Challenges in Dysphagia Management

Large amounts of information, sometimes conflicting
Wide variety of sources - websites, journals, fellow clinicians
Myths vs. anecdotal info vs. evidence

Practice patterns of SLPs

Case review by 254 SLPs (internet survey)
47 different interventions recommended
Only 3.9% of respondents reported choosing their recommendations based on physiologic abnormality
No single combination of therapies was repeated exactly across respondents
58% of recommendations did not match specific dysphagia symptoms

Reviewing the Evidence...

- Were the subjects in the study like my patient(s)?
- Was there some randomization?
- Were the patients treated equally except for the intervention?
- Were other factors controlled for? History? Learning? Maturation? Spontaneous recovery?
- Was the sample size large enough?

Aspiration

Clearance Mechanisms

Cough
Muco-ciliary escalator
Cellular defenses
Aspiration and the Airway

So...

How much aspiration is too much?

Who gets sick?

Aspiration and the Airway

As many as half of healthy adults aspirate small amounts of their secretions...usually in our sleep.

Penetration during the swallow is normal in infants.

Penetration also increases in frequency in the aging swallow.

Aspiration and the Airway

What was aspirated?

Acidity

Fat molecules vs. Water molecules

Bolus Weight

Bacteria

Aspiration and the Airway

Two-tier Assessment Process:

1. What is the likelihood that this patient is aspirating?
2. What is the likelihood that this patient will develop aspiration pneumonia?

Colonization of Bacteria
- Oral Care
- Dental Decay
- Tube Feeding
- Tracheostomy/Ventilation

Aspiration Risk
- GER
- Tube Feeding
- Dysphagia

Host Resistance
- Cough Response
- Cilia Integrity
- Immune System Integrity
- Nutrition

Aspiration Pneumonia

So...Who Get’s Sick?

- Medical condition, co-morbidities? Degree of disability?
- Presence of infection? Immune system integrity?
- Nutritional compromise?
- Respiratory status? Cilia integrity?
- Cough?
- Oral Hygiene?
- Nutritional status?
Reflexive Cough

- Inspiration
- Glottal closure
- Contraction of respiratory muscles, including abdominal muscles
- Expiration with increased flow rate
- Airway opening; release of subglottic pressure

A great deal of variation exists, however.

Brainstem “cough center”
Variation in neurological mediation - vagus, peripheral nerves
Evidence to suggest that different irritants produce cough along different neural pathways
In Larynx/Trachea triggered largely by mechanical stimulation
Bronchial cough generally triggered by mucus, edema
Laryngeal enervation not necessarily needed to trigger

Greatest # cough receptors in larynx, bifurcation of bronchi
But...
Additional receptors in pharynx, tympanic membrane, esophagus, diaphragm, paranasal areas

Expiration Reflex: mechanical stimulation to larynx often triggers immediate expiratory effort

Effectiveness = ability to clear airway
- Muscle strength
- Respiratory capacity
- Cilia integrity
- VF function
Cough

Voluntary Cough

“Modest” relationship between voluntary cough and aspiration/penetration in PD patients

Pitts, et al, 2009

Cough

Cough - Predictor of aspiration in CVA:

Lower than normal...
- inspiratory volumes
- inspiratory peak flow
- expiratory peak flow
- sound pressure levels

associated with aspiration

Smith Hammond, et al, 2009

Cough

Cough and angiotensin-converting-enzyme (ACE) inhibitors

Used to treat HTN, CHF (e.g. Capoten/captopril, Vasotec/enalapril, Altace/ramipril)

Reduce tension in blood vessels, reduce blood flow

Increase cough sensitivity; lower cough threshold; i.e. people who take them cough with less stimulation

Some evidence to suggest that they could prevent aspiration and aspiration pneumonia

Respiration

As breathing changes...so does swallowing...

Breathing and Swallowing

Apneic Signal

Changes with the bolus:
- As bolus increases in volume...
  - Duration increases
  - Earlier onset

Changes with patient populations:
- As we age...
  - Longer duration
  - No change in onset

With disabilities...
- *Increased duration* in ALS, CF, CVA
- *Decreased duration* in COPD

Breathing and Swallowing

Coordination

What’s your pattern?
Breathing and Swallowing

Coordination
Exhalation – Swallow – Exhalation
Inhalation – Swallow – Exhalation

Larger bolus...Post swallow inhalation more likely; more likely to occur at larger lung volumes (greater 0-2 reserve?)
Increased post swallow inhalation with COPD, CP, BPD, preemies, and in aging

Respiration Assessment

Work of Breathing
Physiologic: force required to overcome elastic and frictional resistance
Expansion of lungs against recoil
Airway resistance

Respiration Assessment

Rate
- At rest (norm = 10-14 bpm)
- Change with demands of swallowing?

Coordination
- Changes across bolus types, size
- Single swallows vs. serial swallows
- Changes with fatigue?

Respiration Assessment

Trunk control; positional stability
Observations re: WOB

Respiration Assessment

Respiratory Muscle Strength
- Maximum expiratory pressures (Via EMST device)
- Pulmonary Function Tests (functional vital capacity, expiratory volumes, peak flow)
- Trunk control; positional stability
- Observations re: WOB

Oxyhemoglobin Saturation
Via Pulse Oximetry
Adults: 95% +
Children: 90%
Indication of the “work of breathing”
Respiration Assessment

**Pulse Oximetry**

Measurement of % hemoglobin that is saturated with oxygen
Transmission of red/infra-red light through the bloodstream
Oxygenated and deoxygenated hemoglobin transmit light differently; oximeter calculates saturation based on the two transmissions

Respiration Assessment

**Pulse Oximetry**

Partial atmospheric pressure of oxygen measure - \( \text{PaO}_2 \) - (via ABGs) measures *actual* amount of oxygen in blood as opposed to hemoglobin saturation
Pulse Ox faster, easier in real time; can get readings over time

Respiration Assessment

**Pulse Ox**

Technique:
Adequate perfusion at probe site (cold, anxiety, meds, hand position, probe itself)
Blood pressure at least 80 systolic
Low hemoglobin (anemia) will distort results
Nail polish/artificial nails/dark pigmentation
Edema/movement of extremities
Ambient light

Respiration Assessment

**Pulse Oximetry and Aspiration**

Several studies looking for correlation between changes in Pulse Ox and aspiration
No reliable correlation
Better for measurement of “work of breathing”, endurance for feeding
But...

*Low baseline numbers may indicate aspiration risk*

Respiration Assessment

**Dyspnea** (”breathing discomfort”)
Air hunger
Increased physical work of breathing
Chest/lung tightness

Assessment (speech and swallowing)
Observe in a variety of contexts, demands
Include patient’s perception

Hoit, et al, 2011

Respiration Assessment

**Dyspnea and Speech**

Breath support adequate for connected speech?
At different volume levels?
During other activity?

Look for...
Increased rate
Inspirations mid-word or phrase
Decreased syllables/breath
Activation of neck, upper rib cage muscles
Pausing for breaths
Respiration Assessment

Dyspnea and Swallowing
- Single and serial swallows
- Over the course of a mealtime

Look for...
- Holding bolus in oral cavity
- Pausing between swallows for breath
- Increased respiratory rate

Clinical Assessment

Respiratory Factors Associated with Aspiration
- Rapid RR (>25 bpm)
- Low baseline oxygen saturation (<94%)
- Inconsistent swallow-respiratory pattern
- Post-swallow inhalation
- Short swallow apnea duration

Steele and Cichero, 2014

Improving Respiratory Support

Pacing
- Slow flow cups
- Imposed breaks
- Single swallows
- Bolus hold
- Reduced bolus size

Positioning

Is this patient well positioned?
- Are trunk, head and neck generally in line?
- Can the patient move side to side, rotate at midline?
- Can the patient participate in feeding – i.e. reach, bring food/utensils to his/her mouth; hold utensils?
- Is respiratory rate steady; is breath support sufficient?
- Do lower extremities support the upper body?
- Is there support for the feet?

