Multidisciplinary Collaboration

- **SLP:** primary clinician
- **OT:** adaptive tools; postural positioning/support
- **PT:** postural positioning and support
- **RD:** nutrition/hydration; weight; feeding tubes
- **Physician:** medical/surgical management; feeding tubes
- **Dentist:** oral hygiene; prosthetics
- **Nursing:** swallowing screens; feeding tubes; compliance with team’s recs

Targeted Intervention

- **Patient-specific:**
  - underlying impairment,
  - medical diagnosis,
  - cognitive status,
  - medical status,
  - Patient/caregiver preferences
- **Evidence-based (literature, expertise, preference)**
- **Evaluated under instrumental assessment (pathophysiology)**

Multi-modality Dysphagia Treatment

- **Compensation:** improve safety and efficiency of swallowing *without* directly targeting swallowing physiology; “adapt” to impairment
- **Retraining:** improve safety and efficiency of swallowing by *directly* targeting swallowing physiology; “repair” impairment
- **Surgical Intervention:** most often used in conjunction with behavioral rehabilitation – may be used when behavioral methods fail.

Compensation OR Retraining?
Compensation AND Retraining

• Both can lead to physiological changes (adaptive or maladaptive) and even transient neuroplastic changes
• Some patients may only be able to do one (e.g., patients with advanced dementia)
• Most will be able to do some degree of BOTH
  • Comprehensive evaluation of each option for each patient
• As far as we know (at this time) ONLY retraining can lead to true “recovery”

COMPENSATION

Webster [Biology]: “the improvement of any defect by the excessive development or action of another structure or organ of the same structure”

Compensatory Swallowing Interventions:
• Used to compensate for structural and physiological deficits
• Temporary effect only; do not change swallow physiology

Compensation – Traditional

• Webster [Biology]: “the improvement of any defect by the excessive development or action of another structure or organ of the same structure”

Compensation – Novel

Application of International Classification of Functioning, Disability and Health (ICF)
• Neural level: neural tissue acquires a function that it did not have prior to injury
• Body function/structure: Performing an old movement in a new manner
• Activity: successful task accomplishment using alternate limbs or end effectors
• Not the same as “recovery”

Indications and Contraindications

• Indications
  • Cognitive function adequate to follow instructions
  • Caregiver support for strategy implementation
• Contraindications
  • Poor cognitive function
  • Does not wish to use strategies
Compensatory Strategies

1. Modify foods and liquids
2. Sensory Stimulation
3. Use of appliance (obturator, dentures)
4. Alter posture
5. Employ maneuver

Frontline Tactics – Fluids & Foods

*Modify* fluids and foods:
- Change viscosity/rheologic parameters
- Alter texture (e.g., cohesion)
- Enhance taste/temperature (sensory)

*Delivery* of fluids and foods:
- Control rate
- Control amount/volume
- Alter mode of administration (e.g., bypass oropharynx)

Rheologic Parameters

- Diagnostic materials must have a reliable and meaningful relationship to our treatments (fluids & foods)
- Begin with focus on viscosity (cP)
  - Thin
  - Nectar
  - Honey
  - Pudding

International Dysphagia Diet Standardization Initiative

Varibar - IDSSI Conversions

Rheologic Properties
- Viscosity
- Flow
- Yield stress
- Shear rate
**Functional Targets & Domains**

**Physiologic Components of Swallowing**

1. Lip Closure
2. Tongue Control
3. Bolus Preparation/Maniﬁcation
4. Bolus Transport/Lingual Motion
5. Oral Residue
6. Initiation of Pharyngeal Response
7. Soft Palate Elevation
8. Laryngeal Elevation
9. Anterior Hood Excursion
10. Epiglottic Movement
11. Laryngeal Vestibular Closure
12. Pharyngeal Stripping Wave
13. Pharyngeal Contraction
14. PES Opening
15. Tongue Base Retraction
16. Pharyngeal Residue
17. Esophageal Clearance

**Pharyngeal Stripping Wave (PSW)**

Component 12

- Assesses the progressive contraction of the pharyngeal constrictor muscles, superiorly ➔ inferiorly, in the lateral view.

