Management and Treatment of Adults and Children with Dysphagia?

Nancy B. Swigert, M.A.,CCC-SLP
Central Baptist Hospital
Lexington, KY 40503
Nswigert@aol.com

Bibliography

- For a copy of the bibliography (to be sent as an e-mail attachment) contact:
  - NSwigert@aol.com

△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."
  - (Sackett D et al. Evidence-Based Medicine: How to Practice and Teach EBM, 2nd edition. Churchill Livingstone, Edinburgh, 2000, p.1)

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!

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, Stavri & Hersh, 2004; Sackett et al, 1996, 2000)
  - Systematic reviews often do not yield solid empirical evidence Steele, 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

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

Special Interest Division 13

Swallowing and Swallowing Disorders

Why join?

- 4 *Perspectives* + CEUs yearly (.2 or .3 CE per issue)
- 50% off Div sponsored short courses at ASHA convention
- Listserv to post questions to network w/ colleagues
- Discount on registration for Health Care Conference
- Policy documents to guide practice
- Powerpoint presentations you can use for advocacy
- Apply for grants to support research & practice
- All for a very small annual investment
  - 35^{\underline{00}}$ regular
  - 10^{\underline{00}}$ students

Make an investment in lifelong learning

Bedside evaluation or screening?

- Screening does not identify the nature of the problem
  - But the bedside exam can identify the nature of the oral dysphagia
- Screening identifies who is at risk for significant dysphagia
  - We're getting better at this, but even predicting who will aspirate does not tell us why
- Rosenbek indicates screening is pre-symptomatic testing with aim of early diagnosis
- Therefore, the bedside is not a screening according to those criteria

Bedside evaluation

- Usually the first step in assessing a patient
- Sometimes it is all that can be done
- This evaluation yields important information about the oral phase of the swallow and..
- Provides clues about the pharyngeal phase

Bedside evaluation

- If treatment for suspected pharyngeal disorder is based solely on bedside evaluation, patient is placed at risk
- Aspiration cannot be confirmed or ruled out
- Up to 65% of patients may be silent aspirators

Purposes of clinical exam

Clinical Indicators for Instrumental Assessment of Dysphagia: ASHA 2000

- Integrate info from interview, case hx, medical records, protocols, collaboration
- Observe and assess oral motor function
- Characteristics of dysphagia
- Determine need for instrumental
- Determine if patient appropriate candidate for tx
- Recommend route of nutritional mgt
- Recommend interventions
- Counsel and educate

Efficacy of clinical/bedside evaluation

- Logemann et al
- McCullough et al
- Mann 2002

- All lead to a likelihood ratio
- If patient has certain signs, symptoms, history what is the increased likelihood of dysphagia or aspiration?

Risk ratio example (Logemann, et al 1999)

- Identified variables that were able to classify patients correctly as having or not having:
  - Aspiration 71%
  - Oral stage disorder 69%
  - Pharyngeal delay 72%
  - Pharyngeal problem 70%

How accurate are bedside evaluations?

- Logemann et al concluded:
  - "Even if screening procedures become 100% accurate in defining the presence of aspiration or the presence of problems in the oral stage of the swallow, the pharyngeal triggering, or the pharyngeal stage of the swallow, in-depth diagnosis is still needed to define the anatomic and/physiologic nature of the problem and the effects of treatment strategies…."

McCullough (2000)

- Best history measure: pneumonia
- Best oral motor measure:jaw strength
- Best voice: wet and dysphonia

Risk ratio example (Mann & Hankey, 2001)

- Clinical items as independent predictors of ***dysphagia*** (measured radiographically)
- Age > 70
- Male
- Disabling Stroke (Barthel < 60)
- Palatal weakness or asymmetry
- Incomplete oral clearance
- Impaired pharyngeal response (cough/gurgle)

Risk ratio example (Mann & Hankey, 2001)

- Clinical predictors of ***aspiration***
- Delayed oral transit
- Incomplete oral clearance

Mann Assessment of Swallowing Ability (MASA)Delmar

- Yields probabilities of presence of dysphagia and of aspiration on instrumental exam
- 5 and 10 point scaling of 24 items
- 200 points maximum
- Definite, probable, possible or unlikely dysphagia OR of aspiration on VFSE

How accurate are bedside evaluations?

- McCullough et al (2000)
- Fewer than 50% of the measures clinicians typically employ are rated with sufficient inter- and intra-judge reliability

Do we all do bedsides the same?

