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# Back-To-Basics on Videofluoroscopic Swallow Study: Safety & Efficiency and the Underlying Structure & Physiology

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## Videofluoroscopic Swallow Study (VFSS) aka Modified Barium Swallow Study (MBSS)

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## Learner Outcomes
*Participants will be able to:*

1. Describe how to set up and customize an exam and optimize radiation safety during assessment of the structure and function of the swallow.
2. Identify the underlying structural deficit and/or pathophysiology of the dysphagia based on analysis of the exam findings related to safety (penetration/aspiration) and efficiency (residue).
3. List appropriate recommendations (for diet, strategies, referrals, exercises, etc) that correspond to the deficits noted in the exam.

Here is the problem & Here is what we could try

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## In Other Words - Course Goals are to:

- Cite what we can and *cannot* learn from a Clinical Bedside Swallowing Evaluation (CBSE)
- Describe **why** we need an instrumental examination
- Describe **principles** of the Videofluoroscopic Swallowing Study (VFSS)
- Conduct a **safe but thorough** exam minimizing radiation exposure to yourself and your patient.
- Be able to explain normal and abnormal structure and function of the swallow based in anatomy and physiology rather than describing what the bolus does.
- Explain why it is **not** all about aspiration.
- Complete a thorough exam from the point of the interview and hypothesis formation to analysis and recommendations.

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# Introduction

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## Videofluoroscopy (basics)

Slide courtesy of Dr Ianessa Humbert & Critical Thinking in Dysphagia Management/#CTDM Course

**structures**

- hyoid bone
- larynx
- UES
- velum
- tongue
- pharynx
- jaw

**swallowing events**

- lingual bolus forming
- velar elevation
- lingual propulsion
- jaw positioning
- laryngeal vestibule closure
- UES opening
- hyoid excursion
- laryngeal excursion
- pharyngeal shortening
- pharyngeal constriction

**bolus flow events**

- aspiration
- reflux
- nasal regurgitation
- penetration
- anterior bolus loss

*"Incomplete was your training."*

*Aspiration alone "matters not."*

*"You already know that which you need."*

*Find the FORCE (physiology) behind the problem that see you*

So if you **ask good questions**, test and **analyze** well, then, fix it we can.

Get started, we will…

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## Wisdom from Bonnie Martin-Harris

Dr. Bonnie Martin-Harris, PhD, CCC-SLP, BCS-S, FASHA

*Is the VFSS the **Gold-Standard?***

"One cannot dichotomize."

"It depends on the nature of the question." (Martin-Harris, DRS 2015)

The VFSS is "much more than penetration and aspiration, even though that is what people obsess about!" (Martin-Harris, 2016b)

"Think Backwards!"
Find the underlying action or impairment.
What is the peripheral and central control?
(Martin-Harris, 2016b)

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## Wisdom from ASHA

**Guidelines** for Speech-Language Pathologists Performing Videofluoroscopic Swallowing Studies
ASHA Special Interest Division 13, Swallowing and Swallowing Disorders (Dysphagia)
http://www.asha.org/policy/GL2004-00050.htm

**Knowledge and Skills** Needed by Speech-Language Pathologists Performing Videofluoroscopic Swallowing Studies
ASHA Special Interest Division 13, Swallowing and Swallowing Disorders
http://www.asha.org/policy/KS2004-00076.htm

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## What are we testing?

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## Dysphagia = difficulty swallowing (oral, pharyngeal, esophageal stages)

- Dysphagia is NOT a disease in-and-of-itself.
- Dysphagia is a **symptom** of many different diseases, disorders, and structural/functional abnormalities. Across **many systems.**
- Requires a multidisciplinary or transdisciplinary approach with every patient.
- Instrumental evaluations play a key role in differential diagnosis.

SLPs do not diagnose, but our thoughtful evaluations play a huge role in helping the medical team come to a diagnosis!

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## What can cause dysphagia?

- **Neurologic** (i.e., ALS, Parkinsons, MS, Dementia, Stroke. Hypo vs Hypertonic)
- **Respiratory** (i.e., patient with COPD - Chronic Obstructive Pulmonary Disease - having difficulty coordinating breathing & swallowing)
- **Gastrointestinal** (i.e., GERD, achalasia, esophageal dysmotility, stricture, delayed gastric emptying - Post-prandial aspiration?)
- **Otolaryngology** (i.e., Head and Neck Cancer/CA, early & late effects of radiation/chemotherapy)
- **Renal** (i.e., patients with end-stage renal disease requiring hemodialysis often miss meals, have poor appetite/intake, leading to generalized weakness)
- **Cardiovascular** (i.e., weakness after MI - Myocardial Infarction/heart attack; cardiac surgeries, which may affect the RLN that innervates the vocal cords)
    - **General & Orthopedic** surgeries (i.e., Thyroid surgeries, ACDF - Anterior Cervical Discectomy and Fusion)
        - **Critical illness** & **intensive care** treatments (i.e., infection, sepsis, or *iatrogenic* causes like intubation/tracheostomy/meds)
            - **Sarcopenia** - loss of skeletal muscle, atrophy, frailty. Disuse can cause dysphagia. Use it OR Lose it!

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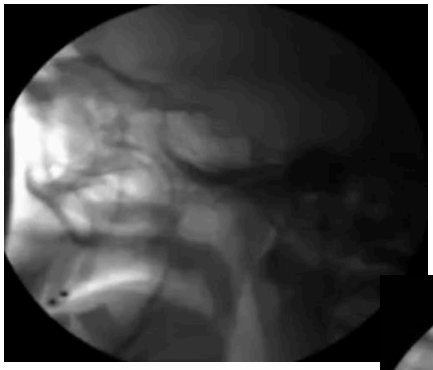
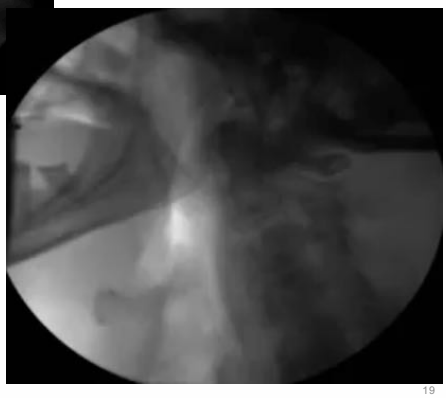


**ACDF patient:**
SLP evaluation was an integral part of the differential diagnosis

***What's wrong?***

**Post revision & hardware removal:**
increased pre-vertebral edema & cricopharyngeal prominence



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## Criteria for Referral to SLP

- Patient/Caregiver report of difficulty swallowing food, liquid, pills, saliva.
- History of dysphagia, pneumonia, associated diagnoses

  Examples: Dementia/Alzheimers, Parkinson's (PD), Multiple Sclerosis (MS), Stroke (CVA), Head & Neck Cancer (CA) with radiation (XRT or IMRT) and chemotherapy
- *Potential* overt signs of aspiration – coughing during/after taking liquids, solids, and/or pills, choking, throat clearing, congestion after meal, wet-gurgly vocal quality when drinking liquids or with secretions.
- Drooling, spillage of liquid out of mouth, pocketing of food in the mouth
  - More subtle signs of dysphagia:
    - Change in eating amount, rate, appetite
    - Unexplained weight loss
    - Shortness of breath with exertion of eating
    - Unexplained exacerbation of respiratory disease
    - Fatigue with eating a meal
    - Low grade temps & Leukocytosis. ? infection source.

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## What Are We Expecting?

We form a hypothesis based on:
- thorough chart review,
- interview with patient and caregivers, and
- clinical/bedside swallowing evaluation (may not have with outpatients).

The instrumental evaluation helps us confirm or negate our hypotheses.

Detective Work!

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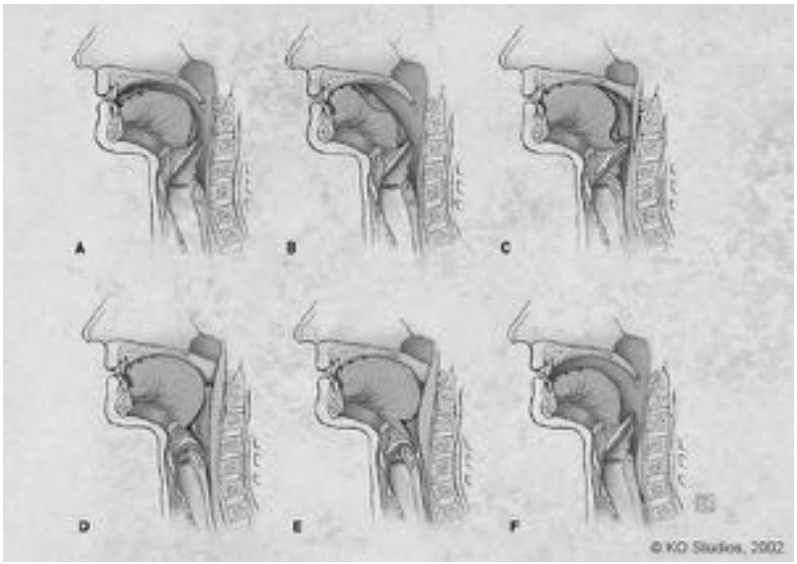
## What we cannot know from a Clinical Swallowing Exam (CSE)

- Bolus flow characteristics
- Pharyngeal & laryngeal anatomy and physiology
- Hyolaryngeal excursion (neck palpation at bedside is not accurate)
- Pharyngeal delay and spillage of bolus during a delay
- Post-swallow residue
- Swallow physiology. Therefore, we **cannot confidently** make swallow strategy or exercise recommendations based on a CSE (i.e., Chin Tuck or double swallow; or exercises like the Masako or Shaker).
- The following are NOT supported in research as predictors/signs of aspiration: absent gag, changes in oxygen saturation, watering eyes, sneezing, and nasal drainage. Even the ***presence of a wet voice and cough*** can give you a false positive/false negative.

(Leder, Suiter & Warner, 2014, November)

**Bedside exam might tell you about aspiration risk, but the instrumental defines the dysphagia.** 22

## What we see on VFSS

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# Break it down!

**4 Interacting Phases:**

What we see on Video

**1.Oral Preparatory Phase**
**2.Oral Phase**
**3.Pharyngeal Phase**
**4.Esophageal Phase**

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## Break it down: Oral Preparatory

**What:**

- **Enjoyment** of eating.
- Taking in liquid/food. Breaking down the food and forming a ball (bolus). Getting the food "**Swallow Ready**." It is within normal limits to drop solids to the valleculae & pyriforms.
- Controlling liquid. **Bolus containment**.

