Pediatric Dysphagia: Evidence into Practice

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Disclosures

- Financial: Mercy Medical Center (employment)
- Non-financial: No relevant disclosures
- Content: Pictures and videos of breastfeeding to follow!

Outline for Today

- Evidence Based Practice
- Anatomy & physiology
- Breastfeeding Basics
- Assessment principles
- Aspiration: current information & theories
- Intervention principles
- Time for questions

Evidence Based Practice: what is it?

- Goal: integrate these three factors to deliver high-quality service
- Dynamic process
- Allows for individualized care

Evidence Based Practice: why do we need it?

- Crucial for the sustainability of our profession
- ASHA Code of Ethics
- And...it’s the best thing for our patients and families!

Evidence Based Practice: What are the (perceived) barriers?

- Time
- Access
- Research reading skills
- ASHA tutorials
- Check out dysphagiagrandrounds.com!
- Resistance to practice changes
- Available research to read
Evidence Based Practice: How do we get there?

• External scientific evidence
• Where to find
  • Free/open access
  • www.doaj.org
  • Possible library access
  • Great analysis of topics via ASHA SIG 13 Perspectives
• How to evaluate
  • ASHA website
  • EBP Tutorials
  • Evidence maps
  • http://www.cebm.net/critical-appraisal/
  • Databases such as PEDro
• Share the load
  • Form journal groups

ASHA Practice Portal

Anatomy

• Vocal fold composition

• Arytenoid length


Newborn & Adult Larynx

http://curriculum.net/SPD/OH/contents/hudbypreview.htm?/3/5/10/08/2099
http://www.entusa.com/larynx_photo.htm

Anatomical Deviations of the Larynx: Laryngomalacia

- Laryngomalacia
  - Softening of laryngeal tissue
  - Typically symptoms present at birth or within first month
  - Inspiratory stridor
  - Difficulty feeding
  - Apnea/cyanosis
- Etiology
  - Anatomic?
  - Inflammatory?
  - Neurologic?

Management
- Depends on severity
- Manage the associated dysphagia
- Typically resolves without intervention before 2 years of age
- Reflux management
- May require surgical intervention if severely impacting breathing/feeding


Laryngeal Cleft

- Congenital malformation
- Abnormal communication between the posterior larynx/trachea and the esophagus

Laryngeal Cleft: Symptoms

- Possible overt symptoms
  - Stridor
  - Hoarse cry
  - Coughing/choking with feedings
  - Cyanosis

- Can be associated with other congenital anomalies or occur in isolation

<table>
<thead>
<tr>
<th>Table 1 Presenting symptoms of patients with type 1 laryngeal cleft</th>
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<tbody>
<tr>
<td>Symptoms</td>
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<tr>
<td>-----------</td>
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<tr>
<td>Aspiration with thin liquids</td>
</tr>
<tr>
<td>Recurrent pneumonia</td>
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<tr>
<td>Chronic cough</td>
</tr>
<tr>
<td>Stridor</td>
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<td>Nipple</td>
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The number of patients and the percentage are shown.


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Laryngeal Cleft: Diagnosis

- Multi-disciplinary
  - Collaboration amongst multiple professionals
  - May include chest CT, broncho-alveolar lavage
  - Referral to ENT
  - Flexible laryngoscopy
  - Direct/rigid scope in OR with palpation of inter-arytenoid space

Chien, et al., 2006; Rahbar et al., 2006; Williams et al., 2011; Neubauer, Rosenthal, Wooten III, Zdanski, & Drake, 2013

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Laryngeal Cleft: Management

- Conservative
  - Diet modification/swallow maneuvers based on swallow study
  - On-going assessment to try to wean
  - Reflux management
  - “Wait and see”

- Surgical
  - Open or endoscopic
  - Gel injection or suture repair

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Laryngeal Cleft: Surgical Management

- Injection laryngoplasty
- Suture repair

WARNING: Intra-operative video, there's blood!
Post-operative Dysphagia Management

