

**FEES: Past, Present, Future**

Susan Langmore, PhD  
Seesen Experts' Workshop

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**Dysphagia Research has Changed  
the Practice of Medicine**

FEES has played a major role

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**Before 1980**

- Primary care physician was the sole provider:
- Patient can eat? → no treatment
- Patient can't eat? → feeding tube

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### Jeri Logemann

- Developed the Modified Barium Swallow (VFSS) study; conducted research in pharyngeal dysphagia and behavioral treatments
- Videofluoroscopy is a great tool to evaluate swallowing

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### Then FEES came along.....

- First publication 1988 – Ann Arbor VA hospital ENT and SLPs worked together
- Nels Olsen (ENT), Ken Schatz (SLP) and Susan Langmore – developed a bedside procedure – as a substitute for fluoroscopy

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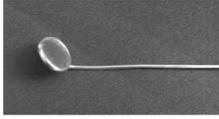
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### Technology Advanced the Procedure



"I'm not sure what happened – it's over!"



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### Cameras and Recording!



I captured the aspiration!



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### One system



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The kinds of patients and the setting for a FEES expanded

- Not just bedside, but
- All Inpatients, ICU patients, outpatients, nursing home patients
- All different medical diagnoses
- Children, babies

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### The Protocol was developed

- The protocol was formalized
- Part 1: Begin with non-swallow assessment of structural movements, secretions status, anatomic alterations
- Part 2: Patient takes different bolus consistencies in different volumes
- Part 3: Trial immediate, compensatory interventions

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### Changes in protocol: (Biofeedback)



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### White food color enhances visualization of the bolus – esp. for clear liquids



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### Protocols for Different Conditions

- Ice Chip protocol: patients currently NPO, severe dysphagia
- Protocols for Parkinson’s, Progressive Supranuclear Palsy, acute stroke – Warnecke, Dziewas

Specific purpose; screening exams?

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### The Scoring System is now being formalized

- Look beyond the bolus ---to uncover the pattern of dysphagia and underlying anatomic, sensory, motor deficits
- 5 patterns of dysphagia identified:
  - Inefficient oral preparation
  - Mistiming at Initiation of the Swallow
  - Incomplete Bolus clearance
  - Penetration/Aspiration before, during, after the swallow
  - (Velopharyngeal incompetence)

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### Standardized Scoring not yet finalized

White out duration:

equivalent to maximum airspace closure?

what about positioning of the scope?

Mozzanica et al., 2018 reported

Mean = 591 msec (+/- 113ms)

longer with more solid bolus,

with larger bolus,

in men and in old persons

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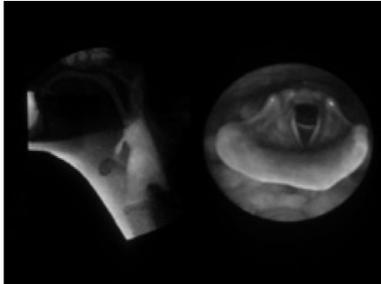
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### FEES vs. Fluoroscopy

- The view is different: What do you want to visualize?




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### Findings Unique to Fluoroscopy

- The bolus during the height of the swallow
- The oral phase in detail
- Completeness of tongue retraction
- UES opening
- Hyoid & laryngeal elevation
- Extent of aspiration
- Anatomical abnormalities beneath the surface mucosa (osteophytes, esophageal narrowing, Zenker's diverticula)

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### Findings Unique to Endoscopy

- Secretions (location, amount, viscosity, patient reaction)
- Direct assessment of sensation
- Surface anatomy / mucosal abnormalities (edema, erythema)
- Configuration of the hypopharynx and effect on bolus flow
- Airway protection
- VC mobility
- Arytenoid movement
- Path of bolus
- Location of bolus residue within the HP

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### Which Exam to do?

- I prefer FEES in the ICU setting and in the Rehab setting
- MBS to analyze UES opening; oral phase
- MBS or FEES for many patients- which is available?
- Repeat exams on children? Favors FEES

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### TWO VIEWS OF A HNC PATIENT

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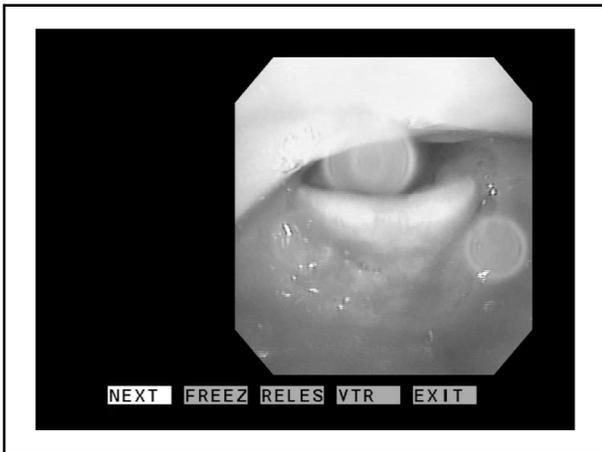
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### Who Should do FEES?