- High degree of consistency on 11 of 19 components
- Inconsistencies in assessment of:
  - sensory function
  - Gag
  - Cervical auscultation
  - Trial swallows with compensations

- Also inconsistent in what was recommended next after the clinical evaluation

  - Mathers-Schmidt 2003

Clinical ‘tests’ to predict aspiration

- Researchers continue to search for non-instrumental methods for predicting aspiration
- Combination of three tests (water swallow; pudding swallow; still X-ray)
- Predicted aspiration on MBS with 90% sensitivity and 71% specificity
- Combination of two without the X-ray with 90 sensitivity and 56% specificity
    - Haruka, et al 2003

3 oz. Water Swallow Test

- DePippo et al (1992)
- Stroke rehab patients
- Abnormal response considered to be:
  - Inability to complete task
  - coughing during or for one minute after
  - wet-hoarse vocal quality
- Patients then underwent MBS (not clear when this occurred)

3 Ounce Water Swallow Test

- Contribution of 3 ounce water test to detection of aspiration during clinical (bedside) swallow screening has been reported, but no clear consensus because of inadequate statistical power due to small sample sizes and varying methodologies

(DePippo, 1992; Garon, 1995; Mari, 1997; McCullough et al., *J Comm Dis*, 34:55-72, 2001; Rosenbek et al., *J Comm Dis*, 37:437-50, 2004)

3 Ounce Water Swallow Test

- Clinical utility of 3 ounce water swallow test focused primarily on adults with neurological disease, i.e., stroke
  - (DePippo, 1992; Garon, 1995; Mari, 1997; McCullough et al., 2001; Rosenbek et al., 2004)
- Variable sensitivity and specificity ranging from sensitivity as high as 0.86 but with specificity as low as 0.50
  - (Rosenbek et al., 2004)

3 Ounce Water Swallow Test

- The clinical usefulness of the 3 ounce water swallow test in more heterogeneous patient populations is unknown

Clinical Utility of the 3 Ounce Water Swallow Test

- Steven B. Leder, Ph.D.
  Yale University School of Medicine
- Debra M. Suiter, Ph.D.
  University of Memphis

Dysphagia (2008) 23: 244-250

3 Ounce Water Swallow Test

Purpose

- Examine the clinical usefulness of the 3 ounce water swallow test for determining aspiration status and oral feeding recommendations in a large and heterogeneous population sample

3 Ounce Water Swallow Test

3 Research Questions Asked:

1. Does the 3 ounce water swallow test ID patients who aspirate thin liquids?
2. Does a failed 3 ounce water swallow test ID pts. who are also unsafe for oral alimentation based on results of instrumental evaluation?
3. Does a successfully passed 3 ounce water swallow test permit specific diet rec. to be made without further objective assessment?

3 Ounce Water Swallow Test

Methods

- All FEES performed from Dec. 1999-Sept. 2006
- All patients allowed to swallow spontaneously, i.e., without verbal command
- Food Challenge:
  - 3 boluses of puree then
  - 3 boluses of liquid
- Safe Swallow: No aspiration during FEES

3 Ounce Water Swallow Test

Methods

- Immediately after FEES, each patient given 3 ounces of water and asked to drink without interruption
- Criteria for Test Failure:
  - Inability to complete task
  - Coughing or choking
  - Post-swallow wet/hoarse vocal quality

3 Ounce Water Swallow Test

Statistics

- Diagnostic value of a test expressed by means of its:
  - Sensitivity: Probability that a Diagnostic sign will be positive given that disease (aspiration) is truly present
  - Specificity: Probability that a Diagnostic sign will *not* be positive given that a disease is truly *not* present

3 Ounce Water Swallow Test

Statistics

- Predictive Value: The chance that persons with a certain test score actually have the disease
- Positive Predictive Value: Which part of persons under study with a positive test score actually have the disease
- Negative Predictive Value: Which part of persons under study with a negative test score are healthy

3 Ounce Water Swallow Test

Statistics

- True Positive: + asp. FEES/Failed 3 ounce test
- True Negative: - asp. FEES/Passed 3 ounce test
- False Positive: - asp. FEES/Failed 3 ounce test
- False Negative: + asp. FEES/Passed 3 ounce test

Does the 3 ounce water swallow test ID patients who aspirate thin liquids?