Exercise

Expiratory Muscle Strength Training
- Calibrated one way valve; increases load to expiratory muscles
- In order to open the valve, user must produce muscle contraction
- Resulted in decreased aspiration, increased cough in PD patients

Oral Hygiene

http://aspireproducts.org
Oral Health Assessment

**Normal Oral Flora**
- Prevent colonization by pathogens by competing for attachment and nutrients
- Antagonize other bacteria
- Assist in immune responses

**Oral Flora and Pneumonia**
- Dental plaque serves as a repository for respiratory pathogens which then migrate to lungs
- And/Or...
  - Plaque changes the epithelial cells in the oropharyngeal cavity, increasing adherence of pathogens

**Oral Health Assessment**

**Dental Plaque:** Colonizing bacteria forms a film on teeth

**Tooth Decay:** Bacteria de-mineralizes the tooth; results in cavities (caries)

**Gingivitis:** Inflammation of the gum; early stage of Periodontal disease

**Oral Health Assessment**

**Periodontal Disease:** Destruction of gum tissue

**Denture stomatitis** - Inflammation under the dentures

**Xerostomia** – Dry mouth

**Aspiration and Oral Hygiene**
- Millions of bacteria shed daily by gums, tongue, teeth
- Increases with disease, xerostomia, malnutrition, dental and periodontal disease
- Plaque re-development begins within minutes of removal; returns to original concentration within 24 hours

**Oral Health in the Elderly**
- Reduced salivary flow
- Medication effects – xerostomia, gingival overgrowth
- Functional dependence
- Cognitive impairment
- Environmental factors: limited staff knowledge, limited staffing, limited supplies, inadequate supervision
- Care-resistant behaviors – refusing, biting, agitation, etc
- Financial access – lack of dental insurance
Oral Health Assessment

Xerostomia
- Disease
- Medication effects
- Radiation treatment

RT affects volume, consistency, and pH of saliva
Manifests early in RT—week 1,2
Dose Dependent

Mucositis
- Painful inflammation and ulceration of mucosal lining

With RT, severity is dose, schedule dependent

Oral Health Assessment

Oral Mucosal Diseases
Candidiasis—fungal infection
- Burning, itching of mucosa
- Predisposing factors include impaired salivation, DM, smoking, immune compromise, antibiotic use

Oral Health Assessment

Oral Mucosal Diseases
Burning Mouth Syndrome (BMS)
- Mucosa appears normal
- Salivary hypofunction often a precipitating factor

Oral Health Assessment

Denture stomatitis
Inflammation under the dentures
Often Candida
Redness, swelling
Typically under upper denture

Oral Health Assessment

Poor Oral Health has been linked to...
- Diabetes
- Heart disease
- Stroke
- Low birth weight premature birth
- Lung disease
- Pneumonia
Oral Health Assessment

Oral Cavity Assessment

- Condition of mucosa (Dry/cracked vs. pink/moist)
- Comfort
- Lips, tongue condition (Moist, dry, coated?)
- Teeth (Clean? Dentures well fitting? Caries?)
- Saliva production (Adequate? Ropey/thick?)

Oral Health Assessment Tools

Brief Oral Health Status Examination

Oral Health Assessment Tool

Assessment of Current Oral Hygiene Care

Oral Health Assessment

To what extent can patient be independent?

- Manual dexterity
- Vision/Perception
- Positioning
- Level of alertness
- Attention to task
- Cognition

Oral Hygiene Intervention

Oropharyngeal cleaning and decontamination with an antiseptic agent

Develop and implement a comprehensive oral-hygiene program (that might include the use of an antiseptic agent) for patients in acute-care settings or residents in long-term-care facilities who are at risk for health-care-associated pneumonia

No recommendation can be made for the routine use of an oral chlorhexidine rinse

Guidelines for Prevention of Nosocomial Pneumonia – CDC, 2003

Oral Hygiene Intervention

An Oral Hygiene Program Should:

- Include assessment of oral cavity
- Include staff education
- Provide a specific protocol for staff to follow
- Provide access to an “expert” resource
- Encourage patient independence with self care; include written instructions
- Provide for sufficient tools, time


Oral Hygiene Intervention

Tools

- Toothpaste – cleansing, protective against dental caries
- Consider pedi toothbrush – smaller, softer
- Avoid lemon glycerol and hydrogen peroxide – linked with decreased saliva production and mucosal abnormalities
- Glycerin promotes bacteria growth
- Foam brush with water is least effective
Oral Hygiene Intervention

**Tools (cont)**

- Tap water, saline when toothpaste not available/appropriate
- Chlorhexidine (Peridex/Periogard): not appropriate for regular use; consider short term use for those patients with immune compromise and/or extremely poor oral hygiene
- Mouthwash – choose alcohol free

**Oral Hygiene Interventions**

**Adaptations**

- Built-up handles for toothbrush
- Flexible handle
- Power brushes
- Non-foaming toothpaste
- Floss holder

**Oral Hygiene Interventions**

**Suction toothbrushes**

- Sage Q-4 suction brush
- Vac U Brush
- Plak Vac

**Oral Hygiene Intervention**

**Frequency - CDC Recommendations:**

- AM/PM Care
- After meals, snacks

*Intubated or Trach patients: Every 2-4 hrs.*

**Oral Hygiene Intervention**

**Duration:**

- 1-2 minutes; include teeth and tongue (CDC)
- Again, disagreement in the literature but minimal acceptable would be 90 seconds (Harris, et al, 2008)
Oral Hygiene Intervention

Dentures
- Label appropriately
- Brush morning/evening; rinse
- Routine disinfection (minimum = weekly)
- Brush gums of edentulous patients

Clean the denture cup too!

Effective Oral Care...
- Reduces bacteria
- Increases appetite
- Improves oral control of bolus
- Increases alertness
- Increases salivary flow
- Reduces pneumonia incidence
- Improves overall health, immune function

So... Why Can’t We Get it Done??
- Lack of training
- Fear, Distaste
- Lack of time
- Low priority on own oral health
- Lack of accountability
- Grooming, rather than a medical intervention
- Lack of pt/resident cooperation

Care Resistant Behaviors
- Actions “invoked by a care-giving encounter...identified as the repertoire of behaviors with which persons with dementia withstand or oppose the efforts of a caregiver”
  - Increase in frequency as dementia severity increases

Care Resistant Behaviors
- Limbic system (specifically the amygdala) detects threats and initiates protective responses; cortex receives these signals and assesses them, adds context
- Dementia interferes with individual’s ability to assess, contextualize threats
- Resident is no longer able to accurately assess threats; employ CRB’s to protect themselves

Care Resistant Behaviors
- Triggers of CRB’s in dementia:
  - Physical assistance (without verbal cues)
  - Forceful insertion of swab or brush into mouth
  - Lack of praise, encouragement
  - Multi-step directions
  - Unsmiling facial expression
  - “Elderspeak”
Behavioral Strategies

Calm approach
Avoid standing over the patient, resident
Give resident something to hold (bridging)
Mirroring
Rescuing

Video of family members
Pre-recorded videos of family members encouraging participation

O’Connor, et al, 2011

Behavioral Strategies

Grabbing/Hitting
Pain?
Fearful?
Startled?