- Typically wait at least 6-8 weeks post repair for repeat swallow study
- Some advocate for clinical weaning/monitoring with repeat VFSS only as necessary if pt had no co-morbidities and symptomatic aspiration
  - (Wentland et al., 2016; Hersh et al., 2016)
- Dysphagia may persist post-operatively
  - Neurodevelopmental compromise strongest predictor of continued need for thickened liquids or NPO (Osborn et al., 2014)

Swallow physiology

- Pediatrics: Phase model
  - Anticipatory Phase
  - Oral Preparatory Phase
  - Oral Transit Phase
  - Pharyngeal Phase
  - Esophageal Phase*
    - Leopold & Kagel, 1997; Logemann 1998
- Useful for organizing thoughts & guiding differential diagnosis
  - Infants: Add layer of suck/swallow/breathe

Suck/Swallow/Breathe Physiology: Sucking

- Efficient sucking is comprised of both suction & expression (compression)
  - (Lau & Kusnietczyk 2001; Cannon et al 2013; Elad et al 2014; Geddes, Chadwick, Kent, Garbin, & Hartmann, 2010)

Suck/Swallow/Breathe Physiology: Sucking

- Breastfeeding vs bottle feeding
  - Muscle activation
    - Bottle feeding: ↑ buccinators & orbicularis oris
    - Breastfeeding: ↑ Mentalis, masseter, temporalis, M Pterygoid

*Geddes, Chadwick, Kent, Garbin, & Hartmann, 2010
Ardran, Kenis, & Lind, 1958; Sakulidis et al., 2012; Geddes et al, 2008; Gomes 1996; Inoue, 1995; Sakashita 1996; Nyvquist 2001
Suck/Swallow/Breathe Physiology: *Sucking*

- **Sucking**
  - Expression develops before consistent use of suction (Lau et al, 2000)

Suck/Swallow/Breathe Physiology: *Swallowing*

- **Swallowing**
  - Tongue base pressure (Rommel 2006)
  - Pharyngeal clearance
  - Shortening & contraction present (Rommel 2006, 2011)
  - Adequate valving needed
  - Reduced pharyngeal peak pressure above the UES which disappears with increasing age (Rommel 2011)
  - Airway protection**
  - Pharyngo-esophageal sphincter opening
  - UES relaxation found to be less complete at time of maximum proximal pharyngeal contraction, improved with age (Rommel 2011)
  - UES resting tone increases with age (Jadcherla 2005)

- **Esophageal motility**
  - Esophageal function: Peristalsis & aerodigestive protection
  - Amplitude of esophageal peristalsis increases with maturation (Gupta 2009)

Airway Protection

- Hyolaryngeal positioning
- Vestibule closure
- Epiglottic inversion?

Epiglottic Inversion

- Rommel 2002, Rommel 2006
  - No consistent epiglottic tilting until after 5 years of age
  - Epiglottis moved an average 34°, range of 9°-49°
  - Mean age of participants was 18 months, range 2-30 months
- Gosa 2012 & Gosa, Suiter, & Kahane 2014
  - Absence of full epiglottic tilting during swallows of infants (age range 1 week-3 months)
  - Anterior movement of arytenoids was sufficient for laryngeal closure

Videoswallow: Epiglottic Inversion?
Suck/Swallow/Breathe Physiology: Breathing

- Swallow Apnea
  - Nasal airflow maintained during sucking, swallow apnea required during swallow

Suck/Swallow/Breathe Coordination

- S/S/B coordination requires complex neural control
- Respiratory phase coordination of swallow apnea
  - Term infants: E-I then I-E most dominant (Kelly et al, 2007)


Suck/Swallow/Breathe Physiology: Breathing

- Healthy preterm infants:
  - I-I and P most dominant (Lau et al, 2003), difference not significant when taking 6-8 oral feedings
  - Pattern matures to I-E dominant by 35 weeks in healthy preterms (Mizuno & Ueda, 2003)
- Preterm infants with lung disease:
  - Worsened with time, 32.6% E-I (Gewolb & Vice, 2006)
  - Highly disorganized (Mizuno et al, 2007)