**PSW Response to Bolus Viscosity**

Thin Liquid vs. Pudding Consistency

**Initiation of the Pharyngeal Swallow (IPS)**

Component 6

- Pharyngeal response to sensory inputs including bolus characteristics and movement of the tongue.
- Position of bolus head at the time of ﬁrst brisk hyoid movement.

**IPS Response to Bolus Cohesion**

Meat, Thinned

**Standardized Recipes for Liquids & Foods**

- **Thickened protein-enhanced beverages** (Patent #US9 930, 906 B1)

- Cynthia Vaughn
Frontline Tactics – Fluids & Foods

Modify fluids and foods:
- Change viscosity/rheologic parameters
- Alter texture (e.g. cohesion)
- Enhance taste/temperature (sensory)

Delivery of fluids and foods:
- Control rate
- Control amount/volume
- Alter mode of administration (e.g. bypass oropharynx)

Penetration Aspiration Scale

<table>
<thead>
<tr>
<th>Penetration</th>
<th>Aspiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Material does not enter the airway</td>
<td>6. Material enters the airway, passes below the vocal folds, and is not ejected from the airway</td>
</tr>
<tr>
<td>2. Material enters the airway, remains above the vocal folds, and is not ejected from the airway</td>
<td>7. Material enters the airway, passes below the vocal folds, and is not ejected from the trachea</td>
</tr>
<tr>
<td>3. Material enters the airway, remains above the vocal folds, and is not ejected from the airway</td>
<td>8. Material enters the airway, passes below the vocal folds, and is not ejected from the trachea</td>
</tr>
</tbody>
</table>

PAS Response to Bolus Volume & Rate

5mL Thin:
- PAS 1, no entry

Cup Sip Thin:
- PAS 4, enters airway, contacts vocal folds, escapes

Sequential Thin:
- PAS 5, enters airway, contacts vocal folds, remains

Bolus Transport/Lingual Motion (BT)
Component 4

BT Response to Mode of Administration

Cup Sip

Syringe

Adaptive Feeding Equipment

TENSILS
DISHES
CUPS
**Compensatory Strategies**

1. Modify foods and liquids
2. Sensory Stimulation
3. Use of appliance (obturator, dentures)
4. Alter posture
5. Employ maneuver

**Sensory Awareness Techniques**

- **Purpose:** useful for those with swallow apraxia; tactile agnosia for food; delayed swallow initiation
- **Techniques**
  - Sour bolus
  - Cold bolus
  - Bolus that requires chewing
  - Large bolus volume
  - Downward pressure of utensil on tongue
  - Thermal tactile stimulation

**Thermal Tactile Stimulation (TTS)**

- **Purpose:** initiate swallow reflex
- **Instructions:**
  - Stimulate faucial arch or posterior pharyngeal wall using laryngeal mirror/spoon soaked in ice-cold water (or use ice lemon glycerin swab)
  - Can also stimulate tongue and around the mouth
  - Caution: limited evidence for generalization!

**Bolus Preparation/Mastication (BPM)**

- **Assessments:** efficiency of chewing
- **Ability of the patient to break down the solid for safe complete transport from the oral cavity
- **Tongue movement is integrated into chewing

**BPM Response to Dental Appliance**
Soft Palate Elevation (SPE) Component 7

- Soft palate to pharyngeal wall contact is based on the presence of contrast or air between the two structures.

