be TRUE
- We can only ever say that there is sufficient evident against the null hypothesis in favor of some alternative
- We can never be 100% sure of anything
  - There is always a small chance we could be wrong and we risk this in EVERY study

Statistics

- **Variables** – factors we are interested in
  - **Independent** – treatment/intervention (input/cause)
  - **Dependent (outcome)** – the output or effect
  - *What is the effect of lingual strengthening exercises as measured by tongue press on bulb in patients with left hemisphere CVA?*

Distribution of data

- We hope that our data gathers around some point
  - Central tendency
    - Means
    - Medians
    - Modes
- We also hope that our data is tightly gathered around our central point
  - Spread (Variability)
    - Standard Deviation
    - Interquartile Range

It’s all Greek to me

- $\alpha$ = alpha level (significance level)
  - Usually 0.05 (5%) but not always
  - We risk a 5% chance that if we could be wrong in rejecting the null hypothesis
    - Type 1 error – When we reject a true null hypothesis
- $\beta$ = probability of a type 2 error
  - Type 2 error – when we fail to reject a false null hypothesis

Power

- $1-\beta = \text{POWER}$
- we want sufficient power to be able to reject the null hypothesis given that the alternative is true
- If the power is low, we have little chance of rejecting the null even if the alternative is true. Power should never be below 80%
- Low power = too small of a sample size

P-value

- the probability that if the null were true and we were to repeat our experiment in different samples many times that we would see a result as large as, or more extreme than our observation.
- If $\alpha = 0.05$ then we can reject the null hypothesis if our p-value is less than 0.05 in favor of the alternative
Estimation
• Because we are sampling from a population of interest we use statistics to estimate a mean that is hopefully representative of the population we are interested in.
• Confidence Intervals tell us with a range of certainty where data are likely to fall

Confidence Interval
• Standard Error (SE) of sample mean: \( \frac{SD \text{ or Sqrt of } N}{N} \)
• 95% Confidence Interval
  – Sample mean \( \pm 1.96 \times SE \)
• Example: hemoglobin
  – Sample mean =12.9, \( SE = 0.2 \)
  – 95% Confidence interval: [12.51, 13.29]
• Interpretation:
  – If this procedure was repeated multiple times, we would expect the interval [12.51, 13.29] contains the true mean of hemoglobin 95% of the time.

Sensitivity
• If a person has a disease, how often will the test be positive (true positive rate)? If result is negative you can be nearly certain that they don’t have disease.
• A Sensitive test helps rule out disease (when the result is negative). Sensitivity rule out or "Snout."
• Sensitivity= true positives/(true positive + false negative)

Specificity
• Specificity: If a person does not have the disease how often will the test be negative (true negative rate)? If the test result for a highly specific test is positive you can be nearly certain that they actually have the disease.
• A very specific test rules in disease with a high degree of confidence. Specificity. rule in or "Spin"
• Specificity= true negatives/(true negative + false positives)

Positive/Negative predictive value
• Predictive value for a positive result (PV+):
• PV+ asks "If the test result is positive what is the probability that the patient actually has the disease?"
• PV+= true positive/(true positive + false positive)
• Predictive value for a negative result (PV-):
• PV- asks "If the test result is negative what is the probability that the patient does not have disease?"
• PV-= true negatives/(true negatives +false negatives)

Some conclusions about the evidence base for dysphagia
• ASHA's National Center for Evidence- Based Practice in Communication Disorders (N-CEP) published three part systematic review of oropharyngeal dysphagia treatments
  – Part I – Background and methodology
  – Part II – Impact of dysphagia treatment on normal swallow function
  – Part III – Impact of dysphagia treatment on populations with neurological disorders
  – Part IV – Impact of dysphagia treatments on post-cancer treatment
Some conclusions:

- Many studies are completed on individuals with a normal swallow
  - Makes it difficult to translate findings to individuals with swallowing deficits
- Some techniques (e.g. effortful swallow) have been studied much more than others
- Many studies are in exploratory stages, and are not efficacy studies

Some conclusions

- When a study is completed on one population (e.g. stroke), the results cannot necessarily be generalized to another population (e.g. neurodegenerative)
- The studies vary in subjects and methods of analyses and “have been conducted more for pre-experimental exploration rather than for substance, direction, and advancement of science” (p. 201)

Speyer review (2010)

- The conclusions found in the literature on the effects of swallowing therapy are strongly dependent on the selected evaluation protocol (e.g., number of swallowing trials, bolus volume and consistency) as well as the outcome parameters (e.g., incidence of pneumonia, temporal or spatial videofluoroscopic parameters, dysphagia-related quality of life).

Speyer cont’d

- Great diversity in type of therapy
- Great diversity in duration of therapy
- Many studies claim short term effects
- Little to no evidence exists on the long-term benefits of therapy
- Heterogeneity of study design

Speyer cont’d

- In general, positive outcomes are reported
- Conclusions of most studies cannot be generalized

What’s a clinician to do?
ASHA Guidelines

- As new guidelines are developed, they will need to be evidence-based
  - The document will be more robust
  - It will take years to develop
- Limitations to EBP framework
  - “the question of whether EBP has positive effects on clinical care itself should be studied empirically” Cohen, Stewart & Hersch, 2004; Sackett et al, 1996, 2000)
  - Systematic reviews often do not yield solid empirical evidence (e.g., 2006)
EBP takes so long... is there an alternative?

- Alternative is a theory-driven approach to care (Sidani and Braden, 1998)
  - Explicit identification of theory underlying the intervention
  - Should specify the nature of intervention, nature of expected effects, process mediating expected effects, and conditions under which the mediating processes occur

Theoretical soundness

- Should this treatment be beneficial vs.
- Is this treatment beneficial (Evidence-based)
- Judging theoretical soundness can work if the clinician understands the nature of the targeted impairment and the therapeutic mechanism of the selected technique
  - Clark 2003

Use what you know to evaluate treatment strategies

- Consider important questions:
  - Can the impaired physiology be changed?
  - Could the exercise do more harm than good?
  - How frequently should the exercise be done?
  - How many repetitions of each exercise will be needed?