- Whoever understands the complexity of swallowing
  - It is more than aspiration!
- And who is trained
- ENT? Phoniatician? Critical Care MD? SLP? MD +SLP?

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### Is FEES safe?

- Yes - excellent safety record, comparable to MBS
- Every state allows SLPs to perform the exam
  - Some states specify training
- 2018 study by Warnecke, Dzwiewas – best evidence of safety
  - And many of the endoscopists were SLTs!

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### Global Reach of FEES

- FEES is done throughout the Western world
- Becoming common in many countries: South America, Middle East, Southeast Asia – as dysphagia care is expanding
- Why?
  - Less expensive than fluoroscopy
  - More accessible; portable
  - Value of the exam

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### Comparing VF to FEES

*Which is more sensitive to viewing penetration, aspiration, residue?*

- 4 simultaneous FV and FEES studies
- All found FEES was more sensitive – detected the bolus abnormality more often
  - Rao, et al, 2003; Kelly et al, 2006; Kelly et al, 2007; Pisegna and Langmore, 2016
  - PAS and residue ratings were equally reliable for VFS and FEES

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### CONTRIBUTIONS OF FEES TO UNDERSTANDING SWALLOWING AND DYSPHAGIA

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How does the Airway Close for Swallowing?

- Airway closure for swallowing is different from airway closure for breath-hold
  - Order of laryngeal closure:
    - 1 arytenoids
    - 2 epiglottis
    - 3 vocal folds
  - Van Daele, et al, 2005
- This order can be altered with training! (SSGS)
- *VIDEOCLIP OF SWALLOW ONSET*

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Spillage is Variable

- Spillage occurs in normal eating, drinking
- More spillage occurs in more natural conditions
  - Dua et al, 1997 – healthy persons spill up to 3 seconds in usual eating, drinking – the head of the bolus is usually visualized before initiation of the swallow
  - Palmer -2018 – food can accumulate in the OP for up to 10 seconds before swallowing
- *FEES can assess different conditions*
- *VIDEO CLIP OF NORMAL EATING*

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FEES is used to guide Management

- Compensatory interventions
    - Postures, bolus variables, behavioral changes
    - FEES able to monitor all of these
  - Rehabilitative interventions
    - FEES can provide biofeedback to teach:
      - Suprasuperglottic swallow
      - Mendelsohn maneuver swallow
      - Effortful swallow
      - Controlled swallow
      - Tongue pull-back exercise
      - Pharyngeal squeeze//laryngeal lift
- VIDEOCLIP OF BIOFEEDBACK*

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**WHAT IS THE FUTURE OF FEES?**

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**Future directions**

- Standardization of the Usual Protocol
- Standardization of the Scoring System
  - BRACS – rating residue – in process

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**Validation of Part 1 tasks; do they predict function during swallowing?**

- Pharyngeal squeeze → pharyngeal squeeze?
  - Fuller, 2008. High predictability when Ph squeeze is good; unreliable when poor
- Epiglottic retroflexion → Hyolaryngeal excursion?
  - VanDaele – yes; Pisegna (in progress)
- Laryngeal lift → laryngeal lift? (needs more study)

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### Sensory Testing

- Sensory deficits have been associated with aspiration
  - Aviv, Onifri, 2014 in CVA patients; Kaneoka, 2014
- Not signif associated with aspiration (Kaneoka, 2017)
- Needs more study

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### FEESSST = Fiberoptic Endoscopic Evaluation of Swallowing with Sensory Testing

- Air pulse delivered through a catheter within a laryngoscope
- Air pulse delivered to the mucosa over the arytenoids or AE folds at a specific air pressure level. (2 - 10mm of Hg)
- Watch for motor response = brief VC adduction (LAR)
- As you adjust the air pressure level, you can find the threshold that elicits the LAR

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### You are Eliciting the Laryngeal Adductor Reflex

- Stimulate mucosal surface in the HP → sensory signal sent up the superior laryngeal nerve to the brainstem
- Synapse with the recurrent laryngeal nerve → motor response to the TVC
- TVC adduct briefly = **LAR**

\*Aviv JE, Martin JH, Sacco RL, et al. Supraglottic and pharyngeal sensory abnormalities in stroke patients with dysphagia. *Ann Otol Rhinol Laryngol.* 1996;105(2):92-97.