**How:**

- Lip closure, facial tone, anterior 2/3 taste (Facial Nerve VII)
- Rotary jaw movement & anterior sensation (Trigeminal V)
- Tongue strength & movement (Hypoglossal XII)
  - Soft palate pulled forward initially to prevent spillage of liquid into pharynx. (Trigeminal, but mostly Vagus X)
    - Taste & Sensation in posterior 1/3rd of oral cavity (Glossopharyngeal IX)

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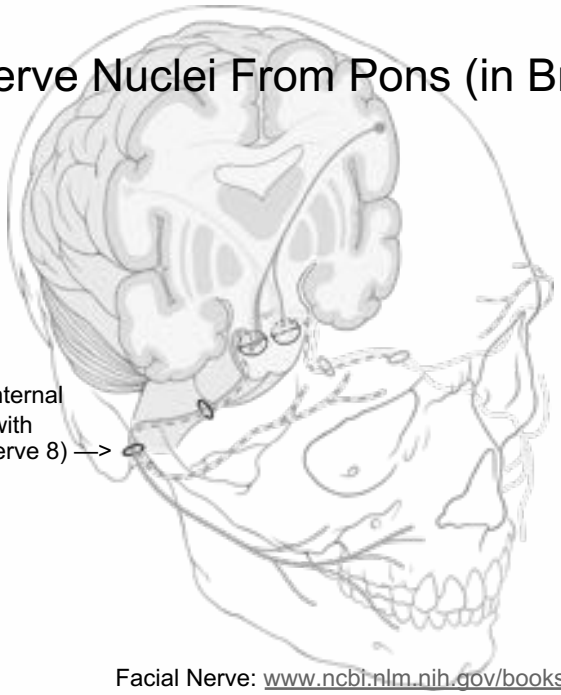
## Facial Nerve Nuclei From Pons (in Brainstem)



Travels through Internal Auditory Meatus with CN VIII (cranial nerve 8) —>

Facial Nerve: www.ncbi.nlm.nih.gov/books/NBK385/ 26

## Break it down: Oral Phase

**What:**

- **Upward & Backward movement of the tongue** to collect and transport the bolus posteriorly. Stripping off hard palate.
- **Propel the bolus posteriorly**.
- Propel the bolus past the faucial pillars and into the pharynx.
- When the bolus reaches *approximately* the **ramus of the mandible**, the **pharyngeal swallow is triggered**.
- See Martin-Harris, et al. (2007) article on normal variations on DELAY - https://www.ncbi.nlm.nih.gov/pubmed/17538102

**How:**

- Note Sensory on previous slide
- Anterior->Posterior tongue propulsion (Hypoglossal XII)
- Soft palate closes off nasal cavity (Vagus X, Trigeminal V)

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## Break it down: Pharyngeal Phase

**What: Needs good timing, strength (motility), coordination**

- Pharyngeal swallow is initiated by good sensory input to medulla to trigger good motor output, together with the cortical modulation. *(Not linear - Synergistic)*
- Propulsive forces (tongue base propulsion and pharyngeal stripping wave) drive the bolus through the pharynx safely.
- Epiglottis has no brain: Tongue movement pushes epiglottis to horizontal plane. Full Inversion is a combo of: hyolaryngeal excursion (anterior/superior), arytenoid tilt & approximation, propulsive forces, and the bolus itself. (Thanks Dr Humbert & CTDM)

**How:** (Cranial nerves simplified. Read More: http://www.swallowstudy.com/crazy-cranial-nerves-swallowing/

- Velopharyngeal closure to prevent nasal regurgitation (V, X)
- Pharyngeal elevation, peristalsis (stripping wave) (Glosso IX, X)
- Anterior & superior hyoid & laryngeal excursion (V, VII, X)
    - Laryngeal vestibule closure & vocal cord closure to protect airway (IX, X). Sensory component by the SLN of Vagus (X).
    - Upper esophageal sphincter relaxation (X) (from lateral medulla). Then hyolaryngeal excursion yanks it open. Bolus forces distend the UES.

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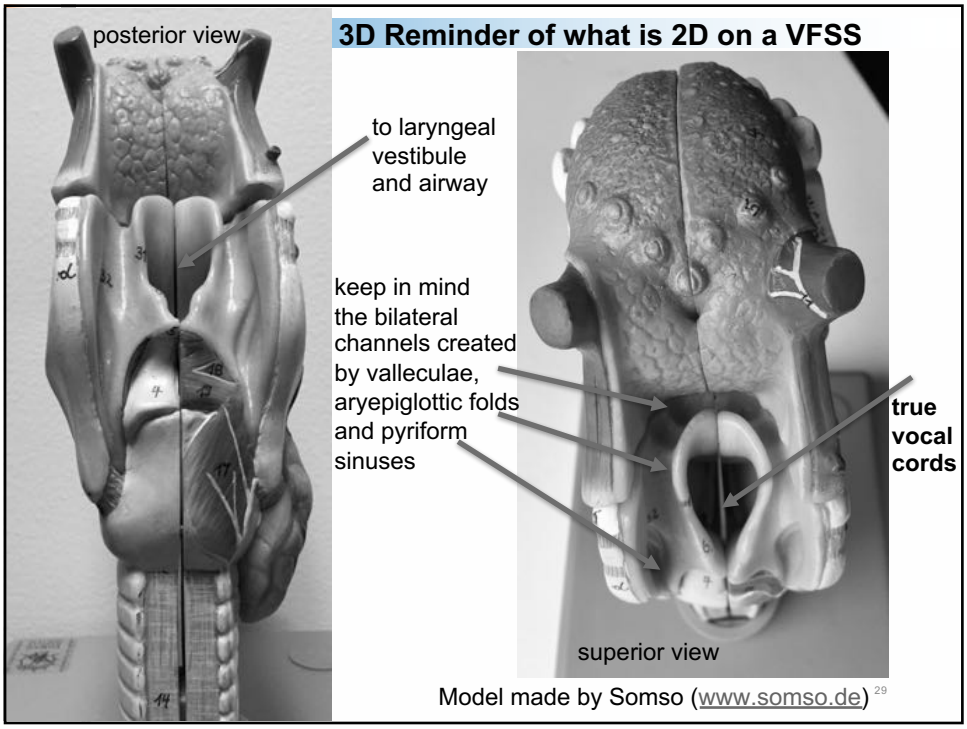
posterior view
3D Reminder of what is 2D on a VFSS
to laryngeal vestibule and airway
keep in mind the bilateral channels created by valleculae, aryepiglottic folds and pyriform sinuses
true vocal cords
superior view
Model made by Somso (www.somso.de)
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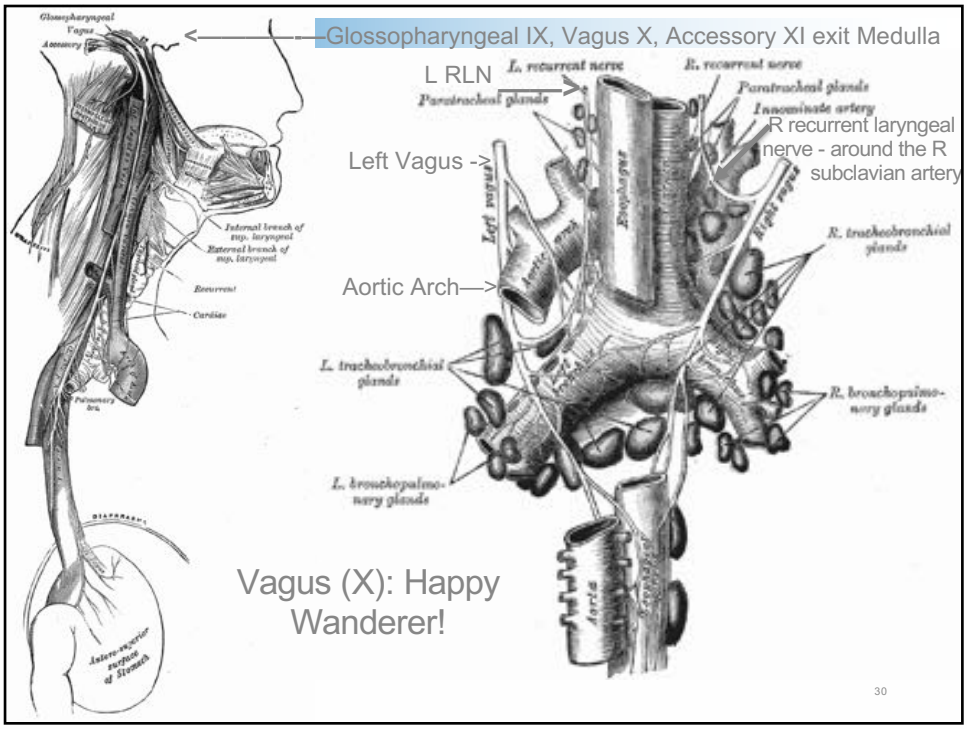
Glossopharyngeal IX, Vagus X, Accessory XI exit Medulla
L RLN
Left Vagus
Aortic Arch
R recurrent laryngeal nerve - around the R subclavian artery
Vagus (X): Happy Wanderer!
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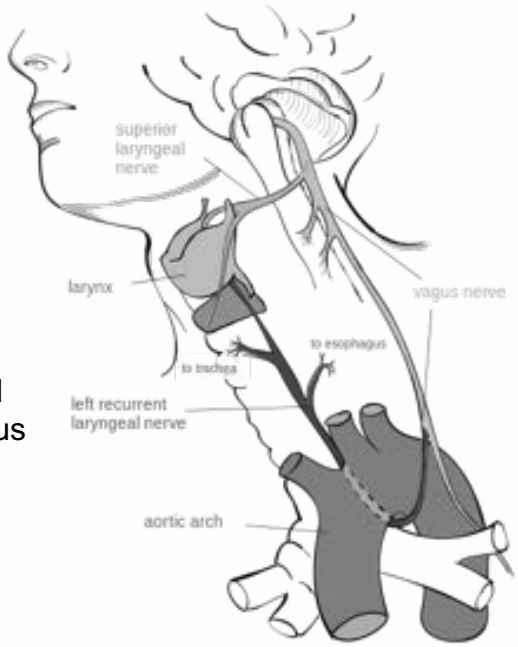
Let's see that Left RLN again! Simplified

Vagus (X)

Recurrent Laryngeal Nerve branch of Vagus on Left side.