Use what you know...

- Should practice be spaced or massed?
- At what point in the continuum of care should which types of strategies be used?
- Rosenbek... “lack of evidence does not necessarily mean a treatment technique does not work”

Less rigorous guidance documents exist

- Division 13, Swallowing and Swallowing Disorders is developing FAQ
  - Short (2-4 pages)
  - Written by panel of experts
  - Evidence included as available
  - Current topics:
    - NPO until dysphagia screen
    - Alternative Nutrition and Hydration in Dysphagia
    - Decision-Making about Dysphagia Management for Patients Nearing the End of Life

ASHA Practice Portal

Outcomes data

- Functional Outcomes
- Variety of rating scales exist to measure changes:
  - Ability to eat
  - Health Status
  - Patient/Caregiver Satisfaction
  - Quality of Life

Outcomes tools dysphagia

- Functional Oral Intake Scale (FOIS)
  - Cray et al 2005
- Dysphagia Outcome and Severity Scale (DOSS)
  - O’Neil 1999

Patient-reported outcomes (PRO) tools

- "any report of the status of a patient’s health condition that comes directly from the patient, without interpretation of the patient’s response by a clinician or anyone else." (FDA 2010)
- PRO tools measure what patients are able to do and how they feel by asking questions.

PRO

- MD Anderson Dysphagia Inventory
- MDADI is a 20-item five-point Likert questionnaire that assesses dysphagia in three domains (functional, emotional, physical)
  - Chen et al 2001

ASHA NOMS (Outcomes)

- Swallowing is one of the areas represented by a 7-point scale called a Functional Communication Measure
- NOMS growing in recognition by governmental agencies
**NOMS in the News**

- NOMS named as one of four patient assessment tools suitable to CMS testing in the development of Medicare Part B outpatient payment policies (Nov. 2006)
- MedPAC cites need for SLP Provider Numbers and reviews NOMS as part of commission’s call for better data collection to assess need for services (July 2006)

**NOMS in the News**

- NOMS approved for Therapy Cap Exceptions – to be used to document functional improvement and justify services (Jan 2007)
- **NOMS as the National SLP Outcomes Tool National Quality Forum (NQF) Endorsement (2008)**

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**What kind of questions can outcomes data answer?**

- How often should treatment be given to achieve maximum gain?
- How long should the treatment sessions be?
- Is treatment more effective when provided 1:1 or in a group?

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**More specifically the data could provide info to answer each question:**

- For a particular diagnostic category
- At different points in continuum of care
- For individuals of different ages
- For individuals with different severity levels of dysphagia

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**Categorizing treatment strategies**

- Compensatory
  - Postural
  - Diet/bolus modifications
- Rehabilitative

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**Compensatory**

- Compensate for lost or impaired function
- Not intended to improve impaired anatomy or physiology
- Achieve a more functional, safe or efficient swallow
- Physical therapy example: Brace to prevent foot drop
- Examples: External pressure to the cheek or placing bolus on strong side
Postural

- Used to re-direct bolus flow in oral, but mostly pharyngeal phases
- Physical therapy example: after a back injury, person has pain with sitting. Using a roll behind lower back may eliminate pain
- E.g. head turn, head tilt

Bolus modifications

- Texture changes
- Temperature changes
- Viscosity changes
- Sensory changes (e.g. sour, carbonation)
- Size of bolus

Rehabilitative

- Designed to alter (and in some cases have been demonstrated to) the physiology of the swallow
  — i.e. result in long-lasting behavioral changes (and maybe changes in neural pathways)
- Should target the underlying impaired physiology identified during assessment
- Require individual to actively participate and in most cases to follow complex directions

Rehabilitative

- Physical therapy example:
  — They use the term restorative
  — Activity-based therapeutic exercise to re-educate and strengthen damaged muscle
  — Thermotherapy to promote healing

Rehabilitative + Compensatory

- Some strategies thought to be rehabilitative (i.e. result in lasting change in physiology) can also be used in a compensatory way (e.g. used to improve safety or efficiency of each swallow during a meal)
  — Mendelsohn maneuver

Combining type of strategies

- Which strategy at what point in continuum of care?
- How well will individual be able to utilize different types of strategies?
- Are certain types of strategies more effective in certain settings (e.g. available caregivers to implement?)
- Physical therapy example: Using crutches to get around while attending physical therapy for treatment of muscular injury
Case example - combining strategies

- 75 year old male with acute CVA
- Oral and pharyngeal dysphagia
- Difficulty following commands
- Postural: head rotation
- Compensatory: support to lips
- Bolus modifications: pureed, nectar thick
- No rehabilitative strategies at this time

CVA case example

- As patient recovers, and repeat instrumental studies are completed:
  - Remove postural and compensatory strategies
  - Adjust bolus modifications
  - Add in specific rehabilitative strategies

Case example – combining strategies

- 87 year old SNF resident with early to mid stage dementia
- Difficulty chewing solids
- No pharyngeal deficits
- Compensatory: reminder sign for second swallow and sip of liquid
- No postural, bolus modifications or rehabilitative

Dementia – case example

- As dementia progresses..
- Individual no longer able to respond to cues for the compensations
- Managed only with bolus modifications

Let’s move to treatment

- Framework
- Techniques
- Efficacy (when we have it 😊)
- Application

SIGNS

What we observe on either the clinical/bedside evaluation or during an instrumental assessment.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Preparatory</td>
<td>Loses food out front of mouth</td>
</tr>
<tr>
<td>Oral (Voluntary)</td>
<td>Can’t form bolus</td>
</tr>
<tr>
<td></td>
<td>Can’t move bolus to back of mouth</td>
</tr>
<tr>
<td></td>
<td>Loses bolus over back of tongue</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>Food enters airway before swallow</td>
</tr>
<tr>
<td></td>
<td>Food enters airway after swallow</td>
</tr>
<tr>
<td></td>
<td>Food left in valleculae</td>
</tr>
</tbody>
</table>
Without knowledge of underlying physiology