Question #1: YES

The 3 ounce water swallow test is:

- Sensitive for ID aspiration of thin liquids: 96% who aspirated on FEES also failed 3 ounce test
- Also, 3 ounce test had high negative predictive value (98%), i.e., if passed also no aspiration on FEES
- Therefore, passing 3 ounce test = good predictor to safely tolerate thin liquids

Does a failed 3 ounce water swallow test ID pts. who are also unsafe for oral alimentation based on results of instrumental evaluation?

Question #2: NO (over-identifies)

However, failure on 3 ounce test often does not indicate *inability* to tolerate safely thin liquids

- Specificity for determining liquid aspiration during FEES = low, 50%, and false positive rate high (50%), i.e., half of patients who failed the 3 ounce test did not aspirate during FEES

3 Ounce Water Swallow Test

Discussion

- The combination of low specificity with a high false positive rate results in approximately 50% of screened pts. referred unnecessarily for further testing
- 3 ounce test fails as a screening tool because it over-refers and unnecessarily restricts liquid intake for almost 50% of patients tested

Does a successfully passed 3 ounce water swallow test permit specific diet rec. to be made without further objective assessment?

Question #3: Yes, but…..

- For the first time with objective data, if the 3 ounce water swallow test was passed, patients can have an oral diet without further diagnostic dysphagia testing.
  - Puree diet if edentulous
  - Soft/Regular diet if dentate

3 Ounce Water Swallow Test

BUT…. nearly 71% of pts. who failed the 3 ounce test were deemed safe for some form of oral intake based on FEES

- *Failure on the 3 ounce water swallow test did not accurately reflect true oral feeding status.*

3 Ounce Water Swallow Test

Discussion

- Clinical Judgment and Experience
- Although 98.3% of patients who passed the 3 ounce test were successful with an oral diet, other patient-specific factors are important for an oral diet to be safe and successful

3 Ounce Water Swallow Test

Discussion

- For ex.:

  Dementia: Following directions, self-feeding

  Stroke: Assess neglect, limb apraxia, hemiplegia

  TBI: Impulsivity and task attentiveness

  De-Conditioned: Diet modifications and assistance with eating

3 Ounce Water Swallow Test

Discussion

- All patients with dysphagia benefit from encouragement and monitoring as work towards the goal of normal eating progresses
- Dysphagia specialist must synthesize objective, subjective, and behavioral data on an individual basis to promote safe and successful eating

3 Ounce Water Swallow Test

Conclusions

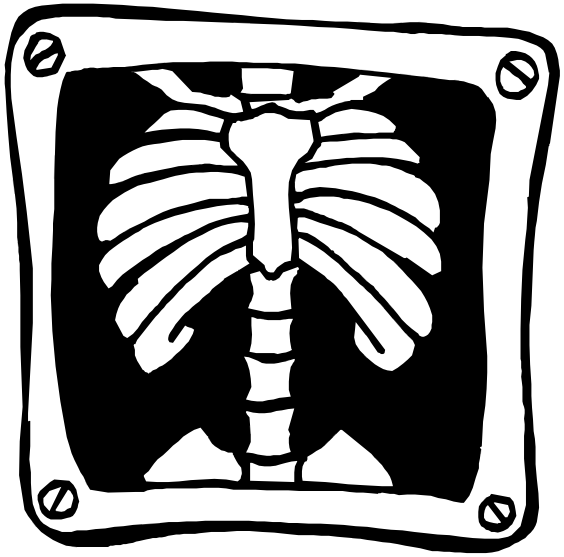
- Caveat: Due to high false positive rate and low specificity, the 3 ounce test is not an efficient screening tool
- However, over-referral, although conservative, is not in and of itself a negative, as it allows greater objective ID of aspiration and the potential to determine diet rec. and Rx to promote safe eating

Methodological weaknesses

- Examiner and order bias
- Patients not randomized
- Criteria for passing FEES® different than for passing 3 ounce water swallow

Instrumental examinations

Clinical indicators for Instrumental Assessment of Dysphagia: ASHA 2000



- Purposes:
  - Visualize upper airway and digestive tract
  - Assess physiologic function involved in swallowing
  - Assess coordination and effectiveness of movements

Purposes of instrumental cont'd

- Determine presence, cause, severity and timing of aspiration
- Visualize presence, location and amount of secretions and ability to clear
- Screen esophageal anatomy
- Assist in determining safest and most efficient route for nutrition
- Bolus consistencies and volumes
- Rate & method of delivery of oral intake
- Postures, positioning, maneuvers etc.