Breastfeeding: Anatomy

Credit on slides in this section shared with:
Colleen Gould, MS, CCC-CLP, IBCLC
Jenny Walters, MPH, IBCLC, LLLL
Breastfeeding: Flow rate

- Flow rate: baby driven vs passive flow
  - Bottle feeding
    - Respond to more of a passive flow
  - Breastfeeding
    - Milk ejection reflex
    - Milk flow rate likely to vary by time of day
    - Milk composition may vary
    - Dependent upon supply and inherent flow characteristics

The Basics: Positioning

- Basic principles of positioning for preterm infants
  - Baby facing directly at the breast, close to mother's abdomen
  - Provide breast support and wedging
  - Keep chin off chest
  - Provide stability/bracing to feet

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Positioning for preterm infants:
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Slide credit shared with: Colleen Gould, MS, CCC-SLP; Jenny Walters, MPH, BOC-L, LLLL, ASHA 2012
The Basics: Positioning


The Basics: Latch

• Latch
  • Characteristics
  • Deep positioning
  • Comfort for mother
  • Strategies
  • Breast wedging
  • Asymmetric latch
  • Nipple shield

The Basics: Latch

• Breast wedging to facilitate a deeper latch

The Basics: Latch

• Silicone nipple shield
  • Ultrathin
  • Come in a variety of brands, shapes, sizes
  • Can help sustain latch and facilitate milk transfer
  • Preterm population: Meier et al 2000

Questions?
**Clinical Swallow Evaluation**

- Evolving utility with adult populations
  - No empirical evidence we can do this reliably
- Judging HLE from our fingers
- Interpreting presence/absence of “wet” vocal quality
  - Less than 50% reliable in identifying aspirators on VFSS based on wet vocal quality (Groves-Wright et al., 2010)
- Cough after swallow
  - Smith-Hammond et al 2009: clinical signs <60% sensitivity for aspiration
  - Daniels 1998: silent aspiration in 2/3 stroke patients

**Silent aspiration in pediatrics: what do we know?**

- Children with neurologic impairment predisposed to silent aspiration
- Silent aspiration described in both neurologic & non-neurologic populations

**Goals of Assessment**

- Overall goals: minimize risk, maximize health, support development, support family goals
- Key= Differential Diagnosis
  - Key factor in pediatric evaluation
    - What are contributing factors?
    - What more information do you need? (e.g., referrals)
  - Immature vs. abnormal patterns?
  - Sensory vs. Motor?
  - Sensory issue vs. behavior?
  - Motor weakness vs incoordination vs abnormal tone?
  - Structural vs neurologic?

**Pediatric Clinical Swallow Evaluations**

- Likely components
  - Detailed history (feeding, medical, developmental)
  - Cranial nerve exam/oral assessment
  - Reflex exam (as appropriate)
  - Assessment of positioning/postural stability
  - Sensory responses
  - Behavior/state control
  - Feeding/swallowing assessment (as appropriate)
Additional Factors to Consider

- Age/developmental stage
- Experience
- Diagnosis
- Status of dysphagia: acute or chronic?
- Setting

Clinical Swallow Examination: Special Considerations for Pediatrics

- Developing system
  - 0-3 year age range is highly heterogeneous (Delaney & Rudolph 2012)
  - Interpreting signs/symptoms in the context of disrupted development
- Developing lungs
- Nutrition is paramount
- Lifetime potential of radiation exposure

Clinical Swallow Evaluation: Summary of Utility

- Acknowledge limitations but also benefits
- Key component: dysphagia assessment involves more than just aspiration risk

Formal Assessment Tools


Videofluoroscopic Swallow Studies (VFSS)

- General procedure
- Goals of the exam
  - Clinical question
    - Dysphagia ≠ aspiration
    - Pathophysiology detailed
    - Compensatory strategies/utensils tested
  - Part of the overall picture, but is not the whole answer