- You might select the wrong treatment techniques for the problem
- A sign/symptom may have more than one possible physiologic cause
- You might select a treatment technique or method which doesn’t even make sense for the problem (e.g. treating a delay when the problem is reduced laryngeal elevation)

Attending to physiology helps determine what to treat

<table>
<thead>
<tr>
<th>Sign/symptom description</th>
<th>Functional short term goal</th>
<th>Different physiologic causes</th>
<th>Reworded functional short term goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of residue in the piriforms post swallow</td>
<td>Patient will reduce the amount of residue in the piriform sinuses to reduce the risk of food falling into the airway</td>
<td>Reduced laryngeal elevation</td>
<td>Patient will increase laryngeal elevation to reduce the amount of food remaining in the piriforms which could fall into the airway</td>
</tr>
<tr>
<td>Presence of residue in the piriforms post swallow</td>
<td>Patient will reduce the amount of residue in the piriform sinuses to reduce the risk of food falling into the airway</td>
<td>Reduced anterior movement of hyolaryngeal complex</td>
<td>Patient will increase anterior movement of hyolaryngeal complex to reduce the amount of food remaining in the piriforms which could fall into the airway</td>
</tr>
</tbody>
</table>

Treatment Objectives

- Often equivalent to treatment techniques
- Smaller, more measurable steps used to achieve the short term goal
- Should choose them based on the physiologic cause of the sign/symptom
- EMR typically don’t accommodate short term goal and treatment objective, so they are worded as one

How would you reword goals if no rehabilitative techniques are selected (i.e. no improvement is expected)?

- Patient will compensate for decreased laryngeal elevation to reduce the amount of food remaining in the piriform sinuses that falls into the airway after the swallow.
- Patient will compensate for decreased closure at the entrance to the airway to keep food from entering the top of the larynx and falling into the airway after the swallow.

Sign: Decreased bolus formation

<table>
<thead>
<tr>
<th>Possible physiological cause</th>
<th>Treatment Objective</th>
<th>Facilitation Compensation Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased tongue lateralization</td>
<td>Patient will increase ability to lateralize tongue to P/L corners of mouth</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Patient will push lateral borders of tongue against tongue blade</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Patient will place food in mouth on stronger side without cues</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Patient will take only foods that form a cohesive bolus</td>
<td>D</td>
</tr>
</tbody>
</table>

Treatment objectives can be written in measurable terms: Vallecular residue

<table>
<thead>
<tr>
<th>Physiologic cause</th>
<th>Treatment Objectives</th>
<th>Measurable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased movement of posterior pharyngeal wall</td>
<td>Patient will utilize tongue hold maneuver</td>
<td>Patient will swallow saliva using tongue hold maneuver on ___ of ___ trials (R)</td>
</tr>
<tr>
<td>Decreased movement of tongue base</td>
<td>Patient will use effort swallow</td>
<td>Patient will use effort swallow with/without cues on ___% of trials (C,R)</td>
</tr>
<tr>
<td>Decreased movement of tongue base retraction</td>
<td>Patient will use tongue base retraction</td>
<td>Patient will demonstrate tongue base retraction with resistance on ___ of ___ trials (D)</td>
</tr>
<tr>
<td></td>
<td>Patient will avoid sticky foods</td>
<td>Patient will avoid sticky foods with/without cues on ___ of ___ trials (D)</td>
</tr>
</tbody>
</table>
Oral phase treatment

For More information about:
Refer to:
Strength Training Exercise Principles

Neuromuscular Treatment Exercise Principles

Lips: Techniques
- Intended to be rehabilitative:
  - Lips around lifesaver
  - Lip strength training using Oral Screen
  - Pucker and retract
  - Puff cheeks
  - Resistance straws
  - Ora-Light

- Intended to be compensatory:
  - External support to lips

- Postural:
  - Chin up

- Bolus modifications:
  - Thicker materials if losing bolus anteriorly

Lip screen device
- Improved lip strength and swallowing capacity in patients with stroke after training with device
  — Hagg and Anniko (2008)

High resistance straws
- No change in lip or cheek strength following 4 weeks training with high resistance straws
  — Sheldon 2011

Objectively measuring change in lip strength
- Iowa Oral Performance Instrument IOPI

Jaw: Techniques
- Intended to be rehabilitative:
  - Open and close against resistance

- Used as compensation:
  - Hand under jaw for support

- Postural:
  - None in adults

- Bolus modifications:
  - Use foods requiring less mastication
**Chewing gum**

- Healthy adults no benefit from high resistance chewing gum
  - Found immediate decrease in chewing efficiency (Tzikis et al 1989)
- Healthy adults had increase in functional capacity of masticatory muscles and strength after chewing extra hard gum (Kiliardis et al 1995)

**Cheeks: Techniques**

- Intended to be rehabilitative:
  - Pucker/retract lips
- Compensatory:
  - External pressure to cheeks
  - Place bolus on stronger side
  - Clean buccal cavity with tongue or finger
  - Rinse and clear
- Postural
  - Head tilt
- Bolus modifications
  - Foods that maintain cohesive bolus

**Cheek strength with IOPI**

- Healthy adults – no change in cheek strength after 9 weeks of training with IOPI
  - Clark et al 2009

**Soft palate: Techniques**

**And now…. The tongue**

- More attention being given to the tongue
- Tongue movement is the initiator for pharyngeal phase
- Better understanding of the interconnectedness of the oral and pharyngeal phases
- Good review – “Rationale for Strength and Skill Goals in Tongue Resistance Training: A Review”
  - Steele, Bailey, Molfenter, Yeates in SIG 13 June 1, 2009

**The tongue: Techniques**

- Intended to be rehabilitative
  - Press tongue (tip, blade, sides, back) against tongue depressor to increase strength
  - Sweep tongue tip from front to back along hard palate
  - Lateralize tongue tip
  - Graduated straws
  - Ora-Light
The tongue: Techniques