Indications for instrumental exam (ASHA document)

- Patient's s/s inconsistent with findings on clinical exam
- Confirm suspected medical diagnosis and/or assist in determination of differential diagnosis
- Confirmation and/or differential diagnosis of dysphagia
- Nutritional or pulmonary compromise and question if dysphagia is contributing

Indications for instrumental exam (ASHA document)

- Safety and efficiency of swallow remains a concern
- Patient is swallow rehab candidate and information is needed to guide treatment

MAY be indicated for making the diagnosis and/or planning effective treatment in patients with suspected dysphagia based on the clinical exam and presence of one or more of the following:

- Medical condition w/high risk for dysphagia
- Previously diagnosed with dysphagia and change in function is suspected
- Condition (e.g. cognitive or communicative) that precludes valid clinical exam
- Chronic degenerative or progressive disease, or stable or recovering condition for which further definition is needed for management

NOT indicated when findings from clinical fail to i.d. dysphagia or when findings from clinical exam suggest dysphagia and include one or more of the following:

- Too medically unstable to tolerate procedure
- Unable to cooperate in instrumental
- In SLP's judgment, instrumental would not change clinical management of patient

Signs of pharyngeal dysphagia ?

- coughing, throat clearing
- multiple swallows
- wet vocal quality/breath sounds
- breathy vocal quality
- reduced laryngeal elevation
- not managing secretions

Instrumental Procedures

- Videofluoroscopy
- Endoscopy
- Endoscopy with sensory testing
- Electromyography
- Pharyngeal manometry
- Scintigraphy
- Ultrasound

Efficacy of instrumental assessment

- The outcome of a videofluoroscopic evaluation can be immediate return to full or partial oral intake
  - Horner et al 1988
  - Logemann et al 1993
  - Rasley et al 1993

Efficacy of the MBS

- Many studies have shown that the MBS allows the SLP to identify specific problems in anatomy/physiology and try appropriate treatment techniques
- Several studies that indicate MBS more accurate than bedside in identifying cause of aspiration

Efficacy of the MBS

- Head and neck cancer patients assessed by MBS (vs. bedside) when planning treatment ultimately had better swallow times and more efficient swallows (Logemann et al 1992)

Clinical Utility of MBS (Martin-Harris et al 2000)

- Database of nonrandom sample of 608 studies
- 10.4% normal
- 32.4% aspiration
- 57.2% swallowing abnormality
- 83% had change in at least one other variable:
- 26.3% referral to specialist
- 48.4% compensatory strategies
- 37.2% swallowing therapy recommended
- 31.4% change in mode of intake
- 43.8% change in diet texture

FEES® -does presence of scope affect the swallow? Suiter & Moorhead 2007

- Two groups of normals
- Videofluoroscopic exam with and without scope in place
- Tapes analyzed for stage transition duration, pharyngeal transit duration, duration of max hyoid elevation and max anterior excursion, duration of cricopharyngeal opening

- No significant main effects for any condition
- Presence of fiberoptic endoscope did not significantly alter swallow physiology

Efficacy of FEES ®

- FEES® - Excess secretions visualized with FEES® have high predictive value for aspiration

  – Murray et al 1996

Murray's rating scale for secretions

- 0 = no visible secretions
- 1 = any secretions evident on entry or following a dry swallow in channels surrounding laryngeal vestibule bilaterally represented or deeply pooled. Includes transitions
- 2 = any secretions that changed from a 1 to a 3 during observation period
- 3 = Any secretions seen in the area defined as laryngeal vestibule

Predicting aspiration from secretions

- All of hospitalized patients with secretions rating of 2 or above were observed to aspirate on FEES
- 0 = 21% aspirated
- 1 = 53% aspirated
- 2 = 100% aspirated
- 3 = 100% aspirated

Comparison MBS & FEES(R)

- Oral phase observed
- Pharyngeal wall and tongue base movement during swallow
- Elevation and forward motion of larynx
- Opening of cricopharyngeus
- Tipping of epiglottis
- Movement of bolus during swallow
- Structures of the larynx and pharynx
- Amount and location of secretions
- Laryngeal sensation
- Closure of true cords
- Arytenoid movement
- Residue in lateral channels

FEES and MBS comparisons

- Briani et al (1998): “videofluoroscopy most sensitive technique in identifying oropharyngeal alterations of swallowing”
- “videofluoroscopy also capable of detecting pre-clinical abnormalities in non-dysphagic patients who later developed dysphagia”

How do the two studies compare?