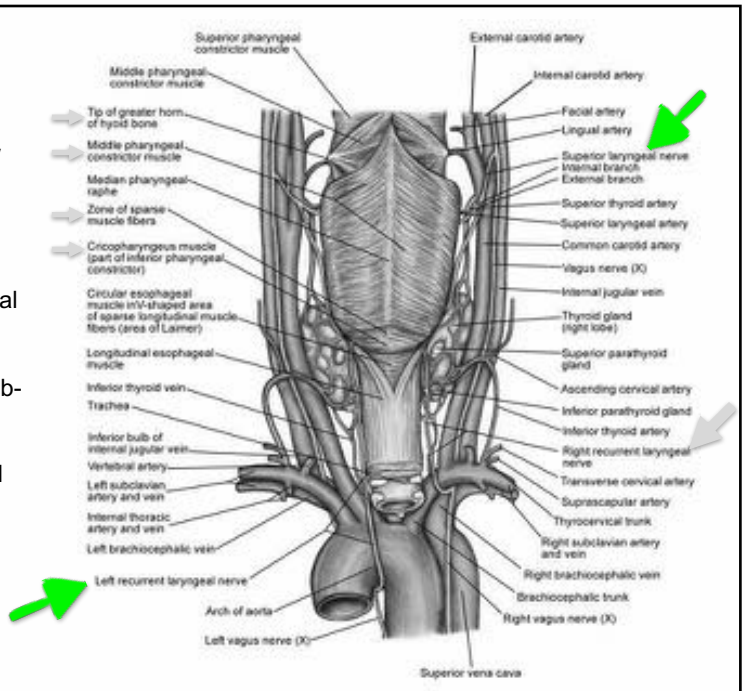



**Posterior view**

See green nerve tracts of the Vagus

Recurrent Laryngeal Nerve (RLN)
Left: around Aorta
Right: around R sub-clavian artery

Superior Laryngeal Nerve (SLN)

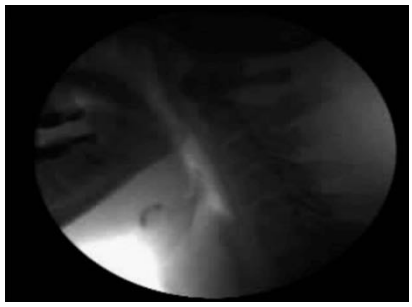



http://emedicine.medscape.com/article/1923100-overview#a1

## The normal swallow is fast!

*The rapid-patterned pharyngeal phase (and all it's biomechanical events) happens in **1 second**!*

- Kahrilas PJ, Lin S, Chen J, Logemann JA. (1996). Oropharyngeal accommodation to swallow volume. *Gastroenterology, 111*(2), 297–306.
- Kendall KA, McKenzie S, Leonard RJ, Goncalves MI, Walker A. (2000). Timing of events in normal swallowing: A videofluoroscopic study. *Dysphagia,15*(2), 74–83.



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## Break it down: Esophageal Phase

- **Upper Esophageal Sphincter** (UES) (aka, pharyngo-esophageal segment or PES) (Jacob, et al., 1989)
    1. Signal to **relax** from medulla in brainstem, and
    2. Mechanical forces yank **open** the sphincter, while
    3. Bolus propulsive forces **distend** it.
    4. Then it **collapses** and is **closed at rest**.
- Primary & secondary peristaltic wave propels the bolus through esophagus.
- **Upper (proximal) 1/3** of the esophagus is **striated** muscle.

- Transition zone into -

- **Bottom (distal) 2/3** of the esophagus are **smooth** muscle.
    - **Lower Esophageal Sphincter** (LES) is closed at rest to prevent reflux, but opens to allow bolus emptying out of esophagus to stomach.

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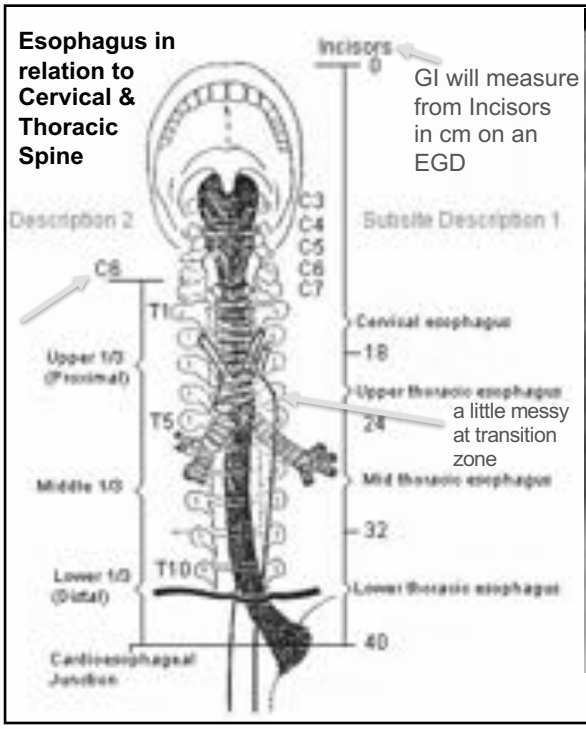
**Esophagus in relation to Cervical & Thoracic Spine**





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# It's Not Just the Cranial Nerves

Swallowing depends on a combination of **Involuntary** and **Voluntary** control (sensorimotor guided behaviors from the primary and secondary sensorimotor cortex, pre and postcentral gyrus - motor and sensory homunculus, insula, basal ganglia, cingulate gyrus and more).

**Oral Stage is mainly under voluntary control.**

- **<u>However, it Becomes a Real Puzzle:</u>**
- Imagine a patient with advanced Dementia who has decreased oropharyngeal sensory feedback due to the disease. He may also have poor vision, poor sense of smell, poor hearing, poor sensation in his hands, and physical limitations that make it hard to feed himself. He gets easily distracted and overwhelmed. He may not recognize what to do with a spoon or straw. He may pocket food in the mouth, forgetting how to manipulate the food.

**Can he get past the Oral Prep Phase?**

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## Put it back together

"Models of swallowing biomechanics are typically divided into phases, including oral, pharyngeal, and esophageal phases.

These phases are **physiologically interconnected**, but distinguishing among them helps to explain the biomechanical and neural control mechanisms associated with the swallowing process as a whole. Although discussed as separate processes, the **interdependence** of the phases must be considered throughout."(page 204)

Humbert IA, Michou E, MacRae PR, Crujido L. (2012). Electrical stimulation and swallowing: How much do we know? *Seminars in Speech & Language, 33*(3), 203-16.

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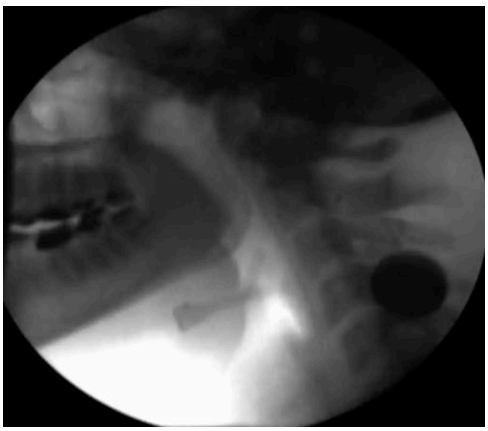
## Know what is "normal" & what are normal variations in the elderly



**Some differences in the elderly:**

- Longer oral preparatory phase
- Decreased sensation
- Longer swallow timing measures, except laryngeal vestibule closure duration (Nascimento, et al., 2017, March)
- Reduced pharyngeal pressures
- Penetration that is ejected
- Slower esophageal and gastric clearance

*Watch an elderly swallow that is within functional limits:*
https://www.youtube.com/watch?v=1UTcEHp8eSI 38

# Principles of the Instrumental Exam

A word on advocating for the exam:
Remind: when there is a fall, you cannot palpate only to see a fracture. When there is a DVT suspected, you cannot just observe the leg.

Instrumental exams save money in terms of pneumonia prevention (health-care associated pneumonia/HCAP) & decreasing readmissions.

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## General Principles

- Exam is not pass/fail
- Protocol, strategies, maneuvers are not selected at random
- Standardized protocol is helpful, with modifications for the patient and per your hypothesis
- What are the questions you are asking?
- What are the medical team's questions?
- What are the patient's concerns & goals (caregivers/family)?
- VFSS is **NOT the gold-standard** to answer all questions. May make referrals for other exams (Fiberoptic Endoscopic Evaluation of Swallow [FEES], Barium Swallow, etc)

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## General Principles

The purpose is NOT to rule-out aspiration.

**Don't Stop With:**
Is the Patient Aspirating?
At Risk for Aspiration?

Continue With:
**Why & What Can We Do About It?**

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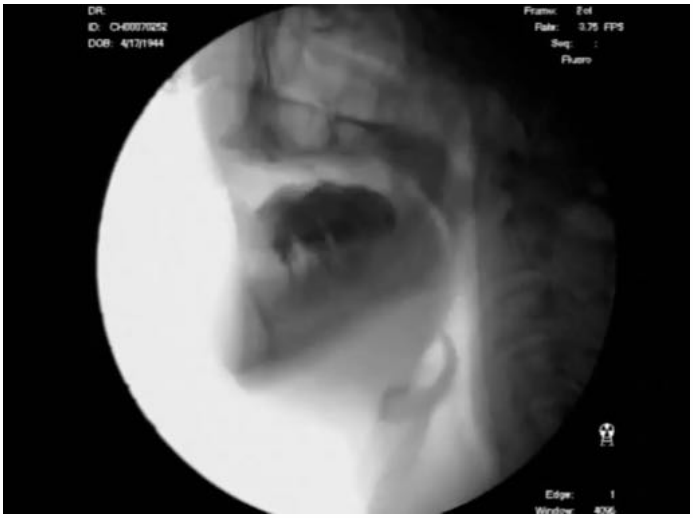
What if there is no aspiration?

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## General Principles

**What is a "functional swallow?"** (*functional* versus normal)
**What contributes to the impairment?**

**Safety** = penetration & aspiration (Penetration-Aspiration Scale/PAS)

***Functional*** = less than 3 on the PAS
PAS of 2 is okay

**Efficiency** = residue and how much residue is too much?

***Functional*** = valleculae & pyriforms less than 25% full.

Bedside: When you *attempt to* palpate the swallow and note more than 2 swallows on 1 bolus = *may be* an indication of residue.

(Dr Catriona Steele in session by Martin-Harris, Coyle & Steele, 2016, November)

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## Instrumental exams ask WHY?

