Pediatric Dysphagia: Myths vs Evidence

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Disclosures

• Emily Mayfield
  • Financial
  • Salary from MercyOne Des Moines/CommonSpirit Health
  • Non-Financial
  • Executive Committee/Board Member of the American Board of Swallowing & Swallowing Disorders
  • Editorial Board member: ASHA Perspectives of SIG 13: Swallowing & Swallowing Disorders

• Julianna Hoffman Kuklin
  • Financial
  • Salary from MercyOne Des Moines/CommonSpirit Health

Outline

• Why do clinical myths persist?
  • Myths:
    • Feeding on high flow oxygen/CPAP is safe
    • Thicker is always better…but there are no safe ways to thicken liquids for infants
    • Instrumental exams are pass/fail
    • Slow flow nipples make infants work harder to feed
    • Epiglottic inversion is key to infant swallowing safety
  • Questions/discussion

Why do clinical myths persist?

• Slow adoption of research into clinical practice
• What are we reading?
• And ARE we reading?
• Different perspectives and experiences
• Variable practice patterns
• Resistance to change

Balas & Boren, 2000; Morris, Wooding, & Grant, 2011; Reynolds, 2016; Madhoun, Siler-Wur스트, Sitaram, & Jadcherla, 2015

Myth #1: Feeding on HFNC/CPAP is perfectly safe!

Portions of slides in this section were developed collaboratively and credit shared with: Dr. Jim Coyle, Dr. Martin Brodsky, and Dana Novotny, RRT

Pediatrics: Nasal Continuous Positive Airway Pressure & High Flow Nasal Cannula

Nasal CPAP

HFNC
**Adults: High-Flow Nasal Cannula**

F&P Optiflow

VapoTherm Precision Flow

**When is non-invasive support used?**

- **Pediatrics**
  - Primary after birth vs post-extubation support
  - Any illness with reduced functional residual capacity (FRC)
- **Adults**
  - Post-operative pulmonary insufficiency
  - Respiratory failure (broad diagnostic diversity)
  - Avoid intubation
  - Post-extubation support

**How it works: HFNC**

- Flow
  - Nasopharyngeal "dead space" wash out
- Gas conditioning
  - Heated & humidified: decreased metabolic workload
- Pressure?

**How it works: CPAP**

- Goal: Distending pressure
  - Recruits lung volume
  - Increases the Functional Reserve Capacity
  - Splint upper airways
  - Also: gas conditioning

**What’s the big deal?**

- Pharyngeal pressure/pressure on the bolus?
- Impact on laryngeal sensation/closure?
- Impact on breathing/swallowing coordination?
- Is it evidence of an unstable acute illness/risk of decompensation?

**Guidance from the literature**

- Pharyngeal pressure
  - Pediatrics
    - CPAP: Pressure ordered might not be the pressure delivered, but it is not typically higher than ordered (De Paoli, Lau, Davis, & Morley, 2005)
    - HFNC
      - MULTIPLE studies available; difficult to compare findings.
      - Factors that influence pressure: patient weight, nare:prong ratio, location of prongs, mouth open/closed
      - Variable correlation of pressure with flow...roughly 1:1 relationship except at <3 L/m

Guidance from the literature

- Pharyngeal pressure
  - Adults
    - Few studies available
    - Average pressures recorded were lower, but peaks existed to 6 cm H2O and higher

(Groves & Tobin, 2007; Okuda et al., 2017; Parke, Eccleston, & McGuinness, 2011; Parke & McGuinness, 2012; Parke, McGuinness, & Eccleston, 2009; Ritchie, Williams, Gerard, & Hickey, 2011; Ward, 2013)

- Pharyngeal/laryngeal sensation & closure
  - Pharyngeal distension on CPAP: Sinha et al., 2015; Walor et al., 2005
  - Laryngeal distension on CPAP: Giann et al., 1999
  - Mixed results on swallow timing: Sanuki et al., 2017 (HFNC); Jadcherla et al., 2016; Nishino et al., 1989 (NCPAP)