Won’t open mouth
Gentle touch to hands, then cheek
Toothpaste on lips

Biting toothbrush
Stop; don’t pull on brush
Distract with touch to arm, head

Chalmers, JM 2000

Case Review

You have just evaluated a 78 year old male with atrial fibrillation, hypertension, GERD, and recent prostate CA
Admitted 36 hours ago with respiratory distress; provided rescue BiPap initially; now O-2 via nasal cannula
Referred for swallow eval to assist with id of possible cause of pneumonia

Case Review (cont)

Chest Xray: Bilateral atelectasis near lung bases

Labs:
- Elevated white blood cell count
- Low RBC, H and H
- Low Iron
- Low Albumin
- ABGs – respiratory acidosis

Case Review (cont)

Oral exam:
- Dentition in poor condition
- Dry mouth
- Slowed oral movements but with intact range of motion

Clinical exam:
- Generally cognitively intact but with some STM impairment
- Patient reports occasional sensation of food “sticking” in throat
- Intermittent wet hoarse vocal quality noted before swallow trials; cleared spontaneously, independently with throat clear
- Prolonged oral management for solids with intermittent post-swallow residue; cleared with liquid wash
- Swallow response appears timely but difficult to assess given slowed oral management
- No cough during swallow trials
- Oxygen saturation falls from 98 to 92 over trials
Case Review (cont)

- What are the risk factors for aspiration?
- What are the risk factors for aspiration pneumonia?
- What would you recommend at this point in the patient’s care?

Case Review (cont)

Modified Barium Swallow Study:
- Slowed oral propulsion with decreased oral containment
- Prolonged dwell time – swallow typically triggered at valleculae for solids; at pyriform sinuses for liquids
- Laryngeal penetration with thin liquids; generally shallow but deeper in laryngeal vestibule for 1/5 trials which resulted in effective throat clear
- Wet vocal quality associated with deep laryngeal penetration
- Aspiration with thin liquids for 1/5 trials due to incomplete laryngeal valve closure; resulted in weak cough which did not completely clear the airway.

Case Review (cont)

- What are the risk factors for aspiration?
- Have your recommendations changed?

Diet Management

Often our first line of defense...

Texture
Liquid consistency
Free water

Texture Modification

Reduce choking risk
Compensate for impaired oral management skills

But...
Compliance issues
Reduced palatability
Nutrient density

Modified Texture Diets

Potential for Nutritional Compromise
Require addition of fluids which dilute caloric and protein density
Pureed diets often do not provide adequate amounts of protein (Dahl, et al, 2007)
Texture modified meals and snacks often fail to provide adequate calories, protein (Bannerman and McDermott, 2011)
Associated with low quality of life (Swan, et al, 2015)
Modified Texture Diets

**Palatability**
Interviews with clients eating texture modified diets:
- Lack of sensory appeal
- Food items indistinguishable from each other
- Percent reporting enjoyment of eating = 0%

Keller and Duizer, 2014

**Modified Texture Diets**

Most common reason stated for lack of adherence?

“dissatisfaction with diet modifications”

King and Ugman, 2011

**Modified Texture Diets**

From the kitchen’s perspective…
Interviews with Cooks, Nutrition Managers:
- Lack of standardized recipes
- Low visual appeal
- Lack of consistency in texture
- Lack of agreed upon terminology

Ilhamto, et al, 2014

**Modified Texture Diets**

From the kitchen’s perspective…
Interviews with Cooks, Nutrition Managers:
- Lack of standardized recipes
- Low visual appeal
- Lack of consistency in texture
- Lack of agreed upon terminology

Ilhamto, et al, 2014

**Modified Texture Diets**

**National Dysphagia Diet**
NDD I: Puree (cohesive foods; little/no chewing required)
NDD II: Mechanically Altered (cohesive semi-solids; ground meats, some chewing)
NDD III: Advanced (soft foods, more chewing required)

**Modified Texture Diets**

Move toward International Standards…
Significant variability internationally in diets, fluid categories

International Dysphagia Diet Standardization Initiative
Goal is to develop internationally standardized terminology for both texture modified foods and thickened liquids

www.IDDSI.org
Diet Modifications

In Skilled Nursing Facilities...

- 50%-70% of residents leave 25% or more of their food uneaten at most meals
- Both chart documentation of percent eaten and the MDS are notoriously inaccurate
- 60%-80% of residents have a physician or dietitian order to receive dietary supplements.
- 25% of residents experienced weight loss when research staff conducted standardized weighing procedures over time.

New Dining Practice Standards, 2011

Diet Liberalization

“Nutrition restrictions, coupled with sensory losses, may result in limited food enjoyment and compromised food intake, potentially leading to unintentional weight loss and malnutrition”

“A liberalized approach to diet prescriptions, when appropriate, can enhance both quality of life and nutritional status”

American Dietetic Association, 2005

Diet Liberalization

“Excessive modification of food and fluid consistency may unnecessarily decrease quality of life and impair nutritional status by affecting appetite and reducing intake.”

CMS State Operations Manual PP, 482.25 Tag F325 Nutrition

Dining Practice Standards

Balance the risks of aspiration against potential benefits of more liberal diets and food consistency

Look for viable alternatives

“Often, aspiration risks must be tolerated because of other, more immediate or probable risks such as nutrition or hydration”

“The risk of choking needs to be compared and weighed to the slow process of wasting away”

Dining Practice Standards

Diet and Dining should be based on...

- Individual choices re: what, where, when, with whom to eat
- Physical supports available (assistance, adapted utensils, positioning assistance)
- Timing, availability of meals, snacks
Improving Intake
121 SNF residents; 11 week RCT
Traditional supplements vs. homemade supplements (that included chocolate), group exercise, and oral care
Individuals in experimental group improved nutrition and overall function

Improving Intake
63 SNF residents in three facilities
Compared oral liquid supplements to offering food, fluid choices twice per day
Food/fluid choices:
- Improved caloric intake
- Reduced cost
- Required less staff time
- Reduced resident refusal
- Reduced waste
Simmons, et al, 2010

Food Availability - Snacks
Snacks:
Frequent dietary behavior in older adults
Provide 25% of energy intake; 14% of protein intake
So...
Can we increase food availability in residential facilities?
Making food available 24 hours per day can help to prevent and treat malnutrition and dehydration in nursing home residents

Dining Practice Standards
When a person makes “risky” decisions, the plan of care will be adjusted to honor informed choice and provide supports available to mitigate the risks.
Most professional codes of ethics require the professional to support the person/client in making their own decisions, being an active, not passive, participant in their care.
All decisions default to the person.

Thickened Liquids
Aspiration and Viscosity
190 dysphagic patients underwent VSS
Assessed thin, thick (nectar), and ultrathick (pudding) liquids
- Aspiration of thick liquids occurred less frequently than aspiration of thin
- Cup sips more likely to result in aspiration than liquids via spoon (within each consistency tested)
Kuhlemeier, et al, 2001

Thickened Liquids
Aspiration and Viscosity
132 pts underwent VFSS
Significant risk factors for thin liquid aspiration: delayed onset of laryngeal elevation, pharyngeal constriction, UES opening, peak elevation of larynx, peak pharyngeal constriction...i.e. timing issues
Risk factors for thick liquid aspiration: insufficient pharyngeal pressures; reduced laryngeal elevation; reduced duration UES opening... i.e. issues related to motility
Choi, K, et al, 2011
Thickened Liquids

Aspiration and Viscosity
FEES studies; Older adults

- Higher Penetration/Aspiration Scale scores for whole milk and 2% milk as compared to skim milk and water.
- Also, higher scores as volume increased

Butler, et al, 2011

Thickened Liquids

“Triangle Test”
Three liquids of the same flavor; two of the same thickness, one different; Participants asked to id the one that was different

- Larger differences more easily identified
- Smaller differences identified only at thinner end of the range

So...