Answer with "What are the underlying problems?":

- **Behavioral/Cognitive** (distractibility, impulsivity, attention, awareness)
- **Structural** (i.e., pouches, diverticulum, tumor, missing anatomy, scar tissue, fibrotic/stiff tissue, edema, ACDF with hardware pressing on posterior pharyngeal wall)
- **Coordination** (i.e., coordination of breathing & swallowing)
- **Physiological**

  Are the physiological problems related to:
  - **Timing** (i.e., oral or pharyngeal swallow delay, slow-spastic movement, slow laryngeal vestibule closure reaction time)?
  - **Motility** (i.e., weakness in the oral, pharyngeal and/or laryngeal muscles, spastic/restricted movement, decreased pharyngeal constriction, UES opening)?
  - **Sensory** (poor sensory input can give weak output; poor sensation can cause problems with airway protection)

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**Structural**

When you see this back flow out of the esophagus, make sure to find out why.


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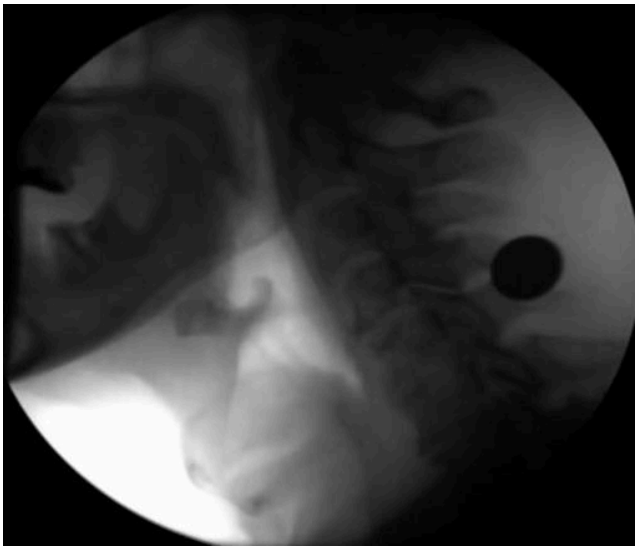
**You can certainly have motility issues & structural issues**



Decreased hyolaryngeal excursion, decreased laryngeal vestibule closure, and…

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## General Principles

- Of course, we treat people & not boluses!
- Analyze the person's structure and function.
- Ask: Are these normal variations or abnormalities?

• What is the patient doing/or not doing to make the bolus do that?
• What is wrong with the structure or function of the swallow:
to cause penetration/aspiration? to cause residue? to cause backflow?

• **What can we do about it? Part of treating the whole person is having goals that address:**

***Safer* & adequate nutrition & hydration, minimizing adverse sequela, while preserving quality of life with the least restrictive diet per person's goals.**

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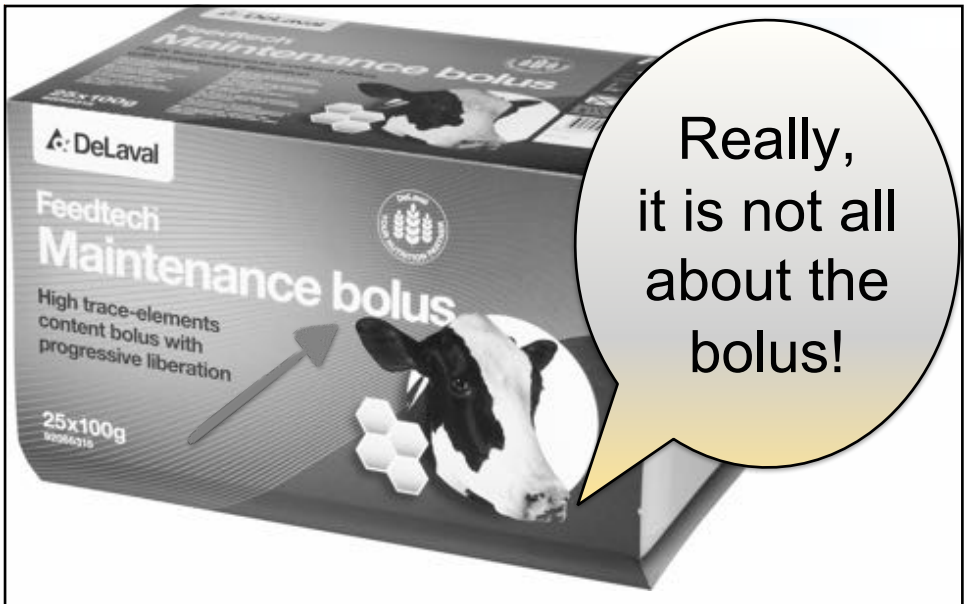


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## AARP: Always As Real as Possible!

- Natural sip size 12-16ml when presented with a 90-130ml in cup. Exams must include sips of over 10ml, as tolerated. Don't be too cautious. (Steele, 2015, March)
- If you are doing just 5ml (teaspoon sips) and small cup/straw sips, you are not getting a natural sampling.
- Amount of trials: Steele recommends at least 3-4 trials of each bolus to achieve a representative sample of swallow function (variability even w/ CVA pts)
- Challenge patient: consecutive sips by cup & straw. Take pill with thin liquids.
- Testing a strategy needs 2-3 trials. Is it too variable? Can the patient do it with less cueing? Is it a realistic recommendation?
- Be quiet! Make sure you do not cue them too quickly. You are noting if the patient performs a dry swallow to clear residue on own OR coughs on own.
    - Solids: mixed consistencies, bread bolus (Per a literature review on choking by www.IDDSI.org, bread is the most common cause of death from choking).

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## Pureed Bolus: Lateral Medullary Infarct - Brainstem Stroke

## Larger Pureed Bolus with Mendelsohn Maneuver

more functional 1st swallow

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Same male with Lateral Medullary Infarct. Aspiration noted on thin liquid, so this video shows Head turn/tuck to weaker side. Closes off weak pharynx and helps yank open UES.

Bread Bolus
Non-functional 1st swallow, followed by second w/ cued strategy.

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# Conducting the VFSS

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Inpatient Referral

When to do a videofluoroscopic swallow study (instrumental):

- Clinical Bedside Swallowing Evaluation inconclusive
- Patient not at baseline and need to determine safest means for nutrition/hydration, *and* **Need answer of why?**
- Acute event, like a right CVA, with high risk for silent aspiration. Also PD & COPD have poor sensation.
- Tracheotomy patient: per Dr Leder, don't mess around with screening when it comes to trach patients

When to maybe wait:

- Patient's condition is changing quickly
- Too lethargic with acute infection.
- Too acutely critically ill: cannot leave the ICU. Test with FEES or when more stable

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## Outpatient Referral

**The doctor's script may just say "dysphagia," so we dig deeper.**

Does your facility send a **case history** form and **quality-of-life questionnaire** ahead of time? Find out medical history and other testing that has been done. Communicate with treating SLP from facility.

Your interview will help form hypothesis quickly with your outpatient:

- Dysphagia to solids, liquids, pills, saliva, reflux? Diet changes? Typical meal? How long does it take to eat a meal? What has worked? What makes it worse?
- Have them point to where they feel the issue.
- Onset: When? Gradual, Sudden?
- Progressively worse? Steady? Getting better?
- Consistent, Inconsistent? Frequent? Every day/every meal? Beginning of day? End of day after fatigue? Shortness of breath with eating/drinking?
- Related issues: PMH? Weight loss? Dry mouth? Dental history? Pain? Allergies? Medications? Smoking history?

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## Radiation Safety


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## The Basics

- In terms of radiology procedures, only long Interventional Radiology (IR) procedures pose a risk of a dose high enough to cause skin burns. Patients with diabetes may be predisposed to longer term risks.
- **Diagnostic fluoroscopy is NOT in this high risk category**.
- Normal life on earth = up to 6.2 mSv per year(millisieverts - unit of ionizing radiation dose). (National Council on Radiation Protection Report 160)
- 1 Gy (Gray)=1 Sv (Sievert)
- Brain is less sensitive to radiation
- **Neck to upper femur** = zone of increased sensitivity (bone marrow, thyroid, abdomen sucks up the dose more)

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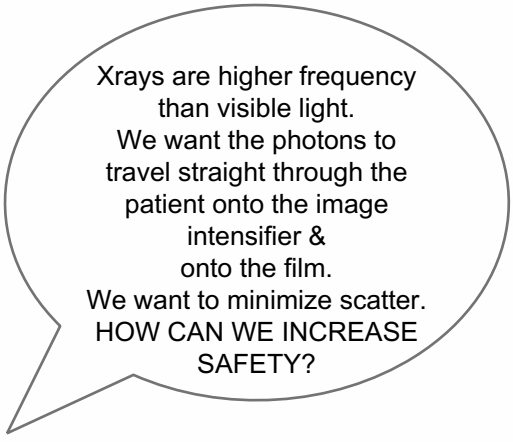
## *ALARA:*
## As Low As Reasonably Achievable




**1.Time**
**2.Distance**
**3.Shielding**

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## 1. TIME

- Radiation Safety is USER dependent
- Use a ***last image hold*** (LIH) feature to figure out what you just saw - when analyzing structures & making positioning adjustments
- May have to say "Fluoro on," "Fluoro off" - especially if new radiology residents are operating the camera
- **Pulsed fluoro** (versus continuous) reduces the beam-on time.

  Pulse Rate = on the camera, vs

  Frames per Second = our recording

more on pulse rate/frames per second

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## The *ALARA dilemma*

- One does not meet this principle if the exam is so brief and inconclusive that the study has to be repeated (that equals more radiation!)
- Radiologists want to use the lowest pulse rate possible to achieve the "minimum clinically acceptable image" (they may have it set at pulse rate of 3 or 7).
- Whereas, the SLP needs a pulse rate of **30** or continuous fluoro.

***If the pulse rate is too low, we miss key parts of the swallow.***

For example, the time from when your **hyoid starts moving** to the time your **laryngeal vestibule is maximally closed** may be **less than 4 frames** at the frame rate of 30 frames per second (fps).