- 34 patients with each, total agreement in 76.4% of patients for propulsion and 82.3% for aspiration (Perie et al 1998)
- 21 subjects, 75% of subjects who had penetration on FEES also had on MBS
- 88% of subjects who aspirated on FEES did so on MBS (within 48 hours) Langmore 1991

FEES and MBS comparisons

- Langmore (1991)
- 75% of subjects who had penetration on FEES® also had penetration on MBS
- 88% who aspirated on FEES® also aspirated on MBS

Reliability MBS (McCullough et al 2001)

- Intra-judge reliability on measures of:
  - Penetration-aspiration
  - Lingual function
  - Oral residue
  - Vallecular residue
  - Pyriform sinus residue
  - Hypopharyngeal residue
- Are acceptable

- Inter-judge reliability of most measures (with exception of aspiration yes/no) varies among clinicians
- Unacceptable

Reliability of MBS

- Inter observer reliability for rating MBS is not good except on determination of penetration or aspiration occurring or not occurring
- However, raters watched only one swallow (and allowed to watch it over and over again)
- Rating had to be made without any clinical info, patient could not be observed, and only one plane available
    - Stoeckli, et al 2003

Influence of barium on validity of MBS results

- 8 Healthy subjects
- Subjects used smaller sip size, longer oropharyngeal transit times and greater variability in tongue movement patterns with opaque liquids
- Transit times significantly longer for subjects over 50 compared to under 30
- Authors recommend matching radiopaque bolus size to what patient uses naturally
    - Steele & van Lieshout 2005

Training in interpretation of MBS
(Logemann et al 2000)

- Significant improvement in identification of both radiographic anatomy and swallowing disorders
- Change negatively correlated with extent of prior experience

MBSImp (Martin-Harris et al 2008 Dysphagia)

- First standardized tool for the measurement of swallowing impairment based on judgments of structural movement relative to bolus flow from videofluoroscopic images using standardized bolus volumes and consistencies

MBSImp

- The MBSImP is composed of 17 physiologic components ranging from lip closure to esophageal clearance.
- Each component is scored on 5-point Likert scale

MBSImp

- Example of a five-point rating scale on the component “initiation of pharyngeal swallow” ranges from a score of “0” when the pharyngeal swallow initiates (onset superior-anterior hyoid movement) as the bolus head approximates the posterior ramus of the mandible to a “4” if there is no appreciable initiation of hyoid movement at any bolus location.

MBSImp

- The study demonstrated that it was not necessary to score each swallow for every volume and consistency; rather, an overall impression (Overall Impression Score –OI) of the impaired components across all textures could be captured.

MBSImp

- Oral and Pharyngeal Impairment scores were significantly associated with penetration-aspiration scores from the Penetration-Aspiration Scale (PAS) and this scale is used in conjunction with the MBSImP.
- However, there were many patients who exhibited swallowing impairment with nutritional and quality of life implications, but who did not penetrate or aspirate

MBSImp

- Creating web-based training modules on the administration and scoring of the MBSImP tool. Each component will be represented by videofluoroscopic images across patient populations with corresponding 3-D animations.
- Prototypes ready for peer review in spring to mid-summer ’09 and plans to offer ASHA CE credit for the training.

Information needed on referral

- Medical history
- Code status
- Tracheostomy
- Medications
- Present/History of Pneumonia
- Present Complaint (be specific !)
- Esophageal symptoms
- Onset of dysphagia
- Previous instrumental and/or clinical exam(s)
- Current diet/intake
- Sitting balance/transfer

Information you should get in the report

- History
- Detailed results which clearly specify the impaired physiology
- Need for service
- Effects of any strategies attempted
- Positive expectation for change
- Specific recommendations
- Diagnosis
- Need for re-evaluation

Rating scales to rate performance during MBS

- Horner et al Dysphagia 1992 describe scale to rate functional ability and degree of radiologic abnormality on 0 - 4 scale in several areas
- Rosenbek, et al Define an 8 point scale to measure penetration/aspiration*

Rosenbek's 8-point Penetration-Aspiration Scale

- 1-Material does not enter the airway
- 2-Material enters the airway, remains above the vocal folds, and is ejected from the airway
- 3-enters, remains above, not ejected
- 4-enters, contacts folds, ejected
- 5-enters, contacts folds, not ejected
- 6-enters, passes below vocal folds, ejected into larynx or out of airway
- 7-enters, passes below, not ejected despite effort
- 8-enters, passes below, no effort to eject