- Are current ranges clinically relevant?
- Is there a role for “thicker thins”?


Thickened Liquids

So...Is thicker better?

Yes....for oral management disorders, delayed pharyngeal response, reduced laryngeal elevation/closure

No....for decreased pharyngeal clearance, cricopharyngeal dysfunction, tongue base weakness

Thickened Liquids

Thickener Types – Starch Thickeners
Mechanism: thickens by absorbing liquid over time
Advantages: mix easily by hand
Disadvantages: thickens slowly; adds starch to diet

Thickened Liquids

Thickener Types – Gum Thickeners
Mechanism: thickens by bonding to liquid
Advantages: thickens quickly; maintains viscosity over time
Disadvantages: difficult to mix

Thickened Liquids

Issues in Management

- Palatability; Patient Compliance
- Consistency of Consistency
- Consistency of Preparation
- Cost
- Hydration
Thickened Liquids

**Patient Compliance – Palatability**

Thickeners...

- Suppress main flavor and impart new flavor (bitter, astringent, sour)
- Result in change in texture (grainy, slick, lumpy)

*Mattia et al, 2006*

---

**Consistency of Preparation**

42 health care professionals involved in liquid modification in their facilities

- 50% prepared at least 2 of 3 nectar thick beverages in appropriate range
- 14% prepared at least 2 of 3 honey in range

*Garcia et al, 2010*

---

**Cost**

Analysis of cost of powder vs. pre-thickened liquids

- Factors included product cost, staff preparation time, and waste
- Pre-thickened liquids significantly less expensive

*Kotecki, 2010*
Thickened Liquids

Complicating Factors

Effects of Saliva
Salivary amylase has a significantly thinning effect on thickened liquids – cup contamination and within oral cavity
Effect increases with longer oral phase times
Varied with base liquid (effect decreased with increased acidity)

Hanson et al, 2012

Thickened Liquids

Hydration
Patients using thickened liquids failed to meet daily fluid requirements in a number of studies
Fluid intake improves with pre-thickened liquids


Thickeners and Satiety

- Added fiber adds to feeling of fullness
- Slower oral transit increases exposure to taste, texture receptors
- Liquids thickened with guar gum do not separate; digested more slowly
- Also slowed nutrient absorption, continuous satiety signals are generated

Cichero, J., 2013

Water and Hydration

Daily Water Turnover
- Skin (sensible and insensible)
- Respiration
- Urinary system
- GI system

Water and Hydration

Dehydration
Cells shrink (water is held in intra and extra cellular spaces)
Elements of body fluids increase in concentration
Antidiuretic hormones released – kidneys re-absorb water and return to blood supply
Water and Hydration

Dehydration – Contributing Factors

- Dysphagia
- Medications
- Limited communication
- Enteral feedings
- Vomiting/diarrhea
- Decreased fluid intake

Dehydration

Risk Factors – Elderly

- Vomiting, diarrhea
- Infection, fever
- Dependence for fluid intake
- Renal disease (fluid restriction)
- Dysphagia
- Lack of thirst

Dehydration

Signs/Symptoms

- Xerostomia
- Constipation
- Lack of urine output
- Lethargy
- Fever
- Increased HR, RR
- Thirst (inconsistently)

Dehydration

Consequences of Dehydration

- Urinary tract infection
- Renal failure
- Confusion, lethargy, weakness
- Slowed wound healing
- Constipation
- Reduced cilia movement
- Increased viscosity of mucus

But what about aspiration of water?

Aquaporins

A family of membrane proteins which transport water

Water crosses cellular membranes

Present in bronchial and alveolar epithelium

Serve as “water channels”; transport water exclusively
Frazier Water Protocol
Rehab patients who are NPO or on a dysphagic diet
Water is unrestricted prior to meals and 30 minutes after a meal
Medications given in puree, or with thickened liquid, not with water
Manner of presentation of free water may be restricted
“Aggressive oral care”
Outcomes = increased pt. satisfaction, increased hydration, no increase in pneumonia rate

Free Water
Possible Exclusion Criteria
Impulsivity
Significantly impaired cognition
Severe coughing
Active pneumonia
Poor oral hygiene despite interventions
Active oral infection

Management – Diet Issues
So...when changing texture
Consider personal preferences
Increase choices
Assistance for family re: caloric density
Increase taste intensity
Visual presentation

Possible Exclusion Criteria
Impulsivity
Significantly impaired cognition
Severe coughing
Active pneumonia
Poor oral hygiene despite interventions
Active oral infection

Thick liquids
Addressing the Palatability Issue
Trial different thickeners (starch vs. gel)
Pre-thickened liquids
Is there a role for “thicker” thins for this patient?

Myths and misconceptions:
- Tube feeding reduces aspiration risk
- Tube feeding reduces risk of pneumonia
- Tube feeding improves nutritional status

Thick Liquids
Addressing the Hydration Issue
Increased access, availability
Volume goal for fluids?
Foods with fluid
Sensory enhancements?
Water?
Tube Feeding

Not without complications...
High mortality in neurological, dementia, and cancer populations
Increased medical intervention, support
Potential for complications (reflux, pain, bleeding, infection, to name a few)
Caregiver burden
Effect on quality of life?

Non-Oral Feeding

Dementia Patients
Metabolic Issues
As dementia progresses, metabolic rate slows
Energy consumption is low
Reduced desire to eat
Tube feeding unlikely to address any of these issue

Head/Neck Cancer Patients
May lead to gastrostomy dependence, exacerbate disuse atrophy
May be under or un-used

Stroke Patients
May decrease nutritional compromise
May reduce mortality
May improve response to rehabilitation
But...
Most dysphagia in CVA patients resolves so why not consider a shorter-term solution?

Nasogastric vs. Gastrostomy tube?
Adult Patients
No difference in mortality
No difference in complication rate
But...
NG tube was less effective; increased pneumonia risk
G tube increased cost

Tube Feeding

Dementia Patients
No evidence that tube feeding
- Improves nutrition
- Increases life expectancy
- Reduces risk of pneumonia
- Improves functional status

Cochrane Review 2009

Cochrane Review 2009

Hoffer, 2006

Hoffer, et al, 2012

Madhoun, et al, 2011

Gomes, 2012 (Cochrane Review)
Tube Feeding

Aspiration Pneumonia

Increased likelihood of aspiration pneumonia associated with tube feeding, particularly when combined with the poor oral care that often accompanies non-oral feeding of institutionalized patients.

Poor Prognostic Indicators

- Age > 75
- Male gender
- Low BMI
- Diabetes mellitus
- Albumin < 3 g/dL
- COPD
- Hospitalized
- Advanced cancer

Plonk, 2005

Management of Dysphagia in Dementia Patients in Acute Care

- Potentially transient or reversible cause?
- Patient’s wishes known?
- Functioning over the last few days, weeks, months?
- Could medication effects be a contributing cause?
- Actively dying?