(Dr Catriona Steele in session by Martin-Harris, Coyle & Steele, 2016, November)

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## More on Frames Per Second

- Cohen, et al., 2009 re pulsed fluoro in children
- Bonilha, et al., 2013: 20% of aspiration events were missed at 15 fps versus 30 fps. They noted that the study question is answered sooner at 30 fps, so this efficiency can also reduce radiation exposure.
- Mulheren, et al. (2017, March) presented at DRS: Studied 15 vs 30fps w/ stroke patients. Yielded inconsistent MBSImP ratings, causing contrasting results. Duration measures, like swallow reaction time and duration of laryngeal vestibule closure were greater for 30 fps vs 15 fps. "VFSS should be conducted at the highest available frame rate."
- "Fluoro performed at <15 fps fails to conform to the ALARA principle and is radiating patients without the possibility of answering the question accurately and should therefore be stopped." (Personal communication w/ Dr Steele 3/9/17)
- See: http://steeleswallowinglab.ca/srrl/best-practice/videofluoroscopy-frame-rate/
    - The funny thing is that Martino, et al. (2015, March DRS) found that reliability btwn two raters was better for 15 fps vs 30 fps. Less frames to disagree!

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## *ALARA:* As Low As Reasonably Achievable

There are other ways to limit radiation dose.

Low-Dose Mode: about 40% of normal flouro.

**Take-home message on ALARA**

"The radiation risk from a fluoroscopic procedure should be offset by the clinical benefit to the patient."

"A procedure should never be stopped based solely on radiation dose concerns. Clinical benefit of completing the procedure almost always exceeds any radiation detriment. Ending a procedure before the desired clinical goal is achieved **results in radiation risk without corresponding clinical benefit**."

-course at Beth Israel Deaconess Medical Center, Boston

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## 2. DISTANCE: Room Set-Up

Right-handed feeding:

- Step back quickly to the side
- As far from the patient as possible
- If the barium table is in front of the patient, you will tend to get more radiation
- Reduce scatter w/ **Image intensifier close** to the patient


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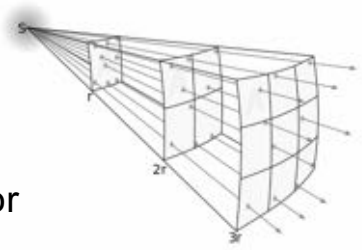
## 2. DISTANCE: Room Set-Up

- Keep your hands out of the field
- Step away from the beam quickly
- Think: Double the Distance for exponentially less radiation
  - 2 feet away = 1/4th the radiation
  - 5 feet away = 1/25th the radiation




Newton's Inverse Square Law
**Intensity** of the image becomes **weaker** as it **spreads out from the source**

Formula:
Intensity / Distance *squared*

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## 2. DISTANCE: Room Set-Up

Collimation:

- Focus the beam in tightly on the area of interest
- Reduces the patient's dose (less tissue irradiated)
- Improves the image contrast (less image degradation)
- Decreases the scatter dose to the therapist and radiologist

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## 3. SHIELDING

The Unsafe Selfie!

Need better coverage

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## Safe

Thyroid Shield

Dosimeter

Tight-fitting & **wrap-around** vest and skirt



**If pregnant:**
- Wrap around vest/apron
- 99% of x-rays are attenuated with 0.5mm aprons
- Could add small lap apron
- Wear additional dosimeter under apron at belly

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## Extra Protection

Use a shield between the beam and you & your work table

Use lead glove if your holding a cup

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## Room Set-Up: Suction

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## Room Set-up: The Chair


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Some chairs have remote control to adjust (see rechargeable battery).

Other chair brands have hand levers to lower the head and raise the feet.
Foot levers to raise the height of the chair.

This picture shows red pull-out handle to drop the armrests.

Foot breaks are key for patient safety.

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# Room Set-Up: Positioning

**Oblique** position to visualize pharyngo-esophageal segment, especially if broad shoulders.

Take off metal jewelry.

Protect clothing (barium stains!)

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## A-P View

## Room Set-Up: The Barium

## Viscosity: measured in centipoise (cps)

Thickened liquids:

- **Increased safety**
- But also increased oral/pharyngeal residue
- Impacts physiology w/ increased lingual pressures
- Reduced palatability
- Increased risk for dehydration
- Risk for decreased quality of life

Newman, R., Vilardell, N., Clavé, P. & Speyer, R. (2016). **Effect of Bolus Viscosity** on the Safety and Efficacy of Swallowing and the Kinematics of the Swallow Response in Patients with Oropharyngeal Dysphagia: White Paper by the European Society for Swallowing Disorders (ESSD). *Dysphagia, 31*(2), 232-249. (link.springer.com/journal/455)
http://link.springer.com/article/10.1007/s00455-016-9696-8

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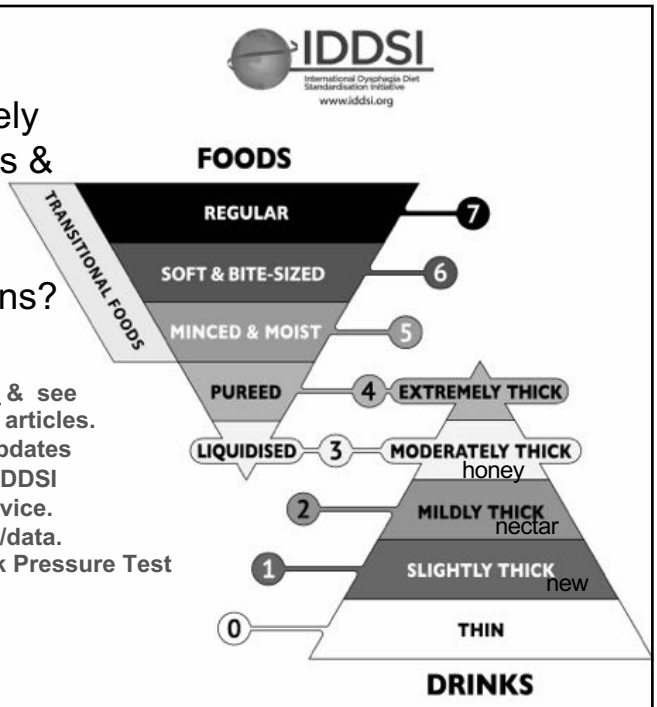
## Do our swallow studies accurately test true textures & viscosities to make diet recommendations?

**My IDDSI To-Do List:**

- **Go to www.IDDSI.org & see Open Access research articles.**
- **Register to receive updates**
- **Download the FREE IDDSI App on your mobile device. It operates without wifi/data.**
- **Learn Flow Test, Fork Pressure Test**



## Are we really testing safety & efficiency for a regular diet?

With just a graham cracker?

Making inferences (aka, educated guess).

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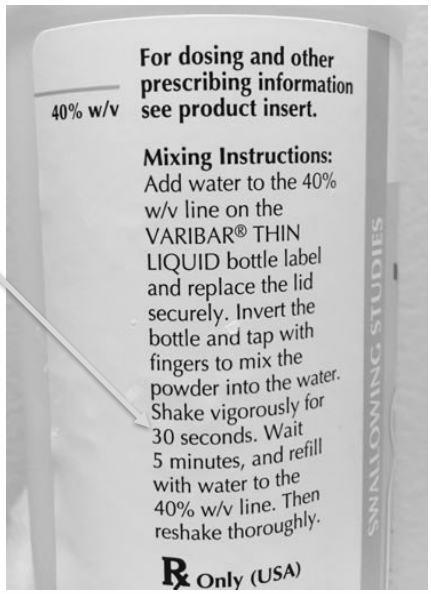
## Is Varibar Thin Liquid really ***thin***?

Varibar Thin Liquid to the **40%** line is really 10 centipoise (cps). Use a **20%** formula to truly test a thin liquid, like water, at 0 cps.

1. Follow directions, filling to 40% line.
2. Then measure out equal parts of 40% Barium and regular water. (i.e., Half Varibar Thin and half water to make a **20% Barium.)**

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## Can we test the new Slightly Thick

Dr Catriona Steele performing IDDSI Flow Test with 10ml syringe* (#ASHA16)

Varibar Barium is classified as a pharmaceutical in the USA. Therefore, BRACCO cannot change their product names, labels or recipes (FDA regs).

However, IDDSI is coordinating a multi-center effort to **confirm the viscosity of Varibar** products & to **verify the best recipe for Slightly Thick**.

IDDSI will create a **chart** to map Varibar products to IDDSI standards.

**Recipe passed IDDSI Flow Test:**
Slightly Thick =
4oz Nectar Thick Varibar + 30cc clear water
(measure with medicine cups)

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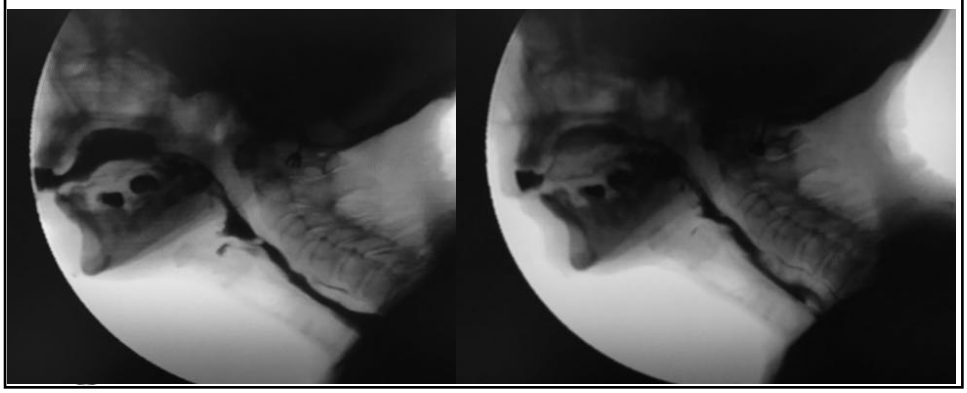
*http://iddsi.org/wp-content/uploads/2015/06/IDDSI-Flow-Test-April-2016.pdf

## Mildly/Nectar thick versus Slightly thick

**One patient example**: Slightly thick (on right) is thinner, and potentially more palatable than the Mildly/Nectar thick (on the left). For this patient, she had less residue and less penetration with the Slightly thick. Because of her additional esophageal dysmotility, the slightly thick was more effective in clearing solids through the esophagus.
Therefore, slightly thick was safer, more efficient, more functional. Better hydration too?



## Now your patient is ready, your barium is ready, and you are waiting for the radiologist…

- Explain the exam procedures. Tell the patient this is not a "pass/fail" exam (some people may be very nervous)
- Educate, train and practice potential swallow strategies that you will want to try on the exam (e.g., details of the super supraglottic swallow)
- Double check oral cavity (wow, are you dry!)
- Double check dentition (ahh, they left her dentures in her room upstairs!)
- Test with an oral sensorimotor exam if on an outpatient and you have no prior information on this

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## Collaborating with your radiologist

**Bring that "OOH LA LA"**

A radiologist at a Dysphagia Research Society meeting, noted that these exams have not been as "*sexy"* as the other new imaging

- Include them in the differential workup. Why should they care?
- Tell them the potential problems and your hypotheses
- Ask them at the end what they think about the esophageal phase, as we cannot diagnose. Does it need further testing?
- Discuss results briefly. Make sure you are both reporting the same findings. Sometimes at busy hospitals the consultants and hospitalists will only look at what the radiologist dictated. This can steer the team in the wrong direction if your findings are not consistent with each other.