• Compensatory:
  – Bolus placement
  – Multiple swallows
  – Sensory input to tongue
  – Liquid mix or wash

• Postural:
  – Chin down
  – Chin up

• Bolus modifications:
  – Cohesive bolus
  – Increased texture
  – Sensory changes

Ora-Light & Straws

• No research published on use of Ora-Light

• TheraSip™
  – Healthy adults – training with high resistance straws improved only effortful sips and did not improve sipping strength
  – Shelton (2011)

Resistance Exercise: Healthy

• 8 weeks tongue-pressure resistance exercise
  – Increased tongue pressures in healthy & aging adults

(Lazarus, Logemann, Huang, & Rademaker, 2003; Robbins et al, 2005)

Improved bolus control

• Three adults with dysphagia
  – Tongue-pressure training was beneficial for improving both instrumental and functional aspects of swallowing.
  – Used IOPI

  • Yeates et al (2008)

Need more than subjective measure of strength

• Inexperienced and experienced raters judge tongue strength differently
  – Clark et al 2003

Devices to measure strength

• IOPI
• SwallowSTRONG
Lingual exercises in stroke
(Robbins, et al 2007)

• 8-week isometric lingual exercise program with IOPI
• 10 stroke patients (acute and chronic)

http://www.iopi.info/index.php?option=com_content&view=article&id=64&Itemid=71

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Resistance Exercise: Swallowing

• Robbins et al (2007) started to take the next step
  – Pen-Asp Scale (Rosenbek et al, 1996)
    • Mean reportedly improved across groups
  – Attempted to measure vallecular & pyriform residue
    • Lower pressures → increased oropharyngeal residue & more likely to aspirate
  – Challenges:
    – difficulties with consistency of measures
    – not all spaces are created equally

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Lingual exercise

• All subjects significantly increased isometric and swallowing pressures
• Airway invasion reduced for liquids
• Two subjects increased lingual volume

So is there an effect on swallowing?

The Next Steps: Swallowing Physiology?

• Other possibilities:
  – Oral control
  – Pharyngeal residue
    • Weak tongue propulsion of bolus
  – Hyoid per VFS (preliminary; Steele, 2010)
    – Closely timed with tongue pressure events
    – Anterior max pressures → elevation
    – Posterior max pressures → excursion
  – Others?
  – Base of tongue: role in initiation of the pharyngeal response?

Categorizing strategies for pharyngeal phase

• AIRWAY CLOSURE
  – Delay
  – Mistiming of initiation
  – Movement impairments
    • Poor back of tongue control
    • Reduced closure at folds
    • Reduced closure at entrance to airway
    • Reduced hyolaryngeal excursion

Categorizing strategies for pharyngeal phase

• BOLUS CLEARANCE
  – Reduced hyolaryngeal excursion
  – Reduced tongue base
  – Reduced pharyngeal wall movement

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Focus on pharyngeal

- What is the sign?
- What is the physiologic cause?
- What treatment techniques are indicated?
- What evidence do we have for the technique?
  - Some listed as “rehabilitative” may only have evidence to support a compensatory effect

A strategy may address more than one impairment in physiology

- Super-supraglottic
  - Airway closure
  - Timing of closure
  - Movement
- Effortful swallow
  - Movement
  - Timing
  - Duration
  - Bolus flow
  - Pressures

Efficacy studies

- Particular approach

  - Thermal-tactile stimulation:
    - Lazzara, Lazarus & Logemann - improved triggering of swallowing reflex
    - Rosenbek et al (1991) - single subject withdrawal design. Failed to reveal that two weeks of thermal stim worked
    - Rosenbek (1996) - TS did reduce duration of stage transition and total swallow transition
    - Regan et al (2010) – TTS had immediate effects (pharyngeal transit time, total transit time, pharyngeal delay time). Pts with IPD

Efficacy studies - particular approach

- Thermal-tactile stimulation: We still don’t know:
  - How frequently and with what intensity
  - For which patients
  - Does is eliminate aspiration
  - Does it matter if mirror is cold
  - Is location important

Efficacy of Mechanical, Cold, Gustatory and Combined Stimulation

- Study broke the components down
- Normal healthy adults
- Only when all three components were presented was there statistically quicker average activity compared to no stimulation
- Used a different methodology: slowly introduced liquid bolus until patient felt capable of swallowing
- Support explanation of temporary facilitative effect of this stimulus combination on swallow-specific activity
- Raised more questions than it answered
  - Sciortino, et al 2003
Delayed initiation of swallow

- Thermal tactile stimulation decreases pharyngeal delay time
- Sour bolus decreases pharyngeal delay time

- Kaatzke-McDonald et al 1996
- Logemann et al 1995

Efficacy: Gustatory (Sour) (Pelletier, 2002)

- 11 SNF residents
- 10 aspirated water (1 penetrator)
- Citric acid (2.7%) improved swallowing safety compared to water
- Eliminated aspiration in 8/10

Efficacy: Gustatory (Sour) (Pelletier, 2002)

- Taste stimuli increased the # of spontaneous swallows observed within 1 minute after initial swallow compared to water
- Gustatory stimuli might facilitate swallowing in some patients with neurogenic dysphagia
- Best response in patients without dementia

Lemon glycerin swabs - Trenter-Roth 1986

- When used for oral hygiene, considered ineffective
  - Lemon reduces oral pH to 2-4 (below the normal 6-7)
  - Acid conditions can irritate the mouth, cause pain and decalcify teeth and increase risk of dental caries
  - Glycerin dehydrates the oral tissues

Effects of sour on tongue movements

- 16 healthy adults
- Tongue movement data for tongue body and dorsum
- Water, high intensity sour (2.7% citric acid), moderate intensity sour, moderate sweet, sweet-sour
- High intensity sour stimulus elicited significantly larger amplitude and higher peak velocity forward and backward tongue body movements than other stimuli
- Suggests Trigeminal irritation may be required to influence bolus transit times during swallowing