Let's move to treatment

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

Knowing what and why to treat

- Knowing WHAT to treat requires the SLP to
  - identify signs and symptoms of dysphagia and to
  - understand the underlying physiology that is the possible cause of the sign/symptom
- Knowing WHY to treat requires the SLP to understand the functional improvement that is sought

Knowing how to treat

- Requires that the SLP understand the physiology of swallow
- Requires that the SLP know which treatment techniques have an evidence-base for improving (or compensating for) that impaired physiology

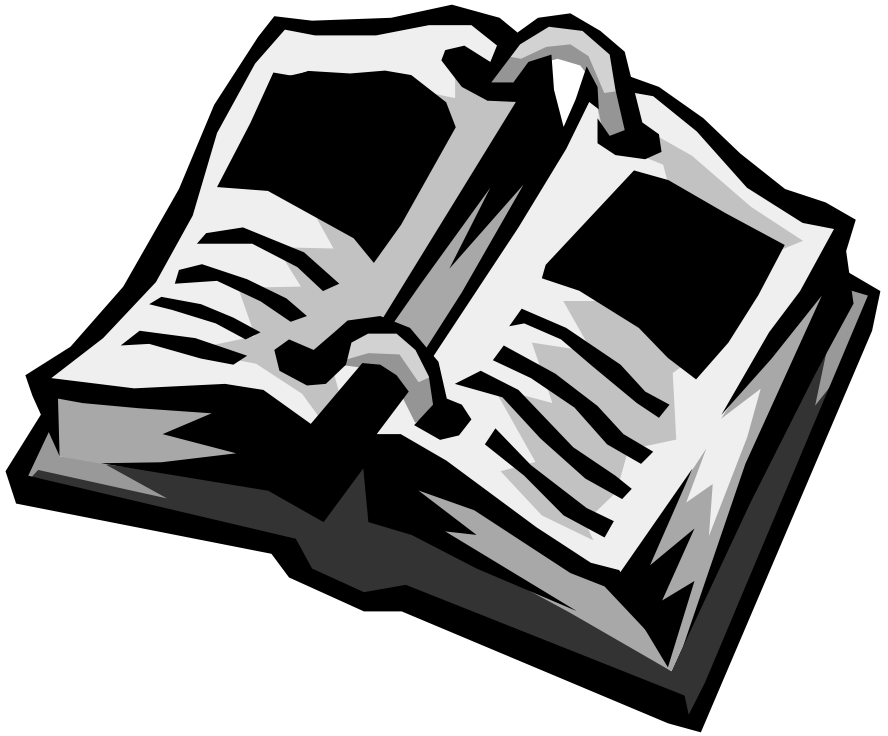
Understanding the relationship between:

- SIGNS ► SHORT TERM GOALS
- PHYSIOLOGY ► FUNCTIONAL SHORT TERM GOALS

- TREATMENT OBJECTIVES

Knowing how long to treat

- Requires understanding of:
  - Etiology
  - Prognosis
  - Outcomes data



SIGNS

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

Phase	Signs
Oral Preparatory	Loses food out front of mouth Can't form bolus
Oral (Voluntary)	Can't move bolus to back of mouth Loses bolus over back of tongue
Pharyngeal	Food enters airway before swallow Food enters airway after swallow Food left in valleculae

Short term goals can be written from the signs observed

Sign	Short Term Goal
Patient can't move food back in the mouth	Patient will improve ability to move food back in the mouth
Patient has food left in the valleculae	Patient will reduce food left in the valleculae
Patient loses food out the front of the mouth	Patient will decrease loss of food out the front of the mouth

Functional short term goals

- are written in terms payers, consumers and other health care professionals can understand
- should talk about WHY you want to improve a skill

Making goals functional

SIGN	SHORT TERM GOAL	FUNCTIONAL SHORT TERM GOAL
Patient can't move food back in mouth	Patient will improve ability to move food back in mouth	Patient will improve ability to move food back in the mouth **to reduce residue that might fall into the airway**
Patient has food left in the valleculae	Patient will reduce food left in the valleculae	Patient will reduce food left in the valleculae **that might fall into the airway**
Patient loses food out the front of the mouth	Patient will decrease anterior loss of food	Patient will decrease anterior loss of food **so that more food is consumed**

Knowing WHAT to treat requires

- Identifying the signs of oral and pharyngeal dysphagia
- Understanding the underlying physiology that is the possible cause of the sign/symptom