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## Yes, use a Protocol; however…

- **Protocol** = standardization & reproducibility, as well as decreased radiation. Test/Retest Reliability. Crucial for new clinicians.
- Use MBSImP Protocol or your institution's agreed upon protocol.
  (e.g., Thin spoon 5ml with bolus hold to test for oral control; Thin cup; Thin straw; Thin sequential; Nectar {Mildly Thick} with same; Honey {Moderately Thick} 5ml; Pudding/Puree 5ml; Cookie; AP view with viscous material of Nectar and Pudding)
- However:
  - First bolus may be the worst, especially for neuro patients
  - Modifications may be necessary to meet the patient's needs and specific questions that need to be answered.
  - Strict adherence to a protocol may not allow for critical thinking

(Humbert, 2017, CTDM)

**"Standardization with flexibility to adapt to needs of the patient."**
**(Martin-Harris, 2016a, November)**

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## Customization

- Test a wide enough variety of **bolus variables** (i.e., large bolus)
- **Bolus delivery** by spoon, cup and straw. Even a medicine cup will give you a different swallow (head tossed back).
- **Cued versus non-cued swallows**: Are you always telling the patient to hold the bolus in the mouth until I tell you to swallow? That may be a swallow strategy (Daniels, et al., 2007 - cued swallows showed shorter swallow durations and higher position of the leading edge of the bolus when the swallow is triggered. See also Nagy, et al., 2013).
- Numbers of trials
- Cueing for strategies. Is the patient accurate without cues?
- When something works, try again to make sure
- **Biofeedback** - show video during exam. Tell the patient: "Make this black stuff go down here," per Dr Ianessa Humbert.

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## Why AP & Why Scan Down

### AP View

- Gross view of pharyngeal movement and vocal cord mobility (tell the patient to sniff and then say "eee")
- See pharyngeal contraction bilaterally on viscous bolus (e.g., Nectar thick)
- Pharyngeal residue: bilateral and equal; more so on left or right; more so in valleculae or pyriforms. See if there is a diverticulum and which side.

### "Scanning" down. Not an esophageal "screen"

- The swallow does not stop at the UES
- Retention in the esophagus directly impacts the safety & efficiency of swallowing
- Globus sensation can be referred to neck, but the problem may be distal in esophagus
- Have you answered the questions if you stop at the pharynx?

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## Pillars of Dysphagia Management

| **Compensatory Strategies** | **Rehabilitation** | **Diet Modifications** |
|---|---|---|
| e.g., Mendelsohn Maneuver, | Strengthening | Thickened liquids |
| Head Turns, Supraglottic | Biofeedback | Pureed foods |

(See Lazarus, 2017)

**Ultimately, during & after the exam we need to consider**:

- **Patient's goals** of care and prognosis. Provide **options**.
- Patient's/caregiver's cognition, motivation, & ability to follow a plan.
- The big picture. We cannot make recommendations in a vacuum
  - Thickened liquids may be the best option if the patient cannot follow directions, recall strategies, or follow strengthening exercises. However, thicker is NOT always better!
  - Sometimes "*less is more"* with a **palliative-care** approach. We may recommend a diet and strategies with a **quality of life** focus, rather than preventing aspiration at all costs.
  - Are there other ways to reduce pneumonia risks?

The patient and family may choose the "least bad" option to minimize adverse outcomes. We cannot prevent aspiration 100%.

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Sorry, this is meant to be a full slide!! Just a few of the tools!

## Tools in the dysphagia toolbox

- **Increasing Sensory Input** (i.e., mealtime changes; carbonation; cold,sour, &/or larger bolus)
- **Postural Variations**:
  - **Chin down or Chin tuck** (These are not the same. They require evaluation by an SLP. Not always beneficial. Could be contraindicated. We cannot tell everyone to chin tuck, thinking we are preventing aspiration. Sometimes it can cause aspiration! Read More: www.swallowstudy.com/to-chin-tuck-or-not-to-chin-tuck-that-is-the-question/
  - Tilting head backward for oral cancer patients (i.e., lingual resection)
  - Turning head to the weak side for pharyngeal weakness
  - Combination of head turn and chin tuck
  - Tilting head to the stronger side for oral weakness
  - Positioning in bed (90 degree angle, elevated side lying, reclined)
- **Voluntary Maneuvers to Protect the Airway & Improve Clearance**
  - Supraglottic Swallow (breath hold to close airway before the swallow)
  - Effortful Swallow (swallow "hard" to increase LVC duration & stripping of the bolus)
  - Mendelsohn Maneuver (increases the duration of laryngeal elevation to assist in yanking open the cricopharyngeal muscle – top of the esophagus)
  - Swallow/Cough/Reswallow to eject penetration
  - **Double Swallow** to clear pharyngeal residue (This is a good example of why we test with instrumental evaluation before blindly offering strategies. Could be contraindicated. If the patient has esophageal dysmotility, an immediate double swallow can disrupt the secondary peristalsis/esophageal clearing wave)
  - Alternating liquids and solids to assist with clearance of solids

***If all else fails, use diet modifications and thickening liquids.**

# Analyzing the VFSS Results


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# What is Normal versus Abnormal? "Functional Swallow?"

- **Structure**
  - Obstruction; Edema; Pre-vertebral edema (s/p ACDF)
  - Missing anatomy
  - Fibrotic anatomy
- **Function**: all the neuromuscular and biomechanical events
  - Safety (penetration/aspiration); Efficiency (residue & risks)
  - Timing
  - Motility: displacement measures
  - Force/Strength & Coordination
  - Caution with the term ***Bolus Kinematics***: deals with aspects of ***motion*** *apart from considerations of mass and force*.

(Merriam-Webster Dictionary)

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Our **Impressions section synthesizes!**

We cannot just explain the bolus kinematics - or bolus movement - without consideration of what is behind the movement. Describe the underlying pathophysiology behind the person's safety and efficiency problems. This helps the medical team learn about why the aspiration and residue are occurring & what we can do about it.

Use Tools to answer questions, but use critical thinking too!

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## Safety & Efficiency

**Safety** = penetration & aspiration (Penetration-Aspiration Scale/PAS)

***Functional*** = less than 3 on the PAS
PAS of 2 is okay

**Efficiency** = residue and how much residue is too much?

***Functional*** = valleculae & pyriforms less than 25% full.

(Steele, et al., 2015b, March;
Steele in session by Martin-Harris, Coyle & Steele, 2016, November)

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1. Tool

## *PAS = Safety score*
## Penetration-Aspiration Scale

Robbins, J., Coyle, J., Rosenbek, J., Roecker, E.B., Wood, J. (1999). Differentiation of normal and abnormal airway protection during swallowing using the Penetration-Aspiration Scale. *Dysphagia, 14,* 228-232.

Rosenbek, J.C., Robbins, J., Roecker, E.B., C… (1996). A Penetration-Aspiration Scale. *Dysph…*

http://www.ncbi.nlm.nih.gov/pubmed/8721066

## PAS Score / Description of Events

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

Rosenbek, JC, Robbins, J, Roecker EV, Coyle, JL, & Woods, JL. A Penetration-Aspiration Scale. Dysphagia 11:93-98, 1996.

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What does the PAS do?

- Tells us about:
  - Bolus direction
  - Depth of the airway invasion
  - Patient sensory to motor response (Do NOT cue to soon. See if the person reacts with a cough).
  - Watch for patterns across boluses
- Meant to be an **agreed upon language** for comparisons. It is an **estimation of risk** attributable to aspiration. Use in combination with other descriptors of the biomechanics of the swallow (Coyle, 2016, November).

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What the PAS does NOT do:

- Does not diagnose
  For example, you could have a score of 1 on the PAS but still have severe dysphagia and high risk.
- Does not fully characterize a patient
- Tells nothing about the WHY there was airway invasion
- Doesn't fully guide treatment

(Carnaby, 2016, November)

More on the PAS:

- Don't average PAS score (e.g., 4.9) - this tells nothing when done in research.
- The scores were meant to be on each swallow, telling the specific pattern of that swallow. Discuss the patterns you see in your impressions.
  - See **Reflections on Clinical and Statistical Use of the Penetration-Aspiration Scale**, Steel, CM & Grace-Martin, K. (2017)
    https://link.springer.com/article/10.1007/s00455-017-9809-z

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## Define the airway compromise

PAS is not enough! Need the WHEN & WHY

| WHEN | WHY |
|---|---|
| BEFORE | Poor bolus containment & spillage<br>Pharyngeal swallow delay |
| JUST BEFORE | Delayed Laryngeal Vestibule Closure Reaction Time (LVCrt) |
| DURING | Decreased LVC closure - why<br>Decreased epiglottic inversion - why |
| AFTER | Decreased tongue base propulsion and pharyngeal constriction, leaving residue<br>Decreased UES opening? Decreased duration vs magnitude? |

Just keep asking WHY - '***The 5 Whys'*** - per Dr. Humbert

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2. Residue Tools

## Residue Measures = Efficiency

- Ordinal scales: MBSImP (none, trace, collection, majority, minimal to no clearance)
- **Eisenhuber Scale**: Height of residue, relative to the total height of the space. How full is the space? 0%, mild = <25%, moderate = 25-50%, severe = >50%

  Aspiration after the swallow was 89% with patient's with severe residue

  (Eisenhuber, et al., 2002)

- **Normalized Residue Ratio Scale (NRRS)**:

Residue proportionate to person's size.

See http://steeleswallowinglab.ca/srrl/best-practice/nrrs-residue/

This can be done with ImageJ software (https://imagej.nih.gov/ij/download.html)

(Pearson, Molfenter, Smith & Steele, 2013)

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3. Tool for Head & Neck CA

## DIGEST: (by Dr Hutcheson of MD Anderson) Dynamic Imaging Grade Swallowing Toxicity

- **Safety Grade**: Grade 0-4

Based on max PAS score across liquid & solid boluses (not those with strategies)

PLUS the **frequency** of the penetration/aspiration (single event, intermittent, chronic)

AND the **amount** (trace, not gross, and gross)

- **Efficiency Grade**: Grade 0-4

Based on maximum percent of pharyngeal residue across liquid & solid boluses after the initial swallow (not those with strategies applied).