Smith, HA, et al, 2009

Guidelines for Practice

Consider other options:
- Hand feeding when patient is awake, alert
- Pleasure feeds
- Oral care to improve comfort
- Pain control

Tube Feeding - Alternatives

“Comfort Feeding Only”

- Alternative to PEG
- Careful hand feeding
- Specific guidelines re: cessation (e.g. agitation, lethargy)
- Goal is no longer nutrition, but comfort

Palacek, 2010

Tube Feeding – Decision Making

Surrogate decision maker satisfaction with decision to PEG pts with dementia:

- Satisfaction with decision and likelihood to re-consent decreased significantly 2 mos later
- Fewer respondents would want PEG for themselves 2 mos after placement
- Knowledge deficits among decision makers: underestimated risk of aspiration; overestimated likelihood of improved condition

Tube Feeding: Preventing Aspiration?

No change in reflux with supine vs semi-recline but significant change in likelihood of aspiration of reflux

Other risk factors: decreased LOC, malpositioned tube, vomiting, advanced age, inadequate RN staffing

No difference NG vs G tube

Metheny, N, 2002, 2006

The NPO decision

Which factors do SLPs consider?

Regardless of diagnosis:
- Amount of aspiration
- Frequency of aspiration
- History of pneumonia
- Patient wishes

Cocks and Ferreira, 2013

The NPO decision (cont)

Stroke Patients (All previous plus...)
- Time post onset
- Cognition
- Oromotor control

Dementia (all previous plus...)
- Desire to eat
- Cognition
- Family wishes

The NPO decision (cont)

MND (all previous plus...)
- Pt wishes higher on list
- Secretion management
- Dehydration

PEG placement - Trends

PEG placement increased by 38% in elderly patients between 1993 and 2003
Placement of PEG in patients with Alzheimer’s dementia doubled over the study period


PEG and Nutrition

117 SNF residents – non dysphagic, dysphagia with PEG; dysphagia with oral feeding
All dysphagia patients at risk nutritionally as compared to non-dysphagic
PEG patients received more protein, calories than oral feeding dysphagics but..

This did not result in increased skeletal mass or BMI

Kimyararov, et al, 2013
Tube Feeding
Survey of SLP’s re: dementia and TF
- 22% recognized that TF was unlikely to reduce aspiration pneumonia risk
- 50.2% understood that TF would not likely prevent an uncomfortable death
- 63% recognized that TF would not enhance QOL
- 70% would consider oral feeding despite risks

Vitale, et al, 2011

Case Review
Remember our patient?
- 78 year old; new pneumonia
- Respiratory distress; O-2 in place
- Prolonged oral propulsion; reduced oral containment
- Laryngeal penetration/aspiration with thin liquids

Case Review
What are your diet recommendations?
Is this a candidate for water? Why or why not?

Case Review
One week later...
Admitted to SNF rehab due to deconditioning
- Ambulating with assistance
- Maintaining oxygen saturation at 98% or higher on room air
- Coughing intermittently (with and without eating)

Case Review
Re-assessment via clinical swallow evaluation reveals
- Continued slowness in oral bolus management
- Occasional wet vocal quality with liquid boluses
- Dyspnea with larger solid, liquid boluses
- Oral cavity is dry but clean; teeth in poor condition
Case Review

Have your diet recommendations changed? Why or why not?

Which aspects of his condition are important in your decision making?

What aspects of his setting are important in your decision making?

Exercise

Oral/Pharyngeal Exercise

Two Perspectives
Remediation is best accomplished at the task level (practice speech to improve speech; swallowing to improve swallowing).

Underlying impairment in neuromuscular function contributes to the disability and should be addressed.

Oral/Pharyngeal Exercise

What happens when we move our muscles?
1. Intent to move – sent from CNS to peripheral system via “action potentials”
2. Action potential (or impulse) is transmitted across the neuromuscular junction via release of acetylcholine (a neurotransmitter)
3. Action potential (electrochemical events) transmitted to muscle
4. Triggers a chemical reaction within muscle fiber that results in muscle contraction

Oral/Pharyngeal Exercise

Motor Unit Concepts
Motor Unit = the motoneuron and the fibers it innervates
Every muscle fiber is innervated by a single motoneuron; some motoneurons innervate many fibers
Motor units are “recruited” by the motor planning and programming system during specific movements
Efficiency of recruitment increases with practice

Oral/Pharyngeal Exercise

Type I fibers
- Small
- Slow contraction time
- High fatigue resistance; better for low force, high endurance activities
- Produce less force

Type II fibers
- Large
- Fast contraction time
- Fatigues more quickly; better for force generation
- Quick forceful movements
- More affected by deconditioning
Oral/Pharyngeal Exercise

Motor Units
Head, neck, laryngeal musculature also contain hybrid fibers (unlike skeletal musculature)
Specialized for speed rather than force
Multiple functions?
Reason for fatigue resistance?

Exercise...
Endurance exercises increase the number of Type I fibers
Resistance exercises increase the number of Type II fibers
Voluntary movements recruit both (Type I first, then Type II)

Intensity: Load – must exceed the typical demand
Exercise Frequency - # of training sessions per unit of time
Progression: Systematic increase in resistance, contraction velocity, duration

Strength – force generating capacity of a muscle
Endurance – ability to continually produce force over a period of time
Power – combination of strength and speed; ability to exert force quickly
Speed – maximal velocity

Targets?
Skill – acquisition and/or refinement of movement sequences – (via combinations of motor sequences)
Strength – Increased force capacity – (via resistance)
Endurance – Capacity for continuous motor output – (via repetition)

Specificity – Exercise does not generalize
Target the muscles exhibiting the weakness
Target movements related to feeding, swallowing
Motor control for speech vs. non-speech mechanisms have different neural controls – some overlap early in development; fully differentiated by two years
Oral/Pharyngeal Exercise

**Specificity** – Lingual Musculature

Healthy Adult Subjects – 3 sessions/week x 4 weeks

Strength training, endurance training, power training, speed training groups

Performance increased for each particular training variable and not in the other areas

Speed training was the only exception – no significant improvement on any variable

Clark, 2012

Oral-Pharyngeal Exercise

**Specificity**

But...

Is some transference possible?

Unilateral strength training in upper and lower extremities has been shown to improve strength in the opposite, untrained limb


Oral/Pharyngeal Exercise

**Detraining**

Occurs more rapidly than training

Atrophy

Muscle fiber shift to fast fatiguing (type II)

Neuroplasticity implications

Less force generating capacity

Weaker, slower, less efficient movements

Oral/Pharyngeal Exercise

**Disuse Atrophy**

What happens to the muscles?

- Decreased size, mass
- Increase in fatty infiltrates
- Reduced range of motion
- Reduced efficiency of recruitment

Oral/Pharyngeal Exercise

**Neuroplasticity**

Increased synthesis of proteins

Synaptogenesis

Cortical map re-organization

Oral/Pharyngeal Therapy

**Principles of Neuroplasticity:**

*Requirements*

Rehabilitation and...