- Short term outcomes
  - Hanin et al., 2015; Leder et al., 2016; Shetty et al., 2016; Slain et al., 2017; Glackin et al., 2017; Sochert et al., 2017; Dalgleish et al., 2016
  - Breathing/swallowing coordination
    - Sanuki et al., 2017 (HFNC); Jadcherla et al., 2016; Bernard et al., 2013*; Samson et al., 2017*; Samson et al., 2018*

* Completed with lambs

- Objective swallowing information
  - Ferrara et al., 2017

- Additional factors to consider for pediatrics
  - Heightened risk for (silent) aspiration
    - Mizuno et al., 2007; Gewolb et al., 2003; Gewolb & Vice, 2006; Arvedson et al., 1994; Velayutham et al., 2012; Weir et al., 2011
  - Risk for negative pulmonary sequelae
    - Piccione et al., 2012; Radford et al., 1995
  - Developmental vulnerability
    - Browne & Ross, 2011; Cong et al., 2017; Hawden et al., 2000; Smith et al., 2011; Thoyre, 2007

(Okuda et al., 2017)

Guidance from the literature

Yes, does it have to be an “always” or “never”?

Does it have to be an “always” or “never”?

RESIST THE URGE TO PLANT YOUR FEET IN ONE CAMP!!
Myth #2: Thicker is Always Better, and There Are No Safe Options for Thickening In Infants

- Gosa, Schooling, Coleman 2011
  - Evidence Based Systematic Review
  - Currently insufficient evidence base for the use of this intervention as a treatment for dysphagia
  - Establishment of safe/effective feeding and swallowing skills that is least disruptive to the developmental progress of feeding acquisition
- Madhoun, Siler-Wurst, Sitaram, & Jadcherla 2015
  - Survey of NICU professionals across US
  - High variability of thickening practices

To thicken...

- Possible Benefits
  - Slower moving liquids may give increased sensory information and allow for greater motor control (Goldfield, Smith, Buonomo, Perez, & Larson, 2013)
  - Improvement in swallow/breath coordination, airway protection (Rempel & Moussavi 2005)
  - Possible decrease/elimination of aspiration and penetration (Mercado-Deane et al 2001; Gosa, Suler, Kahane, 2011).
  - Temporal Measures — duration of UES opening (Gosa, Suler, Kahane, 2011)

...Or Not To Thicken

- Possible Risks
  - Malnutrition/Dehydration
    - Evidence that thickening does NOT effect bioavailability of water in healthy controls
    - Impact on efficiency and turn reduced intake with negative impact on weight gain
  - Gut Health
    - Woods 2012: development of necrotising enterocolitis in premature infants using Simply Thick®
    - Nutrient density (McCallum 2011)
    - Constipation/diarrhea/malabsorption
  - Impact on breastmilk intake
  - Inconsistency of viscosity/recipes
    - Viscosity varies by time, temperature, etc (Gosa and Dodrill 2016)

Thickening Options

- What type of thickener?
  - Infant rice cereal/oatmeal, starch, gum, Gelmix®, fortified specialty formula

Fortified Formula

- Rationale
  - Caloric density, calcium/phosphorous
  - Increased swallow safety with slow flow nipples (Dr Brown Preemie and Ultra Preemie)
  - Supported with classifications of IDDSI Slightly Thick viscosities (Steele et al 2014)
  - Enfamil AR 24 cal formula

Additional Considerations

- Comparable to VFSS barium viscosities
  - Thickening agents may result in formulas that are thinner or thicker than test consistencies
  - Too thin, may not prevent aspiration = risk of poor pulmonary outcomes
  - Too thick, excessive effort expenditure = risk of fatigue and reduction in total volume of intake, resulting in malnutrition and dehydration

- Home bottle/nipple systems must be examined in VFSS

- Consistency in preparation
  - Complexity of successfully carrying out thinning procedure in infants with dysphagia