<10% residue on all boluses presented is a Grade 0
10-49% residue on any bolus type is a Grade 1
50-90% residue on cracker and/or cookie is a Grade 2
50-90% residue on liquid and/or pudding is a Grade 3 (liquid residue makes worse)
>90% residue on any (but not all) bolus types is a Grade 3
>90% on ALL bolus types is a Grade 4

(Hutcheson, 2016, November; Hutcheson, et al., 2017)

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## DIGEST: how life-threatening?

Hutcheson & team wanted a system that was similar to the CTCAE (Oncology's "Common Terminology Criteria for Adverse Events"), which has a **grading of severity of the adverse event.** Grade 1 is Mild, through Grade 3 at Severe/disabling, and Grade 4 is Life-threatening/urgent intervention needed. Grade 5 is death related to the adverse event.

So, the DIGEST Safety & Efficiency Scores combine in a chart to form a total DIGEST SCORE of 1=Mild, 2=Moderate, 3=Severe, or 4=Life Threatening.

**Examples of DIGEST's "Life-Threatening" severity:**

PAS of 7-8 *chronically*, but not in gross amounts OR *not chronically* in gross amounts (OR both chronic and gross aspiration)

***PLUS***

Majority of the bolus remains (50-90%) for even liquids and/or pudding, OR

Near complete residue (>90% of the bolus remaining) for some or all bolus types

Psychometrically sound for head & neck CA, where the problems are **both** aspiration & residue
(Hutcheson, 2016, Nov)

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*Safety and Efficiency*
are useful,

but

We are still left asking: WHY?

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## 4. Tool

### MBSImP™

http://www.northernspeech.com/MBSImP/

Standardized protocol

Speak the same language

Blog by Dr Martin-Harris: https://dysphagiacafe.com/2015/03/05/the-modified-barium-swallow-impairment-profile-mbsimp-standardized-training-in-swallowing-physiology/

**Oral Impairment Domain:**
1. Lip Closure
2. Tongue Control During Bolus Hold
3. Bolus Preparation/Mastication
4. Bolus Transport/Lingual Motion
5. Oral Residue
6. Initiation of the Pharyngeal Swallow

**Pharyngeal Impairment Domain:**
7. Soft Palate Elevation
8. Laryngeal Elevation
9. Anterior Hyoid Excursion
10. Epiglottic Movement
11. Laryngeal Vestibular Closure
12. Pharyngeal Stripping Wave
13. Pharyngeal Contraction
14. Pharyngoesophageal Segment C
15. Tongue Base Retraction
16. Pharyngeal Residue

**Esophageal Impairment Domain:**
17. Esophageal Clearance (upright position)

Evidence, rather than opinion, should guide clinical decision-making.

Great for research and study repeatability

Pediatric MBSImP coming soon

(Martin-Harris, et al., 2008)

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### MBSImP™

https://www.northernspeech.com/MBSImP/

**Rating Tips from Dr Martin-Harris** (2016a, November):

- Pick the more severe of two ratings for a component if you are hesitating between two. Capture the worst score across trials.
- Consider forming a training club where fellow clinicians rate swallows together
- Practice reaching consensus on your ratings with colleagues

More info: https://www.mbsimp.com/uploads/MBSImP-Guide.pdf

WHY ?

**Example: Initiation of Pharyngeal Swallow**

Rate the location of the bolus at the point of the first hyoid excursion

0 = Bolus head at posterior angle of ramus
1 = Bolus head at vallecular pit
2 = Bolus head at posterior laryngeal surface of epiglottis
3 = Bolus head at pit of pyriforms
4 = No appreciable initiation at any location

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## *The Gaps with the MBSImP™*

- **Does not define "delay"**: A location of the bolus in the pyriforms does not equal a delay (?normal variation). Not a true timing measure.
  - Is it an **oral delay**? Did the patient have bolus containment issues with spillage to the pyriforms before the swallow?
  - Is it a **true pharyngeal swallow response delay.** Have to look for actual A-P propulsion by tongue for completion of oral phase. Then find the actual first hyoid burst of movement that leads to a swallow. (Not hyoid bobbing due to tongue pumping)
- **Laryngeal vestibule closure (LVC)**: we need to know more than "complete" or "incomplete" (per MBSImP), such as:
  **Duration of LVC** and **LVC Reaction Time** (i.e., delay in reaching full closure?). More on that soon!
- Only ordinal scales of residue. But **how much residue is too much?**

More on Timing measurements soon

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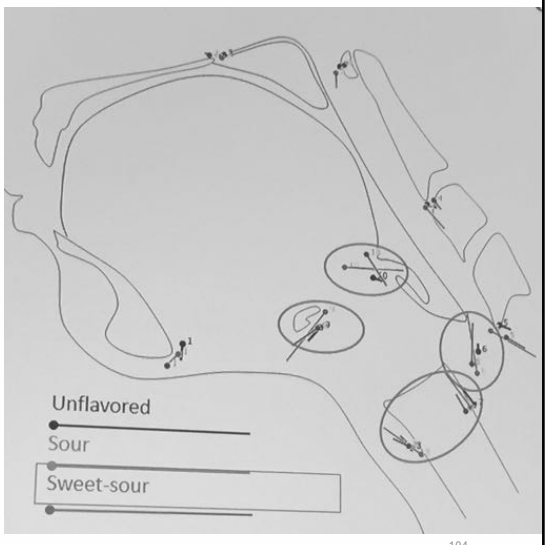
## 5. Tool
## Pearson & ImageJ Software

- William G. Pearson, Jr, PhD created the 2D vectors mapping changes in swallowing mechanics, and related them to specific MBSImP components
- This takes the perceived deficits from the MBSImP and relates them to real mechanical differences or ***shape changes***

Measuring:
- Tongue Base Retraction
- Pharyngeal Shortening
- Laryngeal Elevation
- Hyoid Movement

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## Example: Epiglottic Inversion

Using ImageJ, Pearson and colleagues created ***CASM*** or **Computational Analysis of Swallowing Mechanics**

(See free PMC article: Schwertner, Garand, Pearson, 2016)

**They confirmed Epiglottic Inversion is *dependent* on laryngeal elevation & tongue base retraction**

From their 2016 article ***Computational analysis of swallowing mechanics underlying impaired epiglottic inversion***, Pearson & colleagues stated:

"styloglossus, hyoglossus, and long pharyngeal muscles are implicated as targets for rehabilitation in dysphagic patients with impaired epiglottic inversion."

(Pearson, W.G., 2015, March DRS;

and see free PMC article Pearson, Taylor, Blair, Martin-Harris, Laryngoscope, 2016)

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## 6. Tool

### ASPEKT: a work in progress by www.steeleswallowinglab.ca

**ASPEKT** = Analysis of Swallowing Physiology Events, Kinematics & Timing

*—filling in gaps left by ordinal scales—*

"Follows a rigorous standard operating procedure, which involves:

- Identifying penetration-aspiration events for every sub-swallow of every bolus, then
- Identifying the frame number (timing location) of a series of about 12 different events (both bolus events and physiological events), and
- Moving on to pixel-based measures of structural movement (e.g., hyoid excursion), pharyngeal area (e.g., at rest and at maximum constriction) and residue (to allow for NRRS/residue measures)."

(personal communication with Dr Catriona Steele, PhD, CCC-SLP, BCS-S, S-LP(C), REG. CASLPO, ASHA FELLOW)

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# General Timing Measures

**Some specific points in time to watch out for:**

**Bolus passes ramus of mandible** (was it volitionally sent there - tongue action; or was it passively spilling due to an oral delay with decreased bolus containment?)

**Onset of Hyoid Burst** (first true movement of the hyoid at that start of the swallow, not a result of tongue pumping)

**Hyoid Max (peak position)**

**Maximum closure/height of approximation of the laryngeal vestibule closure (LVC)**

**Duration of LVC: 1st frame of LVC to Laryngeal vestibule re-opening**

**Maximum pharyngeal constriction**

**UES opening & UES collapse/re-closure**

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# Timing abnormalities associated with aspiration

1. How long does the bolus hang out in the pharynx while the laryngeal vestibule is wide open?

**Prolonged Pharyngeal Bolus Dwell Time**

(Morton, et al., 2002 - especially when paired w/ inspiration/irreg.breathing)

**Bolus Dwell Time Prior to LVC** (Nasimento, et al., 2017a, March)

2. Shorter UES opening duration (Molfenter & Steele, 2014)

3. Pharyngeal transit time, swallow response time, LVC duration (Power, et al., 2009)

4. Longer time between laryngeal elevation and complete laryngeal vestibule closure (Nativ-Zeltzer, et al. 2015)

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## Laryngeal Vestibule Closure Reaction Time

- **Laryngeal Vestibule Closure Reaction Time (LVCrt)**: the interval between the *onset of the hyoid burst* to *maximum approximation or closure of the laryngeal vestibule*
- Nascimento,… & Steele (2017b, March): studied the LVCrt in young & older adults {62-87} who had transient laryngeal penetration (PAS of 2, which is still considered safe).

  The stage transition durations were similar; HOWEVER, they found significantly longer LVCrt. Therefore, the speed to reach complete closure makes a difference. These are the "**just before**" the swallow penetrators.

  May not be a significant *swallow delay,* but just slow to fully close the laryngeal vestibule.

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## Laryngeal Vestibule Closure Reaction Time (LVCrt)

Per Dr Steele:

- We have looked at a number of different timing measures to find predictors of penetration/aspiration. We found that the most explanatory variable is what we call "Laryngeal Vestibule Closure Reaction Time."
- Incomplete or LATE laryngeal vestibule closure is one of the most common reasons for penetration and aspiration.
- Better predictor of penetration-aspiration than long stage transition durations.

(personal communication with Dr Steele regarding her lab's findings and presentations at ESSD 2015 and DRS 2017, as noted in previous slide)

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## Volitional LVC maneuver (vLVC)

- Macrae, et al., 2014: The Effects of Feedback on Volitional Manipulation of Airway Protection during Swallowing:
  - Facilitate laryngeal vestibule closure (not *UES opening* like Mendelsohn)
  - Ensure airway protection just before & during swallowing
  - Volitionally prolong the closure (not the *peak* elevation as in Mendelsohn)
  - "Swallow and hold the thyroid notch up as high and as long as possible, while closing the airway. You will not be able to breathe."
  - People CAN volitionally manipulate their LVC through training and feedback
- Guedes, et al., 2017: Examination of swallowing maneuver training and transfer of practiced behaviors to laryngeal vestibule kinematics in functional swallowing of healthy adults:

  Training vLVC allowed for longer durations of laryngeal vestibule closure and **faster LVCrt.** And these faster reaction times carried over post-training.