Carbonation

- Carbonated thickened liquids decreased penetration and aspiration on 5 ml boluses during instrumental exam
  - Sdravou et al 2012
Prepping the system

• Three second prep
• Suck-swallow with added sensory input ((Neurosensory stim)
• Three-step swallow (Langmore)

Added benefits on timing

• Supraglottic and super-supraglottic originally intended to improve closure
• Found to have impact on timing in healthy adults:
  – Earlier and longer laryngeal closure
  – Higher position of hyoid bone at swallow onset
  – Longer PES opening
  – Longer duration of hyolaryngeal complex movement (Logemann et al 1997)

Added benefits on timing

• Mendelsohn found to have impact on timing in a single subject
  – Lazarus et al 1993

Selecting treatment techniques

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<tbody>
<tr>
<td>Aspiration before the swallow</td>
<td>Decreased back of tongue</td>
<td>Chin down (c)</td>
</tr>
<tr>
<td></td>
<td>Delayed swallow</td>
<td>Control bolus size (c)</td>
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<td></td>
<td></td>
<td>Thickened liquids (d)*</td>
</tr>
</tbody>
</table>

Thickening – lessons from Protocol 201

• Honey thick liquids most effective in immediately eliminating aspiration
  – Patients didn’t like it
• Patients who aspirated on all, and were randomized to honey, got more pneumonia
  – More patients assigned to thickened liquids (than chin down) had dehydration, UTI and fever

A word on thickening and carbonation

• Thickening carbonated liquids decreased effect of both starch and gum-based thickening agents
• Rendered thickened carbonated liquid thinner than a non-thickened carbonated liquid
  – Bulow et al 2003
Selecting treatment techniques

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<td>Decreased closure of larynx</td>
<td>Supraglottic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Super-supraglottic</td>
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<td></td>
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<td>Breath hold (Valsalva)</td>
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<td></td>
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<td>Vowel initiate words</td>
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<tr>
<td>Mistiming of laryngeal elevation/closure</td>
<td>Supraglottic</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Mendelsohn</td>
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<tr>
<td>Shortened duration of closure</td>
<td>Effortful swallow</td>
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</tr>
</tbody>
</table>

Efficacy studies - particular approach

- Laryngeal closure: Valsalva, Supraglottic and Supersupraglottic
  - Some subjects close glottis during breath hold, and others did not (Mendelsohn & Martin, 1993)
  - Arytenoid approximation and true vocal fold closure were produced consistently by the majority of subjects on all breath hold maneuvers, but false vocal fold approximation and anterior arytenoid tilting accomplished by majority of subjects only during effortful breath-hold conditions (Martin, et al 1993)

Efficacy studies - particular approach

- Laryngeal closure: Valsalva, Supraglottic and Supersupraglottic
  - Normal subjects produced earlier cricopharyngeal opening, prolonged pharyngeal swallow, some degree of laryngeal valving before swallow, and change in extent of vertical laryngeal position before the swallow
  - Changes more successful and maintained longer with SSG than SG
  - Breath-holding maneuvers alter not only airway conditions before swallow but also temporal relationships and biomechanical events during (Ohmae, et al 1996)

Caution: Supraglottic and supersupraglottic

- Prolonged voluntary closure of glottis may create Valsalva maneuver, which has been associated with sudden cardiac death and cardiac arrhythmias
- Subjects: recent stroke, dysphagia and/or CAD
- 86% demonstrated abnormal cardiac findings(supraventricular tachycardia, premature atrial and ventricular contractions)
- SG and SSG contraindicated for patients with history of stroke or CAD (Chaudhuri et al 2002)

Efficacy studies: Breath-hold (Brady, 2002)

- Effortful breath hold instruction most effective method to obtain TVC closure
- Inhal/easy breath hold least effective
- Easy breath hold better than inhale/easy
- Instructions for supraglottic to take a deep breath and then hold may be counter-productive

Selecting treatment techniques

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<tr>
<td>Aspiration during the swallow</td>
<td>Decreased closure</td>
<td>Head rotation (C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chin down (C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thick liquids (d)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bolus size (d)</td>
</tr>
<tr>
<td>Mistiming of laryngeal elevation/closure</td>
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</table>

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Chin down – do we all agree on what that is?

- Survey with five pictures with variety of head and neck positions
- 23% of Japanese and 58% of US SLPs made a distinction between chin down and chin tuck
- This may explain varying results of published studies on effects of chin down

Chin down – the good & bad

- Posterior shift of AP structures
- Narrowed laryngeal entrance
- Narrowed distance from epiglottis to pharyngeal wall and entrance
- Widened angle of epiglottis
  - Welch et al 1993
- Dementia w or w/o Parkinson’s
- 77% reduction in vallecular area
- 76% of those with reduction aspirated
  - Kunduk et al

Chin down

- 8 healthy volunteers
- Reduced laryngohyoid distance
- Reduced hyoid-mandibular distance
- Weaker pharyngeal contractions
  - Bulow et al 1999

Efficacy: chin down (Lewin et al 2001)

- However… in 21 esophagectomy patients
  - Associated with potential trauma to recurrent laryngeal nerve
- Who had impaired elevation and anterior movement of hyolaryngeal complex with aspiration during swallow in 100% cases

Efficacy: chin down (Lewin et al 2001)

- Aspiration was eliminated in 81% of aspirators with the chin tuck maneuver

Head rotation (and other postural changes)

- Head rotation was one of the postural changes studied in 32 patients s/p head and neck CA surgery
- Each posture eliminated aspiration in at least 50% of patients
  - Logemann et al 1994
Head rotation

- Head rotation to the damaged side twists the pharynx and closes the damaged side so that food flows down the more normal side
  - Logemann, Kahrilas, Kobara & Vakil, 1989
- Used when there is a unilateral pharyngeal wall impairment or unilateral vocal fold weakness