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

Sign/symptom	Functional short term goal	Different physiologic causes	Reworded functional short term goal
Patient has residue in the pyriforms after the swallow	Patient will reduce the amount of residue in the pyriform sinuses to reduce the risk of food falling into the airway	Reduced laryngeal elevation	Patient will **increase laryngeal elevation** to reduce the amount of food remaining in the pyriforms which could fall into the airway
		Reduced anterior movement of hyolaryngeal complex	Patient will **increase anterior movement of hyolaryngeal complex** to reduce the amount of food remaining in the pyriforms which could fall into the airway

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

Treatment Objectives

- Treatment objectives may be categorized as:
-
- Compensatory*: Designed to compensate for lost function. Most often used during meals.
- Changes in posture
- Increased sensory input
- Food placement
- Food presentation
-

Treatment Objectives

- **Facilitation/Therapeutic*:** Designed to improve function. Used during therapy and not necessarily during meals.
-
- **Diet:** Involves changes in diet texture and temperature to help compensate for lost function.

- *Some techniques provide both compensation and facilitation
- e.g. super-supraglottic swallow
-

How would you reword goals if no facilitation 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 pyriform 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

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

Treatment objectives can be written in measurable terms: Vallecular residue

Physiologic cause	Treatment Objectives	Measurable
Decreased movement of posterior pharyngeal wall	Patient will utilize tongue hold maneuver	Patient will swallow saliva using tongue hold maneuver on __ of __ trials (f)
Decreased movement of tongue base	Patient will use effort swallow	Patient will use effort swallow with/without cues on __% of trials (c,f)
	Patient will use tongue base retraction	Patient will demonstrate tongue base retraction with resistance on __ of __ trials (f)
	Patient will avoid sticky foods	Patient will avoid sticky foods with/without cues on __ of __ trials (d)

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?

Selecting treatment objectives

Sign	Physiology	Treatment Techniques (f)
Aspiration before the swallow	Decreased back of tongue control	k,g
		Pressure on tongue blade
	Delayed swallow	Thermal stim
		Three second prep
		Sour bolus
		Neurosensory stim

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

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 transmit times during swallowing

Selecting treatment techniques

Sign	Physiology	Treatment Techniques (c,d)
Aspiration before the swallow	Decreased back of tongue	Chin down (c) Control bolus size (c) Thickened liquids (d)
	Delayed swallow	

Selecting treatment techniques

Sign	Physiology	Treatment technique (f)
Aspiration during the swallow	Decreased closure of larynx	Supraglottic
		Super-supraglottic
		Breath hold (Valsalva)
		Vowel initiate words
	Mistiming of laryngeal elevation/closure	Supraglottic
		Mendelsohn

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)

Efficacy studies: Breath-hold

(Brady, 2002)

- Effortful breath hold instruction most effective method to obtain TVC closure
- Inhale/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

Caution: Supraglottic and super-supraglottic

- 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)

Selecting treatment techniques

Sign	Physiology	Treatment Technique (c,d)
Aspiration during the swallow	Decreased closure	Head rotation(c) Chin down (c) Thick liquids (d) Bolus size (d)
	Mistiming of laryngeal elevation/closure	

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

- 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

Selecting treatment techniques

Sign	Physiology	Treatment techniques (f)
Aspiration after from pyriform sinus residue	Decreased laryngeal elevation	Mendelsohn
		With SEMG
		Falsetto
	Decreased anterior movement of hyolaryngeal complex	Head lift

Efficacy- particular treatment method

- Mendelsohn maneuver
  - Use of maneuver increased the duration of the anterior-superior excursion of the larynx and hyoid and delayed sphincter closure by maintaining traction on anterior sphincter wall (Kahrilas, et al 1991)
  - Improved extent of UES and bolus head velocity (Logemann & Kahrilas, 1990)

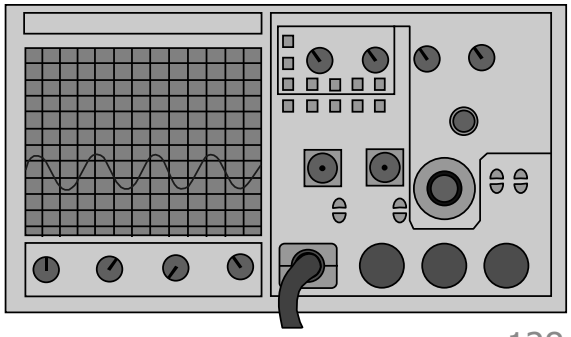
Efficacy of specific method

- 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)