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## 7. Tool

## Swallowtail (Belldev Medical, Inc)


Swallowtail software allows for both timing and displacement measures.

For research & teaching purposes now. Does not have FDA status for clinical.

Review blog:

http://www.swallowstudy.com/do-your-swallow-studies-measure-up/

Examples of Timing Measures:

- **Total Pharyngeal Transit Time/TPT** (measuring from when the bolus moves past the posterior nasal spine to when the bolus clears through the PES).
- TPT of >5 seconds has a 90% increase in risk for aspiration pneumonia (Leonard & Kendall, 1997)

Textbook: Leonard, R. & Kendall, K. (1997). *Dysphagia Assessment and Treatment Planning: A Team Approach*. Independence, KY: Cengage Learning.

## Displacement or Motility Measures

Examples of Displacement Measures:

- Maximum displacement of the hyoid
- Maximum approximation of the hyoid to the larynx during the swallow
- PES Max: greatest expansion of the PES during the swallow in lateral view and AP views

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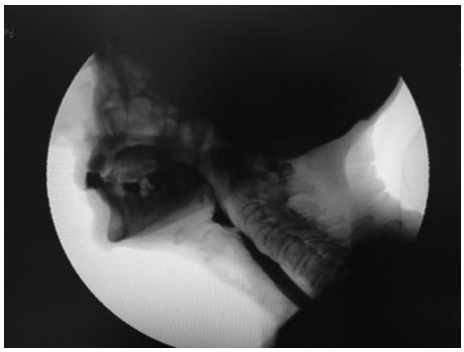
## Pharyngeal Constriction Ratio (PCR)

See "*Fluoroscopic **Surrogate for Pharyngeal Strength**: The Pharyngeal Constriction Ratio (PCR)*" (Leonard, et al., 2011)

- How much of the bolus remains in the pharynx when the pharyngeal area is maximally constricted vs at rest?
- Normal: area should be obliterated (squeeze shut/grayed out)?

*Some day soon, High Resolution Manometry (HRM) will be widely available to truly measure pressures!*



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## Rating the Overall Severity

**MBSImP Overall Impression (OI) scores**

The MBSImP captures and quantifies impairment by assigning Overall Impression (OI) scores for each of the 17 components. The OI score represents the "worst" (i.e. most impaired) score observed across all consistencies and volumes.

Oral Impairment total
Pharyngeal Impairment total.

**ASHA NOMS**

Diet as an outcome measure is not an accurate judge of physiologic severity. (This could be what the patient chooses to eat/drink. There has been no diet standardization within facilities, btwn facilities. Different clinicians have different levels of risk tolerance.)

We should be concerned when oral intake/diet scales, such as the FOIS (Functional Oral Intake Scale) or ASHA's National Outcome Measurement System (NOMS), are the only indicators of progress in therapy or in research.

Read more: http://www.swallowstudy.com/asha-noms/

## FUNCTIONAL ORAL INTAKE SCALE (FOIS)

**ONLY FOR SOLIDS**

A. **TUBE DEPENDENT (levels 1-3)**
   1. No oral intake
   2. Tube dependent with minimal/inconsistent oral intake
   3. Tube supplements with consistent oral intake of food/liquid
B. **TOTAL ORAL INTAKE (levels 4-7)**
   4. Total oral intake of a single consistency
   5. Total oral intake of multiple consistencies requiring special preparation
   6. Total oral intake with no special preparation, but must avoid specific foods or liquid items
   7. Total oral intake with no restrictions

(Crary, et al., 2005)

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## Dysphagia Severity Rating Scale

**0** **Normal** swallowing mechanism.

**1** **Minimal** dysphagia—video swallow shows slight deviance from a normal swallow. Patient may report a change in sensation during swallow. No change in diet is required.

**2** **Mild** dysphagia—oropharyngeal dysphagia present, which can be managed by specific swallow suggestions. Slight modification in consistency of diet may be indicated.

**3** **Mild-Moderate** dysphagia—potential for aspiration exists but is diminished by specific swallow techniques and a modified diet. Time for eating is significantly increased; thus supplemental nutrition may be indicated.

**4** **Moderate** dysphagia—significant potential for aspiration exists. Trace aspiration of one or more consistencies may be seen under videofluoroscopy. Patient may eat certain consistencies by using specific techniques to minimize potential for aspiration and/or to facilitate swallowing. Supervision at mealtimes required. May require supplemental nutrition orally or via feeding tube.

**5** **Moderately-Severe** dysphagia—patient aspirates 5% to 10% on one or more consistencies, with potential for aspiration on all consistencies. Potential for aspiration minimized by specific swallow instructions. Cough reflex absent or non-protective. Alternative mode of feeding required to maintain patient's nutritional needs. If pulmonary status is compromised, "nothing by mouth" may be indicated.

**6** **Severe** dysphagia—more than 10% aspiration for all consistencies. "Nothing by mouth" recommended.

Adapted by Gramigna (2006) from **Waxman**, Durfee, Moore, Morantz, and Koller (1990). Table cited from "How to Perform Video-Fluoroscopic Swallowing Studies," by G. Gramigna, 2006, GI Motility Online (2006), doi:10.1038/gimo95.

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# Recommendations & Referrals

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## Improve communication through clear reports & collaboration

Tips to improve communication about videofluoroscopy testing among the evaluating SLP and the treating SLP by Dr Ianessa Humbert, PhD, CCC-SLP. Need to write reports about **what worked and what did not work, and WHY**. Rationales for techniques tested and ideas for therapy.

- Podcast at www.SwallowingSystemsCore.org: **Down The Hatch** 9 - The Dysphagia Documentation Dilemma
  http://swallowingsystemscore.org/dth-9-dysphagia-documentation-dilemma/
- Getting In Sync, by Dr Ianessa Humbert May 1, 2017, ASHA Leader
  http://leader.pubs.asha.org/article.aspx?articleid=2624728
  ***The ASHA Leader***, May 2017, Vol. 22, 48-52.
  doi:10.1044/leader.FTR2.22052017.48

"SLPs either conduct videofluoroscopy and write reports or use those reports to guide patient's treatment, but there are inconsistencies in report writing and interpretation. So how do we improve our communication about swallow studies?" (pg 49)

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## Prognosis

**Rate**: excellent, good, fair, guarded

-for stated goals/plan? -for improving safety & efficiency of the swallow

Give rationale & timeline, especially for inpatient planning.

Example:

*"Given that this patient's stroke has severely impacted his swallowing, it may take weeks to months (rather than days to weeks) in rehabilitation to regain the safety and efficiency of his swallowing function. Therefore, one option would be to perform a PEG at this time in order to discharge him to rehab. He has a good prognosis with aggressive therapy to regain a functional swallow. The treating SLP at rehab could repeat the instrumental swallowing evaluation in 3-4 weeks to assess progress."*

**Then your Recs should provide very specific exercises to foster the rehab process.**

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## Recommendations:

1. Diet (for "safer" swallowing): (e.g., Ground/Minced & Moist and Nectar Thick/Mildly Thick liquid)
   If wanting to say NPO, provide ***options*** instead.
   Options range from *curative*/aggressive care (with goal to minimize aspiration risk) to *palliative* (with goal to preserve quality of life) to *hospice or comfort* care
2. Medication delivery: (e.g., crushed in puree) (Do not deliver crushed meds in a thickened liquid.)
3. Aspiration & Reflux Precautions with the following strategies: (bullet points)
   - Level of Supervision (e.g., 1:1 assist to help the patient feed himself)
   - Positioning (90 degrees, or elevated side-lying, etc)
   - List strategies/maneuvers (make it clear, in layman's terms)
4. Oral Hygiene & other methods to **reduce aspiration pneumonia risk**, like mobilization and pulmonary clearance techniques. (What ***second line of defense*** can we suggest? Airway clearance devices like flutter valves or cough assist devices. EMST.)
5. Appropriate referrals: OT, PT, RD, ENT/ORL, GI, Neuro, even questions to take back to PCP
6. Further testing: barium swallow, manometry, endoscopy (with FEES vs by ORL for diagnosis. GI for EGD)
7. **Swallow therapy suggestions** with rationales. What may work; what may not work for him?
8. Follow-up (inpatient, VNA, SNF, rehab, outpatient therapy). Repeat testing?

More on med delivery:
http://www.swallowstudy.com/hard-pill-swallow/
More on oral hygiene:
http://www.swallowstudy.com/oral-care-aspiration-pneumonia-prevention/

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## Too risk adverse?
## Too quick to say NPO as only option

- Patient wishes? Patient-centered care model.
- The days are OVER of doctors saying: *"He does not need a video because he does not want a PEG tube anyway."* SLPs used to say flat-out NPO too often. Test is not pass/fail. Now we provide options.
- Encourage conversations. See blog re "The Conversation" & Palliative Care: http://www.swallowstudy.com/conversation-slp-role-palliative-care/
- **Provide options to not force a black or white decision:** Don't force the patient and doctor to say: "Should we follow the SLP's recs or ignore them?" You want to foster the discussion/decision-making.
- Great article re patient-centered care, competence (legal term) versus capacity to make decisions, and how waivers are not appropriate, as they could appear as coercion.
  http://leader.pubs.asha.org/article.aspx?articleid=2624727

Botton Line:

Discuss, educate and **document well**.

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# Early intervention starts with the Instrumental

Dr Martin B. Brodsky, researcher and SLP at Johns Hopkins, spoke on this topic at the Dysphagia Research Society meeting 2017. He commented on a national survey by Macht, et al. (2012) of 1,966 SLPs who regularly evaluate and treat patients for post-extubation dysphagia.

*Many SLPs commented that treatment focuses primarily on dietary texture modification (76%) and compensatory strategies (86%).

**Only **24% of SLPs stated that they focus on intervention** to improve and rehabilitate swallowing function.

Macht, et al., 2012: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3518658/

Read more: #DRS2017 blog: http://www.swallowstudy.com/drs-digest/

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# Resources for planning therapy

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# Thank you for your attention! Questions?

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Follow: @SwallowStudySLP (facebook & Twitter)
Feel free to use contact forms on websites:
www.KarenSheffler.com
www.SwallowStudy.com

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(Citations not already fully stated in the slides)

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# References on Pulse Rate


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