Logemann, Kahrilas, Kobara & Vakil, 1989

Thick liquids and timing

- Healthy Young
- Increased velocities and higher peak velocities with nectar thick compared to thin
  - Hyoid moved faster and further
- Perhaps this is why thickened liquids contribute to improved airway protection
  - Facilitating more timely laryngeal vestibule closure

Hyoid moved faster and further

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Selecting treatment techniques

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<td>Aspiration after from pyriform sinus residue</td>
<td>Decreased laryngeal elevation</td>
<td>Mendelsohn With SEMG Falsetto/Effortful pitch glide</td>
</tr>
<tr>
<td>Decreased anterior movement of hyolaryngeal complex</td>
<td>Head lift/CTAR Mendelsohn</td>
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</tbody>
</table>

Mendelsohn

Efficacy of specific method

- Mendelsohn with SEMG
  - Changes in swallow physiology
  - Improved coordination, longer duration, and increased effort
  - Sustained oral and pharyngeal postures inhibited some of the transient movements noted as part of incomplete swallow (e.g. lingual pumping, repetitive pharyngeal contraction) (Crary, 1995)

Mendelsohn with SEMG

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Efficacy of specific treatment techniques

- SEMG biofeedback
  - Chronic dysphagia secondary to brainstem stroke
  - Physiologic change in swallowing as measured by severity ratings on VFSS
  - 8 of 10 able to return to full oral intake with elimination of G-tube
  - Average of 5.3 months
  - Huckabee & Cannito, 1999
  - Bryant, 1991
  - Crary, 1995

- EMST
  - Significant difference in EMG activity from the submental muscle group between normal swallow and Mendelsohn
  - EMG can be used reliably to differentiate between these two swallow conditions
    - Ding et al 2002

- SEMG
  - 25 healthy male subjects
  - Compared normal swallow, effortful swallow, Mendelsohn and EMST
  - Videofluorographic measurements and SEMG
  - The target threshold was defined as 75% of each participant’s MEP.

EMST

- www.aspireproducts.org
  - The EMST device is a calibrated instrument consisting of a mouthpiece with a one-way spring-loaded valve (Baker et al., 2005), and it is referred to as an expiratory pressure threshold trainer.
  - The valve blocks airflow produced by the user until a sufficient "threshold" pressure is produced to overcome the force.

EMST compared to other techniques

  - 25 healthy male subjects
  - Compared normal swallow, effortful swallow, Mendelsohn and EMST
    - Videofluorographic measurements and SEMG
  - The target threshold was defined as 75% of each participant’s MEP.
EMST

- Compared to normal swallow, Mendelsohn and Effortful swallow, there was less hyoid displacement with EMST
  - Speaks to specificity of the task
- EMST achieved higher maximum and average submental sEMG activity versus normal swallowing.

EMST

- With the Mendelsohn maneuver and effortful swallow, the load imposed was volitional.
  - That is, the submental muscle activity found to increase on sEMG resulted from the intention of the participant to “squeeze” those muscles, or to “swallow hard.”
- Conversely, the load imposed by EMST results from an externally imposed threshold that must be overcome in order to break the spring-loaded valve and allow air to flow through the device.

EMST

- EMST has potential to induce strength gains in the submental muscles secondary to the externally imposed load.
- Expiratory muscle strength training (EMST) increases motor unit recruitment of the submental muscle complex.

Efficacy of specific treatment technique

- Head Lift
  - Health elderly: Increase in:
    - magnitude of anterior excursion of the larynx
    - maximum A-P diameter
    - cross-sectional area of UES
    - decrease in hypopharyngeal intrabolus pressure (decrease in pharyngeal outflow resistance)
    - Strengthens suprahyoid muscles
      • Shaker et al 1997

Efficacy: head lift

- 14 healthy elderly and 14 healthy young
- AP deglutitive UES opening and hyoid bone and thyroid cartilage anterior excursion are reduced in the elderly
- Associated with higher intra-bolus pressure
- Suggests higher pharyngeal resistance
  • Kern et al 1999

Efficacy: Head lift (Shaker et al 2002)

- 27 patients (hemispheric CVA, brainstem CVA, pharyngeal radiation)
- Six weeks of exercise vs. sham
- Improvement in:
  - UES opening
  - Anterior laryngeal excursion
  - Post-deglutitive aspiration resolved
  - Returned to PO
Efficacy: Head lift (patients)

- In addition to strengthening suprahyoid muscles...
- Augments thyrohyoid muscle shortening
- 11 patients with UES dysfunction
- Compared traditional therapy to Shaker
  - Mepani et al 2009

Shaker compared to traditional

- Pre and post MBS
- Traditional: Super-supraglottic; Mendelsohn; Tongue base; yawning; gargle; tongue pull back

Shaker vs. traditional

- Shaker: reduced post swallow aspiration to greater degree than traditional
- Traditional: superior hyoid and laryngeal better (uses greater muscle effort than Shaker)
- Both: significant increase in width of UES opening on paste
- Aspiration after Shaker
- Reduced range of movement in structures of pharynx: traditional therapy

CTAR

- Increase in submental muscle activity with use of CTAR in healthy adults
  - Yoon et al 2014

Head lift – effect on voice?