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### FEESSST Protocol Replaced by Touch Test

- This equipment is no longer available
- Today most clinicians do "Touch Test"  
Lightly and quickly touch the arytenoids with the tip of the scope

Problem: Variable pressure between examiners! Gross sensory test

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### Two Methods of Sensory Testing



	Air Pulse Method	Touch Method
Main use	research	clinical
Equipment	air pulse stimulator (Pentax AP-4000)  channel scope (FNL10-/13RAP)	regular endoscope 
Stimulation	air pulse, 2-10 mmHg, 50 ms	light touch
Test sites	arytenoids	arytenoids, the tip of epiglottis
Responses	The Laryngeal Airway Reflex (the LAR)	The LAR, subject report, cough, gag, swallows, etc.
Measurements	4 mmHg < normal (Aviv, 1997)	present / absent (Langmore, 2001)

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### VIDEO DEMONSTRATION OF AIR PULSE TEST AND TOUCH TEST ON NORMAL SUBJECT

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### Recording speed

- Current standard = 30 images/second
- High speed cameras – up to 4000 images/second
  - Adapt this for swallowing (?500 fps)
  - Would allow longer look before white out??
- Video Example

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### “Measuring” residue with FEES?

One study: Pisegna, 2017  
Computed area of vallecular residue and compared it to vallecular residue on MBS

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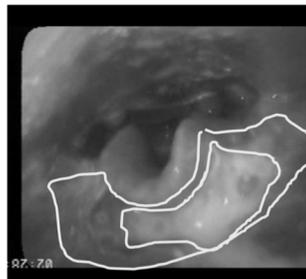
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### Pisegna, 2017 (presentation)

Residue Area: 51411 pixels  
Cavity Area: 128868 pixels  
FEES valleculae  
% filled: 51411 / 128868 = 39.9%



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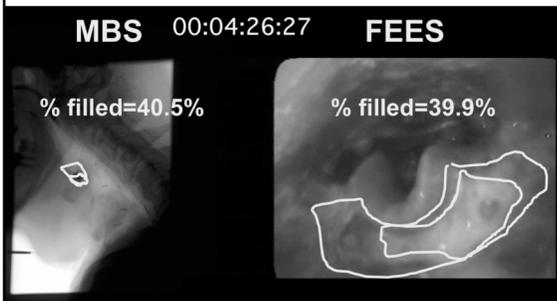
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Pisegna: quantifying residue



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3 DIMENSIONAL VIEW

- Endoscope with 3-D view would allow better estimation of depth and width of valleculae, piriforms

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What do we need to be able to Measure exact residue with FEES?

- You could measure the % of the cavity filled.....
  - with a 3 dimensional endoscope that measures distance in order to convert it to percent
- If measuring the exact volume left in a cavity.....
  - Need to know the capacity of a cavity
  - Or the average capacity of the piriforms, lat channels, valleculae??

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**Experiment at Boston Med Center:  
How much did Mike's channels hold?**

- Mike Walsh SLP volunteered
  - Infused liquid into HP with syringe = into the vallecula, piriforms
  - He suppressed a swallow.
  - Measured volume that had been delivered
- Volume in 1 piriform – about 2.5 – 3 ml  
**in both piriforms (& lateral channels)= 5-6 ml**  
**in his valleculae = 1.5 ml**

One subject!!

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**Short video of BMC experiment**

- Folder = Mike Filling up channels  
– → 4 Mike HP Vall LC Pir Thick

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**Simultaneous VFS and FEES**

- Helps reconcile the two views
- Learn more with more information
  
- Cumbersome, more time to set up, analyze
- Patient must take barium

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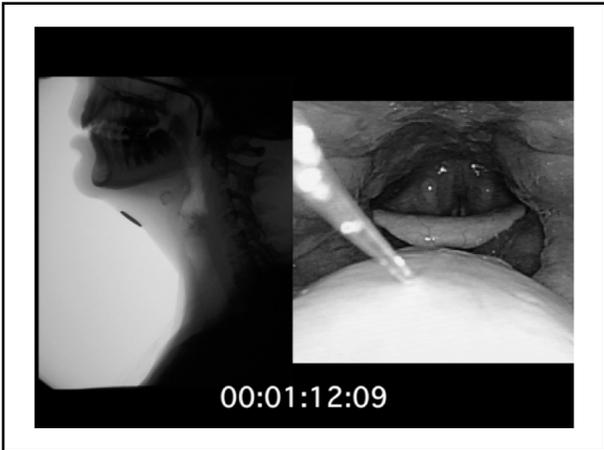
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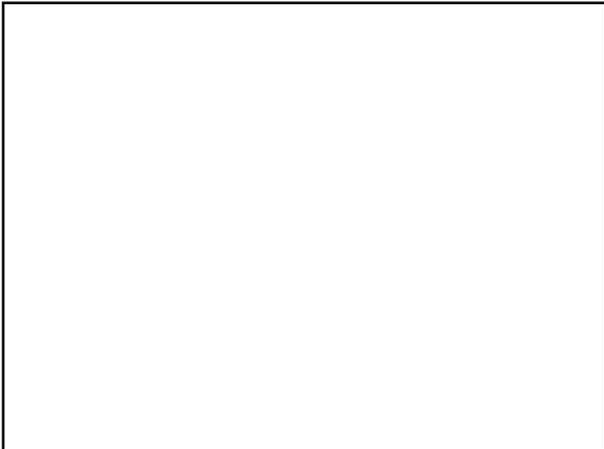
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