An area of healthy cortex
Oral/Pharyngeal Therapy

**Principles of Neuroplasticity:**

- **Timing** – plasticity is different at different times post-injury but in general...
  - Earlier is better than later
  - Protracted rather than brief
  - Continuous rather than intermittent

---

Oral/Pharyngeal Exercise

**Principles of Neuroplasticity**

- Reversibility (Use it or Lose it)
- Repetition (Use it and Improve it)
- Specificity
- Variety (multiple planes facilitate recruitment)
- Intensity

---

Oral/Pharyngeal Exercise

**Lingual Strengthening**

Iowa Oral Performance Instrument
Progressive resistance
As isometric pressure increased, oral pressures during swallowing also improved
Increased bolus transit, decreased aspiration in CVA patients


www.IOPImedical.com

---

Oral/Pharyngeal Exercise

**Swallow Strong Device**

Linguo strengthening device which targets specific tongue regions
Visual biofeedback

www.swallowsolutions.com

---

Oral/Pharyngeal Exercise

**Swallow Strong**

8 week program that included device-facilitated exercise, nutritional counseling, respiratory function monitoring
- Increased lingual pressures
- Improved reported QOL; decreased reported effort
- Improved FOIS scores
- Decreased pna hospitalizations post program


---

Oral/Pharyngeal Exercise

**Effortful Swallow**

With or without bolus
Increased pressure generation between tongue and palate; between tongue base and pharyngeal wall, in velopharyngeal region, and in UES region
Emphasize tongue to palate squeeze in instructions for increased pressures (Huckabee et al, 2007).
Progression via increasing bolus size? Viscosity?
Oral/Pharyngeal Exercise

Mendolsohn Maneuver
With or without bolus
Increased suprahypoid muscular activity (vertical > anterior)

Masako Maneuver
Increased muscular load but no “immediate increase” in pharyngeal pressures; may place laryngeal vestibule in less protected position; may strengthen pharyngeal constrictors

But... Resulted in decreased pharyngeal pressures and reduced UES opening in one study

Kahrilas, 1991; Fujiu, 1996; Lazarus, 2002; Doeltgen, 2011;

Oral/Pharyngeal Exercise

Shaker Head Lift

Results in...
• Increased hyolaryngeal excursion
• Improved UES opening
• Increased strength in suprahypoid musculature
• Improved bolus clearance

Shaker, 2002
Mepani, et al, 2009

Oral/Pharyngeal Exercise

Chin Tuck Against Resistance

Modification of Shaker
• Seated position
• Compression of an inflatable ball between chin and sternum

Compared to Shaker...
• Greater sEMG activation of supra-hyoid muscles
• Participants reported increased comfort


Oral/Pharyngeal Exercise

Jaw Opening Exercises

Goal = strengthening suprahypoid muscles
Mylohyoid, anterior belly of digastric and geniohyoid are involved in jaw lowering AND hyoid excursion

Subjects opened jaw to max extent, held 10 sec x 10 reps x 2 sets daily

Hyoid excursion, UES opening measured via VFSS
Significant improvements in vertical hyoid movement and in UES opening; no change in forward movement

Wada, et al, 2012

Oral/Pharyngeal Exercise

Effortful Pitch Glide

Pitch Glide to highest pitch, then sustain highest pitch with effort

MRI of EPG and swallowing revealed similar...
• Anterior hyoid movement
• Hyolaryngeal approximation
• Laryngeal elevation
• Pharyngeal wall medialization
• Pharyngeal shortening

Miloro, et al, 2014
“Pharygocise”
Divided HNC patients into three groups: usual care, standardized sham, pharyngocise (high intensity treatment)
“Pharyngocise” Group:
Greater muscle preservation (genioglossus, mylohyoid, hyoglossus)
Less deterioration in functional swallowing (per MASA)
Less decline in mouth opening
Preservation of salivary flow
Preservation of taste acuity
No differences in aspiration frequency or weight loss measures.

Oral/Pharyngeal Exercise
Lee Silverman Voice Treatment (LSVT®)
Shown to improve vocal intensity, speech intelligibility in Parkinson’s Disease
Trains high phonatory effort
60 min sessions 4x/week for 4 weeks with daily home exercise
Improvements in lingual lateralization, oral transit time, oral clearance, pharyngeal clearance

Oral/Pharyngeal Exercise
McNeil Dysphagia Therapy Program
Chronic Dysphagia Patients
Intensive exercise-based therapy
Multiple swallows/session
Preset food hierarchy — ice chips through foods of patient’s preference without restriction
At each food level, volume increased, then advance to next food level

McNeill Dysphagia Program
Results:
Improved MASA scores
Improved FOIS scores
Weight gain
Improved patient perception of swallowing function
Improved hyolaryngeal elevation; lingual-palatal and pharyngeal pressures
Carnaby-Mann and Crary, 2010; Crary et al, 2012

Frailty
What is Frailty?
No agreed upon definition.....
Accumulation of abnormalities
Reduced potential for compensation
May manifest as shrinking/weight loss, weakness, fatigue/exhaustion, reduced mobility, reduced physical activity...

Frailty
Results in....
- Increased fall risk
- Immune compromise
- Low reserve
- Higher degree of disability
- Increased morbidity and mortality
Frailty and Dysphagia

Growing evidence to suggest that frailty associated with
- Dysphagia
- Aspiration
- Malnutrition


Assessed Swallowing and Handgrip strength in cardiac surgery patients intubated >12 hours (n=14)

Majority of patients (12/14) had low handgrip strength...

Of those...
- 50% deep laryngeal penetration
- 38% silent aspiration
- Diet modifications for 80% of patients

Hathaway, et al 2015

Falls

One-third of people 65 and older fall each year.
Every 29 minutes an older adult dies from a fall.
1 out of 5 falls causes a serious injury such as a head trauma or fracture.
Over 2 million older adults are treated in emergency departments for nonfatal fall injuries each year.
Direct medical costs for fall injuries total over $28 billion annually. Hospital costs account for two-thirds of the total.

Risk Factors for Falls

INTRINSIC
- Advanced age
- Previous falls
- Muscle weakness
- Gait/Balance problems
- Reduced vision
- Postural hypotension
- Chronic conditions (arthritis, PD, CVA, dementia)
- Fear of falling

EXTRINSIC
- Lack of stair handrails
- Lack of grab bars – bathroom
- Dim lighting/glare
- Obstacles/tripping hazards
- Slippery/Uneven surfaces
- Improper use of assistive device
- Psychoactive medications

Hip FX population – Dysphagia Prevalence

Love, et al, 2013:
Dysphagia Rate = 34%
Risk factors = pre-existing neuro and resp co-morbidities, delirium, age, living in a residential facility prior to admission

Meals, et al, 2015:
- Dysphagia rate = 42%
- ASA III and IV status were predictors of dysphagia
Muscle Tone

Defined as...
- Resistance of a muscle to passive stretch
- Muscle spindles within the muscle respond to the lengthening of the stretch with a "stretch reflex" which causes muscle to contract (i.e. the perceived resistance)
- Slight resistance = normal tone
- Function = Movement, stabilization
- CNS continually adjusting tone as needed

Muscle Tone

Abnormal Tone

Results in difficulty with
- Adjusting direction of movements
- Velocity of movements
- Symmetry of movements

Muscle Tone

Oral Musculature
- Difficult to assess in Oral Mechanism
- Few OM muscles available for passive stretch
- Overlapping muscle groups in oral, pharyngeal cavities
- Only masseters exhibit stretch reflex

Muscle Tone – Interventions

Stretching
- Limited evidence to support (Cochrane review); may be applicable to jaw

Vibration
- Some evidence to support in spasticity

Tapping
- No evidence

Icing
- Moderate support overall; improved jaw opening in children with CP

Exercise

Expiratory Muscle Strength Training
- Calibrated one way valve; increases load to expiratory muscles
- In order to open the valve, user must produce muscle contraction
- Resulted in decreased aspiration, increased cough in PD patients

EMST

Procedure:
- Patient blows into device that provides resistance
- 70-80% of max pressure
- Spirometer to measure max
- Nose clip; cheek/lip press (to maximize flow through mouth)
- 25 trials/day; 5 groups of 5; 5 days/week
EMST

Contra-indicated with untreated htn, recent surgery
May increase VP activity (duration of closure; range of soft palate)
Goal originally to increase resp musc for cough, tolerance for swallow apnea

EMST vs IMST

EMST improves non-ventilatory functions – cough, swallow, speech
IMST improves ventilatory capacity