- 21 subjects
- Dysphonia Severity Index scores improved in 10 of the 21 participants after 6 weeks of exercise

Falsetto/Effortful Pitch Glide

- Falsetto- hypothesis that elevation for falsetto will facilitate elevation for swallow
- Effortful Pitch Glide (Miloro et al 2014) – Healthy Adults
- Saw similarity in movements with EPG and swallow
  - Anterior hyoid
  - Hyolaryngeal approximation
  - Laryngeal elevation
  - Lateral pharyngeal wall medialization
- Only superior hyoid movement was greater during swallowing
Selecting treatment techniques

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<td>Head rotation (c)</td>
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<td></td>
<td>Avoid sticky (d)</td>
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<tr>
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<td>Decreased arytenoid tipping</td>
<td>Falsetto/EPG</td>
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<td>Slow or mistimed closure of larynx</td>
<td>Super-supraglottic</td>
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<td>Tongue retraction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effort, yawn, gargle</td>
</tr>
<tr>
<td></td>
<td>Decreased pharyngeal wall movement</td>
<td>Yawn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gargle</td>
</tr>
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<td>Mendelsohn</td>
</tr>
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<td>Falsetto</td>
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- Pull-back (tongue retraction): “Pull the back of your tongue to the back of your mouth and hold for a second”
- Yawn: “Pull your tongue back during a yawn and hold for a second”
- Gargle: “Pull your tongue back during a gargle and hold for a second”
  - (Subjects were consecutively referred patients)


- Gargle task most successful in eliciting more tongue base retraction for the group of subjects (although not in every subject)
- Number of repeat swallows on each bolus correlated significantly with approximate % of residue in valleculae
Efficacy: tongue hold (Masako)

- CA patients with tongue resection
- Noted increased anterior bulging of PPW 3 months after surgery
- More bulging with greater tongue resection
- Suggested PPW could compensate
  - Fujiu et al 1995

Efficacy: Tongue hold (Masako)

- 10 normal adults
- Increased PPW bulging at mid and inferior levels of second cervical vertebra
  - Fujiu & Logemann, 1996

Tongue hold (Masako)

- Do NOT use with food
  - The move impairs some of the natural movements of swallowing (inhibits tongue base retraction)
- Three negative findings:
  - Increased pharyngeal residue, particularly in valleculae
  - Shortened duration of airway closure
  - Increased pharyngeal delay time in triggering the pharyngeal swallow

More evidence that tongue hold is rehabilitative only (Doeltgen et al 2007)

- 20 healthy participants
- Tongue hold swallows created significantly lower pressures in upper pharynx than non-effortful saliva swallows
- The increased anterior bulge cannot compensate for decreased pressure generation at level of upper pharynx
  - This might impede bolus flow through the pharynx

Effortful swallow: unintended consequences

- Patient changed mechanics of swallow
- Interfered with typical bolus flow
- Used abnormal tongue base seal with bolus still in oral cavity
- Resulted in nasal backflow
- Authors stressed importance of carefully monitoring behaviors taught
- They observed this on MBS, and could not tell clinically

Effortful swallow and esophagus

- Healthy adults
- Effortful swallowing resulted in increased peristaltic amplitudes within the distal smooth muscle region of esophagus
Selecting treatment techniques

<table>
<thead>
<tr>
<th>Sign</th>
<th>Physiology</th>
<th>Treatment techniques (c,d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration after from vallecular residue/pharyngeal wall</td>
<td>Decreased tongue base movement</td>
<td>Bolus size (c)</td>
</tr>
<tr>
<td></td>
<td>Decreased pharyngeal wall movement</td>
<td>Stay seated up (c)</td>
</tr>
<tr>
<td></td>
<td>Decreased laryngeal elevation</td>
<td>Multiple swallow (c)</td>
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<tr>
<td></td>
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<td>Liquid wash (c)</td>
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<tr>
<td></td>
<td></td>
<td>Head rotation (c)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid sticky (d)</td>
</tr>
</tbody>
</table>

Efficacy studies (or lack of) for a particular approach

- Does technique make sense?
- Is there a possibility of harm to patient?
- Why isn’t there any published information?
- If it works for a single patient, is that enough?
- Is it taking time away from a “proven” approach?

Lack of evidence: DPNS

- Lack of controlled randomized studies
- Anecdotal case reports:
- Research design
  - Non-specific subject selection
  - Varied duration and etiology of dysphagia
  - Inclusion/exclusion criteria
  - Role of spontaneous recovery
  - Defined technique  - Stefanakos

Techniques that began with no evidence and are being studied

- E-stim
- Freed et al: Rationale compares electrical stimulation to thermal stimulation

Electrical stimulation in dysphagia

- Broniatowski et al, 2001 – recurrent nerve
  - To provide vocal fold closure during swallow
- Freed et al 2001 – transcutaneous
  - Provided sustained stim during swallow
- Leelamanit et al 2002 – transcutaneous
  - Used submental EMG to trigger surface stim
- Park et al 1997 – transmucosal, palatal
  - Sensory stimulation to aid swallow onset
- Power et al 2003 – transmucosal, faucial pillars
  - Sensory stimulation to aid swallow onset

Studies with design flaws
Electrical Stim for Treatment of Refractory Dysphagia

- 6 adult patients with treatment refractory chronic dysphagia
- NMES treatment for one hour/day, 5x week for three weeks
- Clinical and instrumental baseline and post treatment evaluations
- 80% of patients demonstrated significant improvement (improved clinical swallowing ability, functional oral intake, change in body weight)
  - Carnaby-Mann, G. & Crary, M. March 2006

ES compared to standard therapy

- Chart review of 40 pts undergoing solely ES and 40 undergoing traditional therapy
  - Chronic dysphagia in LTAC
- Used a 6-point scale of safe food consistency to measure progress (Freed scale)
- Patients receiving ES did significantly better in improvement of swallowing function
  - SLPs not blinded to condition
  - Perhaps patients with poorer prognosis were not placed into the ES group
  - Blumenfeld, Hahn, LePage, Leonard, Belafsky 2006

VitalSTim™ Compared to Traditional Swallow Therapy

- 22 patients
- Initial and follow-up videofluoroscopic swallow study
- No statistically significant difference in outcomes between experimental and control groups
- Some design issues with the study (e.g. control group closer to onset date)

E-stim in patients with MS

- 25 patients treated 2x week for 3 weeks
- FEES pre and post
- Examiner blinded
- Results: decreased pooling of saliva in pyriforms in 6; less aspiration in 9; patient reported swallowing improved
- NO control group

VitalStim retrospective review

- 11 of 18 patients demonstrated some improvement in their swallowing
- 6 of 18 d/c feeding tube
- Only 2 of 5 with ‘severe’ dysphagia showed any improvement
  - No control group
  - Shaw et al 2007