Key points to consider (Arvedson & Lefton-Greif, 2017)
- Increased concern of radiation exposure with infants/children
- Justification
  - Adequate knowledge to know risks vs benefits
  - (Huda, 2009)

Optimization
- ALARA (As Low As Reasonably Achievable)
- Plan exam to limit fluoro time needed to answer questions
- Number of swallows needed? Plan for fatigue?
- Pulse rate: 30 fps (Bonilha et al., 2013)

Temporal Measures: Normal
- Preliminary Temporal Measurement Analysis of Normal Oropharyngeal Swallowing in Infants and Young Children
  - Weckmueller, Julia, Easterling, Caryn, Arvedson, Joan
  - Dysphagia (2011) 26:135–143
- Retrospective review of 15 normal swallow studies
- Separated into 3 age categories
- Important findings re: initial look at “normal”
- Most clinically applicable findings:
  - Bolus at or fully contained in the valleculae at the onset of laryngeal closure
  - For all 15 subjects, laryngeal closure occurred after the head of the bolus passed the tongue base
Penetration

- Retrospective review of videoswallow studies
- N=125, aged 7 days to 19 years
- Significant increase in incidence of aspiration in children w/deep penetration (85%)

Deep Laryngeal Penetration as a Predictor of Aspiration.

Barium Use in Pediatric Studies

- Barium liquids were more viscous, more dense, & had higher yield stress than mealtime liquids
- No comparability between barium and formula mixtures
- Gosa & Dodrill (2016)
- Frazier et al. (2016)
  - Several infant formulas stayed within NDD thin range with 20% w/v E-Z Paque barium added
  - Specialty formulas acted differently: Enfamil AR 20 cal got thinner with addition of barium, the 24 cal Enfamil AR got thicker

FEES: Fiberoptic Endoscopic Evaluation of Swallowing

**Indications**
- Question aspiration of secretions
- Patients who are NPO or minimal PO intake
- Question airway protection specifically
- Need more information after a videoswallow
- Unable to adequately simulate feeding position with fluoroscopy

**In the Literature**
- Description of procedure with pediatric patients: Willing 1995
- Clinical utility: Hartnick et al 2000
- Good correlation with VFSS: Madden et al 2000, Leder & Karas 2000
- Sensory thresholds correlated positively with pooled secretions, penetration, & aspiration: Link et al 2000

**Pros**
- Better simulates feeding environment & experience
- Clear view of structures
- No barium or radiation
- Assess caregiver interventions
- Assess during breastfeeding
- No set time constraints
- Promote family involvement

**Cons**
- Possible discomfort to patient
- Specialized training required
- No view of esophageal phase
- Chain swallows in infants can be difficult to interpret
- White out during the swallow
- Equipment cost

**In the Literature**
- Adapted from Willing, CE 2013
- Adapted from Link et al 2000
- Adapted from Reynolds & Sturdivant, 2014
FEES in the NICU
- Safety/tolerance
  - No major complications occurred when used in NICU infants under the age of 3 months; stable physiologic parameters (Willette et al, 2016) (Suterwala et al, 2017)
- Breastfeeding assessment (Willette et al, 2016)
  - Used safely and effectively during breastfeeding assessments
  - Not able to establish reliability due to lack of other instrumental option
- Reliability (Suterwala et al, 2017)
  - Good inter-rater agreement for penetration with VFSS (87%) and FEES (80%)
  - Good inter-rater agreement for aspiration with VFSS (90%) and FEES (80%)

Decision Making: Aspiration
- Response to aspiration
  - Protection: mechano & chemo receptors on surface of pharynx, epiglottis, arytenoid cartilages, vocal folds (Tutor & Gosa, 2012)
  - Protective response varies by age
  - Preterm infants: apnea (prolonged), bradycardia, and reduced respiratory efforts (Thach, 2001; Miller 1952)
  - Term infants: brief cessation in respiration and initiated 1-2 swallows (Thach, 2001)
  - Adults: Cough, swallow (Thach, 2007)