- Standard instructions on thickeners without consideration of makeup of specialty types of fluids (formula)

- Parent Training and compliance

(See and Dostaire 2016)

Enfamil AR 24 kCal Syringe Test

Enfamil AR 24 kcal

2:1 Nectar:Thin Barium

Myth: Instrumental Exams are Pass/Fail

- ASHA Practice Portal
  - Visualize structures
  - Assess physiology
  - Presence/cause/severity of dysphagia by visualizing bolus
  - Responsivity to bolus misdirection and residue
  - Presence/location/amount of secretions
  - Sensitivity to secretions, attempts to clear
  - Determine cause of penetration/aspiration
  - Effects/safety of varying bolus consistencies and strategies

- MBSImp
  - Standardized online training and reliability testing
  - Assessment of 17 components in adults
  - Scoring metric
  - Reporting results

- Pediatrics
  - Lack of normative data, but must complete descriptive analysis and use available norms (Weckmeuller et al., 2011; Gosa et al., 2015; Arvedson & Lefton-Grief, 2017)

No aspiration, no risk?

- What you don't see might still hurt you
- Factors that might increase/decrease actual aspiration risk
  - Impairments in timing and/or coordination?
  - Presence of deep laryngeal penetration
  - Presence of frequent/deep laryngeal penetration
  - Airway protection?
  - Fatigue?
- Results must be validated by clinical observation
Video Swallow Studies

Part 1 - Pediatrics

- Anatomy
  - Appearance, movement and function of the nasopharynx, pharynx/larynx
- Secretions
  - No standardized scales
  - Descriptive in nature

Part 1

- Anatomy
  - Symmetry of structures
  - Integrity/condition of structures and mucosa
  - Lesions/abnormalities observed
- Secretions
  - Presence and severity of secretions prior to bolus administration
  - Murray Secretion Scale 1996
  - Pluschinski et al 2016
  - Kuo et al 2017

(Fearn et al, 2018; Dysphagia. 2019; 34: 371-86.)

Part 1

- Movement
  - Vocal fold mobility
    - Base of tongue retraction

31

32

33

34

35

36
Part 1 - Pediatrics

- Movement
  - Vocal Fold Mobility

- Swallow Frequency

http://cursoenarm.net/UPTODATE/contents/mobipreview.htm?29/15/29939

Part 1 (Langmore, 2017)

- Movement
  - Pharyngeal constriction
    - Fuller 2009: Pharyngeal Squeeze Maneuver vs Pharyngeal Constriction Ratio (in fluro)

Part 1 (Langmore, 2017)

- Pharyngeal elevation
  - Miloro et al 2014: effortful pitch glide imitates kinematics of swallow

Part 1 (Langmore, 2017)

- Sensation
  - FEEST = air pulses delivered to mucosa at juncture of arytenoids and AE folds
  - "Touch Method" = light touch to arytenoids to assess for laryngeal adductor reflex
  - Kaneoka 2014: touch method was significantly associated with abnormal PAS scores

Part 2 – Pediatrics

- Intake of various consistencies

Part 3 – Pediatrics

- Bottle/Breast feeding trials
  - Response to Compensatory Strategies
FEES – Normal Adult

FEES - Infant

Pediatric FEES

- 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 aspiration with VFTS (97%) and FEES (80%)
- Good inter-rater agreement for aspiration with VFTS (90%) and FEES (80%)
- Accuracy (Armstrong et al, 2019)
  - Agreement between VFTS and FEES – 92% for aspiration, 96% for penetration
  - FEES detected more instances of penetration than VFTS (greater sensitivity to penetration than VFTS)

Myth #4: Infants work harder to feed with a slow flowing bottle nipple

Slowing the flow

- Rationale based on knowledge of typical development
- What can disrupt this typical patterning?
- What happens when flow rate exceeds ability?
- What happens when flow rate matches ability?
- How do we “know the flow”?