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



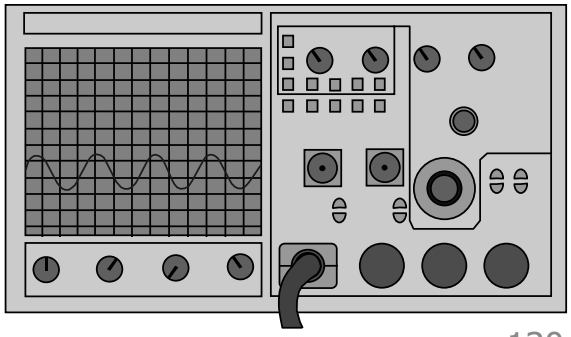
Efficacy of specific treatment techniques

- SEMG biofeedback
  - Stroke and Head/Neck Cancer patients
  - Reduced hyolaryngeal elevation, reduced pharyngoesophageal segment opening & residue
  - Daily 50 minute sessions and portable biofeedback to practice at home
    - Average # sessions 12/stroke and 9/head & neck
  - 87% of patients increased functional oral intake by at least one scale score on FOIS
    - Stroke had more functional gains
      - » Crary, et al 2004

Efficacy of specific treatment techniques

- SEMG
  - 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



EMST

- 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 Wheeler-Hegland, et al 2008

- 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)
    - 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

Selecting treatment techniques

Sign	Physiology	Treatment Technique (c,d)
Aspiration after from pyriform sinus residue	Decreased laryngeal elevation	Liquid wash (c) Multiple swallows (c) Bolus size (c) Head rotation (c) Avoid sticky (d) Thickened liquids (d)
	Decreased anterior movement of hyolaryngeal complex	

Selecting treatment techniques

Sign	Physiology	Treatment Techniques
Aspiration after from penetration into laryngeal vestibule	Decreased laryngeal elevation	Mendelsohn
		Falsetto
	Decreased arytenoid tipping	Super-supraglottic
	Slow or mistimed closure of larynx	Mendelsohn
		Supraglottic

Selecting treatment techniques

Sign	Physiology	Treatment Techniques
Aspiration after from penetration into laryngeal vestibule	Decreased laryngeal elevation	Bolus size (c) Chin down (c) Thickened liquids (d)
	Decreased arytenoid tipping	
	Slow or mistimed closure of larynx	

Selecting treatment techniques

Sign	Physiology	Treatment techniques
Aspiration after from vallecular residue/ pharygeal wall	Decreased tongue base movement	Tongue retraction Effort, yawn, gargle
	Decreased pharyngeal wall movement	Yawn Gargle /i/ Tongue hold
	Decreased laryngeal elevation	Mendelsohn Falsetto

Efficacy: Three techniques on Maximum Posterior Movement of Tongue Base (Veis, et al 2000)

- 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)

Efficacy: Three techniques on Maximum Posterior Movement of Tongue Base (Veis, et al 2000)

- 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

Selecting treatment techniques

Sign	Physiology	Treatment techniques
Aspiration after from vallecular residue/ pharygeal wall	Decreased tongue base movement Decreased pharyngeal wall movement Decreased laryngeal elevation	Bolus size (c) Stay seated up (c) Multiple swallow (c) Liquid wash (c) Head rotation (c) Avoid sticky (d)

LSVT® for swallowing disorders
Parkinson's Disease Will et al 2005 (Sharkawi et al 2002)

- Improvement in oral transit time and percentage of oral residue
- Tongue rocking disappeared
- Reduction in delay, improved tongue base retraction with reduction in amount of residue spilling from valleculae
- OPSE score improved for all except cookie
- Hypothesize the LSVT® may activate neuromuscular control of entire aerodigestive tract

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

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

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)
    - Kiger M, Brown CS, Watkins L. 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

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

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 Hyo-laryngeal movement in Normal Individuals at Rest and During Swallowing *Humbert el 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

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

Ludlow et al 2007

- Motor stimulation at rest
  - Lowered the hyoid in the neck
- Sensory stimulation
  - Reduced the risk of pooling and aspiration during swallowing
- Motor stimulation
  - Reduced aspiration in patients with the greatest hyoid depression
- Electrical stimulation may have served as a resistance therapy in patients who could raise the hyoid

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

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.

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.

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 augmentatin
- 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
- Augmentatin 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

What's next?

- Some researchers beginning to experiment with submental placement
- No studies published yet