Compensatory Strategies

- Modify foods and liquids
- Sensory Stimulation
- Use of appliance (obturator, dentures)
  4. Alter posture
  5. Employ maneuver

Optimal Positioning

- Upright between 70 – 90 degrees
- Head neutral position

Postural Techniques

- Reclined (semi-supine)
- Head Extension (head back)
- Recumbent (side-lying)
- Head Lateral Flexion (head tilt)
- Head Flexion (chin tuck)
- Head Rotation (head turn)
- Postural Combinations (head flexion + rotation)

Reclined Position

Indications for use:
- Inefficient oral transit
- Decreased pharyngeal clearance
- Post-deglutitive penetration/aspiration

Impact:
- Utilizes gravity to clear oral cavity
- Redirects bolus away from laryngeal vestibule
- Maintains retention in pharyngeal recesses

Caution: Get medical clearance for those with neck/cervical spinal injuries!!

SPE Response to Palatal Appliance

Obturator

45 degree recline
Head Extension

Instructions: While holding the food/liquid in your mouth, tilt your head back. Swallow while keeping your head tilted backwards.

Indications for use:
• Inefficient oral transit
• Decreased oral clearance

Impact:
• Utilizes gravity to clear oral cavity

Recumbent Position

Indications for use:
• Unilateral oral and/or pharyngeal dysfunction

Impact:
• Redirects bolus away from impairment and towards stronger side

Head Lateral Flexion

Instructions: While holding the food/liquid in your mouth, tilt your right/left ear towards your shoulder. Swallow while keeping your head tilted.

Indications for use:
• Unilateral oral and/or pharyngeal dysfunction

Impact:
• Redirects bolus away from impairment and towards stronger side

Head Flexion

Indications for use:
• Delayed initiation of the pharyngeal swallow
• Reduced tongue base retraction
• Reduced airway closure

Impact:
• Widens valleculae (timing, reduces residue)
• Improves laryngeal vestibular closure
• Brings pharyngeal wall closer to tongue base
• Elimination of aspiration in treated mixed dysphagic patients (Ekberg, 1986; Logemann et al., 2008; Solazzo et al., 2012; Ohmae et al., 1997)

Head Rotation

Instructions: While holding the food/liquid in your mouth, turn your head all the way towards the right/left. Swallow the bolus while keeping your head tilted.

Indications for use:
• Unilateral pharyngeal bulging/paresis
• Unilateral laryngeal paresis/paralysis
• Decreased pharyngoesophageal segment (PES) opening (cricopharyngeal dysfunction)

Impact:
• Causes the bolus to lateralize away from the direction of head rotation (Ohmae et al., 1998)
• Decreases loss of cavity pressure
• Pulls cricoid away from posterior pharyngeal wall
• Elimination of aspiration in treated H&N CA and neuro pts (Rasley et al., 1993; Logemann et al., 1994; Lewin et al., 2001)

Head Flexion + Rotation

Indications for use:
• Delayed initiation of the pharyngeal swallow
• Unilateral pharyngeal bulging/paresis
• Decrease PES opening
• Unilateral laryngeal dysfunction

Postural Combinations

Indications for use:
• Delayed initiation of the pharyngeal swallow
• Unilateral pharyngeal bulging/paresis
• Decrease PES opening
• Unilateral laryngeal dysfunction
Evidence for Physiological & Transient Neuroplastic Changes

- **Head Rotation**
  - Significantly longer duration of pressure above baseline in the velopharynx
  - Reduced upper esophageal sphincter (UES) resting pressure and a delay in UES closing via pharyngeal manometry
    - (Shin et al., 2009; McCullough et al., 2010; hallo et al., 2010; Kim et al., 2017)

- **Head Flexion**
  - Lower UES maximum pressure
    - (McCullough et al., 2010; Balou et al., 2014)
  - Transient small neuroplastic changes (EEG evidence)
    - (Jestrovic et al., 2016)

Evidence for Physiological & Transient Neuroplastic Changes

ADAPTIVE & MALADAPTIVE Compensatory Strategies

1. Modify foods and liquids
2. Sensory Stimulation
3. Use of appliance (obturator, dentures)
4. Alter posture
5. Employ maneuver

Swallow Maneuvers

- **Immediately alter pharyngeal swallow to improve safety and efficiency of the swallow**
- **Maneuvers**
  - Supraglottic
  - Super-supraglottic
  - Effortful
  - Mendelsohn

Supraglottic Swallow

- **Indications for Use:** Reduced or delayed laryngeal vestibular closure
- **Impact:** Voluntary breath hold closes vocal folds before and during swallow to prevent airway invasion (Martin et al., 1993).
- Post swallow throat clear, expels residue from laryngeal vestibule if present.