Health Impact of Aspiration
- Short term
  - Apnea/bradycardia/desats?
  - Could these lead to longer term growth issues?
    - (Wang, 2010)
- Long term
  - Evidence of pulmonary symptoms & CXR finding?
    - (Mercado-Deane et al, 2001)
    - Odds ratio of PNA
      - Taniguchi & Moyer, 1994
      - Lung damage via high resolution chest CT
        - Pezzine et al 2012***, Bosch et al 2006***
        - High prevalence of bronchiectasis in children with chronic pulmonary aspiration, seen as early as 8 months

Recommendations: Factors to Consider
- Patient characteristics
  - Age
  - Environment
  - Overall health status
    - Comorbidities, ability to fight infection
  - Capability of following through with plan
  - Need for adequate nutrition

Recommendations: Factors to Consider

- Dysphagia Characteristics
  - Frequency and amount of aspiration
  - Chronicity of the problem
  - What is aspirated
    - Liquids only? Solids?
  - Source of aspiration
    - Likely to improve with time? Structural?
- Support for pt/family goals in the context of the disease trajectory (Pollens 2004)

Recommendations?

- What to do?
  - Individualized, team-based approach, based on each patient’s medical history, presentation, & goals of care

Flow Rate: Bottle Feeding

- Rationale:
  - Preterm infants more efficient with more controlled flow rate (Chang 2007, Lau et al 1997, Lau & Schanler 2000)
- Bottle characteristics (Ross & Furham, 2015)
  - Hole size (Jackman, 2013; Pados, Park, Thoyre, Estrem, & Nix, 2015),
  - Pliability (Zimmerman & Barkow, 2008)
  - Shape and size (Eishima, 1991; Segami 2013)
  - Air exchange (Lau 2015)
  - Hydrostatic pressure (Lau & Schanler, 2000)

Milk Flow Rates From Bottle Nipples Used for Feeding Infants Who Are Hospitalized.

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Suck/Swallow/Breathe Coordination

- External pacing/co-regulated feeding
  - Rationale: responding to cues from the infant that intervention/increased support is needed to maintain coordinated breathing/swallowing, postural stability, & state regulation (Shaker, 2013)
  - Articles of interest: (Shaker, 2017) x2
    - Co-regulated feeding resulted in: less oxygen variability, decline, and time spent in desat state, less heart rate variation & decline, less behavioral dysregulation, better fluid management, decreased work of breathing
    - Law-Morstatt et al, 2003
      - Pacin resulted in: statistically significant decrease in bradycardia, more efficient sucking pattern

Flow Rate: Breastfeeding

- Prone positioning
- Pump before feeding
- Nipple shield
- Scissor hold
- Flat hand/heel pressure (Dr Carol Chamblin)

Positioning

Elevated side-lying (ESL)

Why would this work?
- Possible decreased work of breathing due to less anti-gravity movement required (Vanderghem, Beardsmore, & Silverman, 1983)
- Can help to decrease gravity effect on bolus (toward pharynx)
- Simulates cross-cradle breastfeeding position
- Clinical expertise: does this work? My experience is yes.

Positioning

- Side-lying position
  - Clark et al 2007
    - Trend toward greater physiologic stability in ESL position (increased SpO2, more stable heart rate)
  - Dawson et al, 2013
    - Little difference found in infants’ physiologic stability between the two feeding positions
    - Trend toward infants consuming a smaller proportion of their feed in cradle hold
Positioning
• Lau, 2013
  • No difference in time to attain full oral feeding between cradle, side-lying, and upright positions
• Park, Thayre, Knafl, Hodges, & Nix, 2014
  • Elevated side-lying: Significantly less variation in HR, less severe & fewer decreases in HR, RR closer to pre-feeding state, shorter & more regular intervals between breaths, shorter & fewer feeding-related apneic events