EMST

Outcomes
Improved PA scores
SWAL-QOL improved in both EMST and control groups but greater in EMST group
Improved cough
Increased respiratory pressures
Results highlight the importance of the respiratory system to airway protection

EMST/IMST by Population

MS – Increased cough effectiveness in patients with moderate levels of disability (EMST)
Elderly – Improved cough pressures, effectiveness (EMST)
PD – Improved swallow safety (changes in PAS scores); improved hyolaryngeal movement; improved cough effectiveness (EMST)
Ventilated patients – Increased inspiratory pressures; increased weaning success (IMST)
COPD – Decreased dyspnea; reduced WOB (EMST)

Neuromuscular Electrical Stimulation

Electrical current creates a contraction by depolarizing the nerves responsible for innervation of the muscle or specific muscle fibers
Transcutaneous (surface) or percutaneous (intramuscular, intrinsic)

Estim Basics
Estim Basics

Surface estim
Applied with two bipolar electrodes adhered to skin surface that overlays the muscles
Motor point (where nerve enters muscle) stimulation = > contractions
Increased current = stim to deeper structures, muscles
Current strength diminishes as it goes deeper – specificity, then is difficult to achieve

Estim Basics

Estim activates only those neurons it contacts
Current = amt of electron flow; flows along path of least resistance; skin, fat, air have high impedance, low flow
Voltage doesn’t predict current flow because of differences in different mediums

Estim Basics

Muscle fiber stimulation results in acetylcholine release at neuromuscular junction
So… estim not appropriate for patients who don’t have normal acetylcholine mechanisms (e.g. MG)

Estim Basics

Stimulates muscles closest to the surface first and with the most strength
In order to reach deeper muscles, must stimulate surface muscles too

Estim Basics

Submental placement:
• Platysma
• Anterior belly digastric
• Mylohyoid (raises hyoid)
• Geniohyoid (anterior hyoid movement)

Throat placement:
• Platysma
• Sternohyoid (lowers hyoid)
• Omohyoid (lateral hyoid movement)
• Thyrohyoid (laryngeal elevation)

Estim

The controversy...
But...
Healthy subjects (n=16) using effortful swallow with estim evidenced increased hyoid elevation
So...
Patients who can overcome the downward pull on the hyoid may be the patients who benefit from estim
**E-Stim**

**What do we know...?**
- Decreased pain, xerostomia after head/neck CA
- Can result in hyoid elevation when combined with effortful swallow
- Generally well-tolerated
- *Works most effectively when paired with other swallow exercise, maneuvers*

**What do we need to know...?**
- What is the optimal dosage and should that vary with different population?
- What is optimal timing of NMES use in recovery process?
- Role in pediatric intervention?
- Which exercises, maneuvers benefit most from NMES adjunct?
- Does NMES have a role to play in sensory stimulation of the swallow response?

**Candidates**
- Intact sensory/motor nerves
- Must be able to access muscle fibers (peripheral neuropathy, e.g. would not be a candidate)
- Must be able to initiate a swallow

**Case Review**

Remember our patient?
- 78 years old; recovering from recent pneumonia
- Oral/pharyngeal dysphagia
- Is he a candidate for exercise?
- Why or why not?

**If you choose to utilize exercise as a modality for this patient, which exercises might be appropriate?**

**Sensory interventions**
Sensory Input and Swallowing

Nucleus Tractus Solitarius

- Primary sensory processor
- Important for swallow trigger

Nucleus Ambiguus

- Innervation of soft palate, pharynx, larynx and upper esophagus

Sensory Input and Swallowing

- Sensory nerve fibers synapse in nuclei tractus solaris (NTS)
- Neurons from the NTS project to the nuclei ambiguous (NA)
- NA activates motor neuron to floor of mouth; controls tongue, hyoid

Sensory Input and Swallowing

- Taste perception and swallow response share pathways...

And...

- Sensory information is utilized to shape swallow response

So... Is there a role for sensory stimulation in improving swallow response?

The Senses...

Audition
Vision
Proprioception
Olfaction (ortho vs retronasal)
Gustation
Oral chemesthesis – perception of chemical molecules (e.g. citric acid, carbon dioxide, cooling, heat)

Vision

Impacts anticipation
Identification/misidentification of taste
Sip size
Color can...
Increase ratings of flavor intensity
Change thresholds for taste detection
Change accuracy of flavor identification
**Proprioception**

Body awareness; interpretation of interaction with environment
Important in self-feeding

Impacts anticipatory cues

**Olfaction (Smell)**

Orthonasal olfaction = “sniff”; perceived as more intense than retronasal

But...

Retronasal olfaction – important to appreciation of flavor – chewing increases aroma...implications for texture modified diet??

And...

Retronasal stimulation resulted in higher swallow frequency

Welge-Lüssen, et al, 2009

**Olfaction**

**Smell in Aging:**

Loss begins as early as 40 years in some; continued gradual loss

70% loss by age 70

May account for reported change in taste in elderly

Pelletier, 2002

**Chemesthesis**

Chemical molecules activate cells with Transient Receptor Potential (TRP) channels

Perception of heat, irritation, cooling

**Gustation (Taste)**

Redundant innervation (VII, IX, X)

Triggers digestion

Enhances satiation

Important to food acceptance, preference

**Taste**

Remember this?

Well, forget it!
**Taste Development**

- Non-tasters vs. Super Tasters
- Females > males at extremes of taste distribution
- Picky eaters at extremes of taste distribution

**Taste and Aging**

**Taste loss?**
Bitter most affected but *little difference* as we age

*What does happen* is loss of smell and retronasal olfaction
Also, diminished hunger, thirst; diminished sensory specific satiety

**Anticipatory Cues**

*Include...*
- Hearing
- Vision
- Cognition (recall of previous experiences; attention to current one)
- Motor (utensil use)

Impact feeding/swallowing behaviors including sip size, oral movements, onset of swallow apnea...PRIOR TO actual oral sensation

What does this mean for dependent feeders? MBS subjects? Adults with sensory loss?

**So...what does this mean for intervention?**

Can we manipulate the sensory properties of the bolus to enhance or improve various aspects of swallow response?

**Olfaction**

*Olfactory stimulation*
Black pepper oil; inhaled one minute before eating
- Increased swallow response in elderly subjects
- Increased swallow response and increased volume of intake in pediatric subjects

Olfaction

Black Pepper Oil
Improved swallow response times

Following one month trial...
Increased blood serum concentration of substance P (which appears to be responsible for innervation to pharynx/larynx)

Ebihara, et al, 2006

Olfactory stimulation

Lemon concentrate – odor + taste
Resulted in increased motor evoked potentials (via TMS) for up to 90 minutes

Wahab, et al, 2010

Olfaction

But...
Lavender oil did not have the same effects...

Is the irritant (trigeminal stimulation) more important than the odor (olfactory stimulation)?

Olfaction

Transitioning infants to oral feeding
Exposure to breast milk odor...
Helps infants to initiate sucking
Reduces length of hospitalization for premature infants
Facilitates transition to oral feeding

Iranmanesh, et al, 2015

Suggestions from Fine Dining...