Super-supraglottic Swallow

- **Indications for Use:** Reduced or delayed laryngeal vestibular closure
- **Impact:** Effortful breath hold brings arytenoids forward to close vestibular entrance before and during the swallow. (Martin et al., 1993)
- Post swallow throat clear, expels residue from laryngeal vestibule if present.

Supraglottic & Super-Supraglottic Swallow Maneuvers
Supraglottic & Super-Supraglottic Swallow Maneuvers

Effortful Swallow

Indications for Use:
- Reduced tongue base retraction
- Decreased pharyngeal contraction
- Reduced pharyngeal stripping

Impact:
- Effort increases posterior tongue base and pharyngeal movement (Pouderous & Kahrilas, 1995)
- Facilitates pharyngeal closure
- Engages all pharyngeal musculature

Mendelsohn Maneuver

Indications for Use:
- Reduced hyolaryngeal excursion
- Reduced PES opening
- Reduced laryngeal closure

Impact:
- Facilitates and sustains laryngeal closure and PES opening (Cook et al., 1989; Jacob et al., 1989)
- Facilitates and sustains contraction of oropharyngeal muscles

Evidence for Physiological Changes

Mendelsohn maneuver
- Decrease in UES pressure, nadir duration and pre-opening pressure with increase in post-closure pressure (Hoffman et al., 2012)
- Longer and stronger pharyngeal contraction (Hoffman et al., 2012), velopharyngeal pressure duration (Hoffman et al., 2012)
- Does not prolong duration or width of UES opening (Hoffman et al., 2012; Doeltgen et al., 2017)
- Reduced proximal esophageal pressures (Doeltgen et al., 2017)

Evidence for Physiological Changes

Mendelsohn maneuver
- Temporal changes:
  - Significantly prolonged hyoid anterosuperior motion
  - Velopharyngeal closure
  - Laryngeal anterior and glottic closure
  - No change in duration of UES opening
- Displacement changes:
  - Hyoid anterosuperior movement
  - No change in width of UES opening
- Pharyngeal constriction ratio:
  - Mendelsohn: 100%, control swallows: 95.1%

INSTRUCTIONS:
1. Swallow normal and feel your voice box lift
2. Now, swallow again, and when your voice box lifts, hold it up there by using your muscles.
3. Relax
Pharyngeal Pressure Response to Maneuvers & Postures

RETRAINING

• Webster: [Biology] "the action, process, or result of restoration especially by therapeutic means to an improved condition of physical function"

• Re-training can lead to “recovery/re acquisition of skills” (Levin et al. 2009)

• Behavioral Rehabilitative Swallowing Interventions
  • Change swallowing physiology
  • Potentially lead to neuroplastic changes (adaptive or maladaptive)
  • Behavioral Driver: motor skill acquisition

Re-training (Rehabilitation) – Traditional

Clark, 2003; Robbins et al., 2008; Langmore & Phelps, 2015

Rehab Management

• Intended to improve swallowing physiology
  • Thus, improve swallowing (functional) outcomes

• Ideal candidate
  • Adequate cognitive status to participate
  • Motivated
  • Can practice independently or have support from caregivers
  • Impairment need for restorative technique(s)
  • Physician clearance

Behavioral Re-training Approaches

• Strengthening
  • Lingual (e.g., Robbins et al., 2007; Lazaro et al., 2006; review by: McKenna et al., 2017)
  • Hyolaryngeal (e.g., Shaker, Mendelsohn) (Shaker et al., 1997; Mishra et al., 2015; McCullough et al., 2012)
  • EMST (e.g., Soare et al., 2010)