Studies on normals

- Chart review of 40 pts undergoing solely ES and 40 undergoing traditional therapy
  - Chronic dysphagia in LTAC
- Used a 6-point scale of safe food consistency to measure progress (Freed scale)
- Patients receiving ES did significantly better in improvement of swallowing function
  - SLPs not blinded to condition
  - Perhaps patients with poorer prognosis were not placed into the ES group
  - Blumenfeld, Hahn, LePage, Leonard, Belafsky 2006
Effects of NMES on Submental Muscle Activity

- Healthy volunteers
- Two weeks NMES
- 7 of 8 subjects exhibited no significant gains in myoelectric activity of submental muscles following NMES
  — Suiter, Leder & Ruark, 2006

NMES & hyoid elevation

- Healthy volunteers
- Paired effortful swallowing with NMES at contraction level and NMES sensory level
- Each increased hyoid elevation
- Neither changed myoelectric activity of submental muscles
- Effect faded within two weeks
  — Park et al 2009

Work done at NIH

Electrical stimulation and dysphagia

- Ludlow and colleagues at NIH
- Studied surface and needle electrode placement
- Effects depend on the depth of the electrical field
- Stimulates muscles closest to the skin first

Effect of Surface Electrical Stimulation on Hyolaryngeal movement in Normal Individuals at Rest and During Swallowing Humbert et al 2006

- Healthy volunteers (29)
- Stimulation at rest at maximum tolerated levels
- 6 different electrode arrays
- Looked at effects of placement 3b on swallowing a 5 ml liquid bolus

Humbert et al

- Note: The hyoid and laryngeal elevator muscles are small, deep and variably oriented
- Vocal folds deep to the thyroid cartilage(cricothyroid first – lengthens vocal folds)
- Intensities high enough to activate deep muscles must activate superficial muscles first
Vital Stim in Healthy Volunteers - Humbert

- Lowered the hyoid bone in the neck during stim
- All positions except submental alone lowered the hyoid
- Submental position did not raise the hyoid or the larynx
- Submental stimulation was too weak to overcome the sternohyoid effects on hyoid position
- Reduced hyo-laryngeal elevation during swallowing in healthy volunteers

Chronic dysphagia

Effects of Surface Electrical Stimulation both at rest and during swallowing in chronic pharyngeal dysphagia: Ludlow et al 2007

- Patients had chronic dysphagia for >6 months
- Relying on enteral feeding
- Most could not swallow own saliva

Ludlow et al 2007

- Used videofluorography to track movement while stimulation was cycled from on-off-on at maximum tolerated levels
- Used NIH Swallowing Safety Scale
  - 0 normal
  - 13 most severe
  - Considers pooling, esophageal entry, aspiration and penetration

Clinical implications

- Sensory stimulation may aid all patients in swallowing by serving as a facilitory input to the central nervous system
- Motor stimulation may serve as a resistive therapy in patients who can already raise the hyo-laryngeal complex by making them augment volitional elevation
- BUT....
In patients **without** elevation

- Hyoid depression may put patients at further risk as it opens the vestibule in patients who cannot overcome depression by volitional elevation
- High levels of stimulation that produce hyoid depression should only be used in patients with hyo-laryngeal elevation

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**Well controlled trials comparing traditional to NMES**

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**Bulow NMES**

- This study, completed at three European swallowing centers, compared traditional therapy to NMES in patients with stroke.
- The pre- and post- ability to swallow was assessed videographically as well as with analysis of nutritional status and oral motor function.

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**Bulow: NMES (2008 Dysphagia)**

- The study found that patients in each group (traditional therapy and NMES) made progress, but there was no statistical difference between the two groups.
- Only weakness is that the study might be underpowered.

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**Ryu et al 2009**

- Patients with dysphagia after treatment for head and neck cancer
- Control group sham electrical stim
- Treatment group had benefit on only one measure

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**Review articles**

- Electrical neuromuscular stimulation in dysphagia: current status (2010)
  - Ludlow: Current Opinions Otolaryngology Head Neck Surgery 18: 159-164
- Evidence-Based Systematic Review: Effects of Neuromuscular Electrical Stimulation on Swallowing and Neural Activation (2009)
  - Clark et al: AJSLP Vol 18: 361-375

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What's next at NIH?

- Examining intramuscular stimulation to trigger muscle stimulation during swallowing
- Trained a patient to push a button before swallowing to improve volitional control
- Combined stimulation producing best movement — Geniohyoid, mylohyoid and/or thyrohyoid

Findings

- Training to volitionally press a button to initiate stimulation may augment cortical control (got better elevation with just the button press)
- Most patients had reduced risk of aspiration with stimulation
- Significant decrease in UES pressure with intramuscular stim
- Geniohyoid was most effective muscle for reducing UES pressure
- Laryngeal elevation accounted for most of the reduction in UES pressure

Intramuscular stimulation

- Intra-muscular stimulation of the geniohyoid may augment UES opening
- Requires new team approach
- New scope of practice for SLP
- ENTs and SLPs select patients who are chronic and require augmentation
- ENT does implant
- SLP works on programming the device and training patient and caregiver
- Post training check-ups

Surface vs. Intramuscular

- Non-invasive
- Temporary and inexpensive
- Low levels of current may provide sensory facilitation
- High levels lower the hyoid, provide resistance to movement
- Could put some at risk
- Consider early in recovery in less severe patients

- Invasive
- Permanent and expensive
- Augmentation of patients’ movement and UES opening
- Increases sensory feedback
- Provides prescriptive training by the SLP
- May augment volitional control
- Option for chronic patients who fail therapy

Self-triggered functional electrical stimulation during swallowing

- Nine healthy subjects — manually synchronized FES with hyolaryngeal muscle activity
- Targeted intramuscular electrical stimulation can elevate the larynx and may improve airway protection in dysphagic individuals with impaired hyolaryngeal movement if applied during swallowing

Let’s wrap up

- Questions and answers?
- What else would you like to touch base on:
  — End of Life?
  — Developing protocols?