Olfactory enhanced plate-ware
Olfactory enhanced cutlery
Atomizers

“Aromatic dining...designing for the dominant sense”
Spence and Youssef, 2015

Taste Stimulation

Taste Stimulation – the Theories...
Increased taste intensity heighten nerve activation in NTS
Results in...
Increased stimulation of motor neurons in NA responsible for swallow response
OR...
Cortical facilitation (via trigeminal afferent pathways)
Taste Stimulation

**Sour**
(50/50 barium and lemon juice)

*Resulted in...*

- Increased swallow response
- Decreased aspiration

*But...*

- Low palatability


---

**Taste Stimulation**

**Sour**

Citric acid; healthy subjects

- Increased anterior lingual/palatal pressures
- Pressure increased with increased taste intensity

Pelletier and Steele, 2004

---

**Taste Stimulation**

**Sour**

80 healthy female subjects

High intensity sour boluses elicited higher amplitudes of anterior tongue pressure

This effect increased in *super tasters*

Pelletier and Steele, 2014

---

**Taste Stimulation**

**Sour**

Patients with dysphagia

Sour and Sweet/Sour

- Sour reduced aspiration but was not palatable
- Sweet/Sour more palatable but no effect on swallowing

Pelletier and Lawless, 2003

---

**Taste Stimulation**

**Sour**

Head/Neck Cancer patients and healthy controls

Sour, sweet, salty liquid boluses

Sour shortened pharyngeal transit times in both healthy controls and HNC patients

So...

Sour may be effective even in patients with peripheral sensory impairment

Pauloski, et al, 2013

---

**Taste Stimulation**

**Sour**

Impact on swallow musculature?

- Stronger muscle contractions (Palmer, 2005; Ding, 2003; Leow, 2007)
- Activation of swallow musculature more closely coordinated (Palmer, 2005)
- Increased sEMG activity (Miura, 2009)

But...

*Not with larger volumes* (Hamdy, 2003)
**Taste Stimulation**

**High/Low Taste Concentrations**

80 healthy women; age, genetic taste status evenly distributed

Pure taste stimuli (no aroma) – sweet, sour, bitter, salt in high and low concentrations

Measured tongue-palate pressure during swallows

• Higher concentrations elicited stronger swallow pressures in general
• Effect was heightened in super tasters
• Salt elicited stronger swallow pressures in non-tasters

So... *perceived taste intensity is an issue*  

Nagy, et al, 2014

---

**Chemesthesis**

Added piperine (alkaloid found in pepper) to boluses during VFSS

**Piperine...**

Improved swallows (as measured by PAS)
Resulted in faster laryngeal vestibule closure

Rofes, et al, 2013

---

**Chemesthesis**

**Capsaicin and Menthol**

Institutionalized elderly subjects
Ingestion of above trigeminal agents prior to water swallows
Improved swallow response as evidenced by increased sEMG activity

Ebihara, et al, 2005; Ebihara, 2006

---

**Chemesthesis**

**Carbonation Effects**

In patients with dysphagia...compared carbonated thin with nectar thick
No effects on transit times
Did result in lower P-A scores (decreased asp)


---

**Chemesthesis**

**Carbonation**

Healthy young and elderly subjects (hospitalized but no dysphagia)
No differences in young subjects
In elderly...

• More timely swallows for carbonation
• More timely swallows for water *following* carbonation

Morishita, et al 2014
Chemesthesis

**Carbonation – Pediatric subjects**

24 children (5-18 yrs) with neuro dx
Excluded children with dysphagia prior to neuro event
 Compared non-carbonated thin to carbonated thin

*With carbonation*
Significantly less penetration and aspiration
No significant difference in residue

Lundine and Bates, 2015

---

**Chemesthesis**

Carbonation

39 healthy subjects
Carbonated vs non in hot, cold, and room temp beverages
Normal paced swallows; command to swallow as fast as possible; swallows within 150 ms time window
Measured swallow response time

*Carbonation improved swallow response in challenged situations*


---

**Chemesthesis**

In that same study....

*Cold* improved swallow response in normal paced situation

Is there a place for thermal stimulation?

---

**Thermal Stimulation**

Stimulation to faucial pillars
Conflicting data...

*Immediate effects:*
Improved swallow response (Logemann, 1983; Rosenbek, 1996)

*Or not:*
No improvement (Rosenbek, 1991)

*Or sometimes:*
Improvement with paste but not liquids (Lazzara, 1986)

---

**Thermal Stimulation**

Cold and Hot Boluses
Healthy subjects
Water swallows of varying volumes; sEMG measures
With cold (8-10 degrees C) and hot (58-60 degrees C):
*More timely swallow responses*
*Faster pharyngeal transit*


---

**Mixed Input**

*Carbonation Effects*

Increased lingual pressure (club soda)
Increased further with carbonation + strong taste (ginger brew)
Cumulative effect of sensory input?

Krival and Bates, 2012
Mixed Input

- Carbonation perceived to be more intense at lower temperatures

_Could there be a cumulative effect of cold + carbonation on swallowing?

Newton Yau, and McDaniel, 1991

Mixed Input?

_Cold_ may amplify effects of _sour_ (Cola, et al, 2010)

_Olfaction_ plus _gustatory_ stimulation (lemon smell + sour taste) improved function of submental swallow muscles when individual inputs did not (Wahab, et al, 2010)

Flavor Enhancement

**Flavor enhancers:**
Mixtures of odorous molecules that are extracted from natural products or synthesized (e.g. monosodium glutamate).

*Intensifies* the flavor of food rather than increasing taste and smell

May improve intake and immune function in elderly

Shiffmann, 2000

Sensory Stimulation

**Implications for Dietary Modifications**
Flavor enhancement, amplification
Aroma enhancement
Variety in taste, texture (sensory-specific satiety)
Visual presentation of foods (color implications)

Anticipatory Cues

*Can we facilitate anticipation? How do we maximize pre-oral input?*

- Auditory, visual cues
- Enhanced smell
- Assisted feeding vs. dependent feeding
- Hand over hand assist

Anticipatory Cues

**Environment:**
- Increased lighting; use of contrasting colors
- Appropriate assistive devices
- Music at mealtimes
- Appropriate seating, positioning
- Family style dining – increases intake
- Socialization
- Honoring prior mealtime practices and foods
Compensatory Strategies

Compensations

What’s your goal?
- Improve breathing/swallow coordination?
- Improve airway protection?
- Improve swallow response?
- Improve pharyngeal transit?

Compensations – Breathing/Swallow Coordination
- Comfortable, upright position
- Impose breaks; slow pace
- Energy conservation
- Small bites, sips
- Bolus hold – may stabilize breathing; increase post-swallow exhalation
- Avoid breath-holding maneuvers

Compensations – Airway Protection
- Voluntary Swallow
- Effortful Swallow
- Chin-tuck head position
- Manipulation of bolus size; slow pace
- Supra-glottic/Super supra-glottic swallow (HNC > Neuro)

Compensations – Airway Protection

Chin Down Head Position
Reduces aspiration by reducing space between tongue base and pharyngeal wall, epiglottis and arytenoid; narrows laryngeal vestibule
And… requires more effort
But…
Positions airway below pyriform sinuses – may increase aspiration of post-swallow residue

Compensations – Swallow Response
- Cold
- High flavor
- Carbonation
Compensations – Pharyngeal Transit

- Effortful Swallow
- Multiple swallows
- Manipulation of bolus size
- Pacing

Case Review

Remember our patient?

- 78 year old; recovering from pneumonia
- Oral/pharyngeal dysphagia

Which compensatory strategies would be appropriate for him?

- Is he a candidate for sensory interventions? Why or why not?

Dysphagia Treatment - Future Directions

Exercise – dosing, protocols
Pre-chemo, radiation exercise
Sensory stimulation techniques (taste, volume, texture); modification of sensory thresholds
E-stim – protocols for surface NMES; intramuscular techniques, implants for intractable dysphagia
Long term study of thickened liquids in re: pulmonary clearance, pneumonia risk
Cough

“Thats all Folks!”