• Skill-based learning
  • Biofeedback-assisted swallowing skill training (Levin et al., 2009)
  • Respiratory-swallowing coordination training (Levin et al., 2009)
  • Tongue pressure profile training (Levin et al., 2009)

• Combined Interventions
  • MDTP (e.g., Crary et al., 2012)
  • Boot Camp and Intensive Dysphagia Rehabilitation (IDR) approaches (Hutcheson et al., 2013; Malandraki et al., 2016)

Behavioral Re-training Approaches

• When behavioral re-training approaches are appropriate for a specific patient (and his/her pathophysiology) AND they are implemented using principles of exercise physiology, motor learning, and neuroplasticity, patient outcomes will very likely be positive.

• Not only the specific exercises, but more importantly the way these exercises and programs are implemented is key to the success of the patients.
Neuroplasticity

- Ability of neural systems to alter (adapt) function in response to change (e.g., injury/disease)
- Principles of neuroplasticity should be applied during dysphagia rehabilitation

Principles of Neuroplasticity

- Use it or lose it: if not active, function degrades
- Use it and improve it: skill training
- Specificity: training is relevant to target behavior
- Repetition: induces and maintains brain changes
- Intensity: optimal intensity

Overload principle: increase demands to force adaptations

Principles of Neuroplasticity

- Timing: pair restorative with compensatory treatment; longer and continuous training
- Salience: purposeful; meaningful
- Age: younger systems are more adaptive
- Transference: promotion of concurrent or subsequent plasticity (combined stimulation and skill)
- Interference: negative effects

Strength Training and Skill Training

Connected concepts – impairment in both present but may not be equally distributed

Skill
Strength
Skill
Strength

Strength Training

- Not all swallow damage is CENTRAL ... Not all have a NEURO basis!
  - Noted strength changes with ageing
  - Noted strength change with head and neck cancer

Age associated decline in muscle mass (Narici 2010)
Fatty infiltration and shortening of swallow m. (Carnaby 2006)

STRENGTH TRAINING
Muscle Strengthening

- Muscles are highly responsive to exercise
- To increase strength, the muscle must be exercised at a level above its usual “load”
- Load increases gradually and systematically over time
- Through continued practice, muscles develop efficiency and stabilize motor plans – improved performance!
- Rest facilitates muscle benefits from exercise

Isometric vs Isotonic

Isometric
- No joint movement
- Muscle length does not change
- Hold static position

Isotonic
- Joint movement
- Shortening and lengthening of muscle
- Range of motion

Lingual Exercise

- Improved tongue strength in healthy young and old (isometric tongue strengthening exercises – resistance exercise)
  - Lazarus et al., 2003; Med & Robbins, 2004; Robbins et al., 2005 & 2008
- And in patients with CVA – improved maximum isometric tongue pressures, maximum swallow pressures, PA Scale
  - Kays et al., 2004

- Improved tongue strength in healthy young and old (isometric tongue strengthening exercises – resistance exercise)

Combined Isotonic-Isometric Exercise

- Effortful Swallow
  - Reduced tongue base retraction
  - Shields laryngeal inlet
  - Reduced pharyngeal stripping
  - Decreased pharyngeal contraction

Strength Training Exercises

- Mendelsohn Maneuver
- Effortful Swallow
- Masako Maneuver
- Tongue Pull Maneuver
- Shaker (Head Lift) Exercise
- Chin Tuck Against Resistance (CTAR) Exercise
- Falsetto Exercise

Indications/Rationale

- Reduced tongue base retraction
- Shields laryngeal inlet
- Reduced pharyngeal stripping
- Decreased pharyngeal contraction
- Effort increase posterior tongue base and pharyngeal movement (Pouderour & Kahrilas, 1995)