Intervention: Thickening
• Gosa, Schooling, Coleman 2011
  • Evidence Based Systematic Review
  • Currently we have an insufficient evidence base for the use of this intervention
  • (Madhoun, Siler-Wurst, Sitaram, & Jadhrele, 2015)
  • Survey
    • Variability of thickening prescriptions, thickening agents, recipes

Intervention: Thickening
• Possible benefits of thickened liquids
  • Slower moving liquids may give increased sensory information and allow for greater oral motor control (Goldfield, Smith, Buonomo, Perez, & Larson, 2013)
  • Slower flowing to improve timing of airway protection (Rempel & Moussavi 2005)
  • Possibly decrease/eliminate aspiration (Mercado-Deane et al 2001; Gosa, Suiter, Kahane, 2011)
  • After temporal measures (Gosa, Suiter, Kahane, 2011)
  • Clinical experience?

Intervention: Thickening
• Possible downsides/risks
  • Malnutrition/dehydration?
    • Evidence exists that thickening does not affect bioavailability of water in healthy controls (Hill et al 2010, Sharpe et al 2007)
    • May impact efficiency, and therefore intake/weight gain
  • Gut health?
    • Woods 2012 detailed development of necrotizing enterocolitis in premature infants using Simply Thicker
  • Constipation
  • Inconsistency of viscosity/recipes
    • Viscosities vary by time, temperature, etc (Garcia et al 2005, 2008) (Gosa & Dodrill, 2016)
    • Even experienced SLP’s not able to reproduce consistent nectar or honey (Glassburn & Dean 1998)
    • Possible cessation of breastmilk

Thickening: Factors to Consider
• What type of thickener to use
  • Rice/oatmeal, starch, gum, Gelmix, fortified specialty formula
• Weaning from thickened liquids
  • Based on individual swallow physiology
  • May repeat instrumental exam or wean clinically and closely monitor
    • Progressive weaning of thickening

Thickening: Fortified Formula
• Rationale:
  • Many preterm infants need higher caloric density and added calcium/phosphorus
  • Clinicians have long noted the perception of increased thickness of anti-reflux formula (Enfamil AR), approximating half strength nectar
  • Anecdotally, NICU clinicians report that frequently half strength nectar is sufficient for swallowing safety with use of slow flow nipples (Dr Brown’s P and Ultra P)
  • Possible option:
    • Enfamil AR fortified to 24 cal
Viscosity Measurements of Fortified Infant Formulas
Mayfield, Woods, Gould, Walters, Bullock
2014 ASHA Convention

Direct Muscle Intervention
- Motor training principles
  - Robbins et al., 2008 principles of neuroplasticity
  - Use it or lose it
  - Use it and improve it
  - Plasticity is experience specific
  - Repetition matters
  - Intensity matters
  - Age matters
  - Time matters
  - Salience matters
  - Transference
  - Interference

Direct Muscle Intervention
- Oral phase interventions for preterm infants
  - 3 systematic reviews
    - (Arvedson, Clark, Lazarus, Schooling, & Frymark, 2010)
    - (Lima, Côrtes, Bouzada, & Friche, 2015)
    - (Tian et al., 2015)
  - Conclusion from 2015 studies: oral phase interventions may shorten the transition time to full oral feeding

Direct Muscle Intervention
- Oral phase interventions for older infants/children
  - One systematic review
    - (Arvedson, Clark, Lazarus, Schooling, & Frymark, 2010)
  - Conclusion: insufficient evidence for OR against
    - (Gosa & Dodrill, 2017)

Direct Muscle Intervention
- Pharyngeal phase intervention
  - Neuro Muscular Electrical Stimulation (Christiaanse et al., 2011)
  - Conclusion: NMES did not improve swallow function
  - Two systematic reviews
    - (Morgan, Dodrill, & Ward, 2012)
      - Insufficient evidence to support or refute
    - (Harding & Cockerill, 2015)
      - Lack of evidence to support or refute

Questions?