Rationale for slowing the flow

- Organized suck/swallow/breathe patterning
  - Brief apnea during swallowing when vocal folds close (Barlow, 2009; Harlon et al., 1997; Heo et al 2003)
  - Larger the bolus, longer the apneic period? (Ohbuda et al., 2017)
  - More frequent swallowing decreased minute ventilation (Koeng, 1990)
  - Term infants are good at modulating this process (Al-Sayed et al., 1994, Bamford et al., 1992)
  - Maturation effect on improving coordination and phase timing (Kelly, 2007)

Wolf & Glass (1992)
Rationale for slowing the flow

• What can alert this rhythmic patterning?
  • Immaturity
    - Central pattern generators and cross-system interaction (Amaizu, et al., 2008; Barlow, 2009, 2010; Barlow & Estep, 2009)
  • Illness
    - Decreased cardio-pulmonary reserve
    - Decreased ability to make modifications to pattern
    - Decreased endurance
  • Decreased ability to make modifications to pattern
  • Decreased endurance

(Gewolb, et al., 2001; Gewolb. et al., 2003; Gewolb & Vice, 2000; Isokawa et al., 2017; Jacobson et al., 2010; McCrattan et al., 2017; Past et al., 2006; Yi et al., 2017)

• Patterning can be HIGHLY variable
  • Smaller bolus-less disruption

(Mizuno et al., 2007)

What happens when the flow is too fast?

Infant attempts to make modifications
• Alter sucking pattern to decrease flow
  • Decrease suck amplitude
  • Short sucking bursts
  • Long pauses between bursts
  • Oral loss

Infant not able to make modifications
• Airway compromise
  • Physiologic instability
  • Aspiration

(Al-Sayed et al., 1994; Capilouto & Cunningham, 2010; Craig et al., 1999; Craig et al., 1999; Davis et al., 2013; Dohrrill & Gosa, 2018; Gewolb et al., 2003; Goldfield et al., 2000; Eishima, 1991; Lee et al., 2011; Mathew, 1991; Mizuno et al., 2007)

Stressful experiences

(https://www.nfant.com/)

Video: fast flow feeding

Source: https://www.nfant.com/
What happens when the flow rate is manageable?

- Anecdotal/theoretical
  - Key part of infant-guided feeding
  - Improved behavioral tolerance
  - Optimize stability and safety
  - Supports overall positive experience
- Direct evidence
  - Increased intake/efficiency
  - Increased physiologic stability

(Chang, Lin, Lin, & Lin, 2007; Lau & Schanler, 2000; Lau, Sheena, Shulman, & Schanler, 1997; Pados et al., 2017)

Brain-oriented care

- Impact of stress on infant
- Impact of stress on parents
- Motor learning and adaptation
- Impact of feeding skill on future development

Altmier & Phillips, 2013; Bader, 2014; Coughlin et al., 2009; Browne & Mox, 2011; Cong et al., 2017; Estrem et al., 2016; Howland et al., 2005; Mathison et al., 2000; McBride & Cooper et al., 2010; Pados et al., 2010; Sanders & Hall, 2010; Smith et al., 2011; Spittle & Treyvaud, 2014; Tuffy et al., 2017; Van Den Engel-Hoek et al., 2011

Know the Flow!

(Pados, Park, & Dodrill, 2019)
Flow Rate: Bottle Feeding

- Bottle characteristics (Ross & Furham, 2015)
  - Hole size (Jackman, 2013; Pados, Park, Thoyre, Estrem, & Nix, 2015; Pados, Park, & Dodrill, 2019).
  - Pliability (Zimmerman & Barlow, 2008)
  - Shape and size (Eishima, 1991; Segami 2013)
  - Air exchange (Lau 2015)
  - Hydrostatic pressure (Lau & Schanler, 2000)

Myth: Epiglottic Inversion Is Key To Infant Swallowing Safety

- Rommel 2006
  - No consistent epiglottic tilting until after age 5 years of age
  - Epiglottic movement ranged average 34°, range of 9°-49°
- Gosa 2012 and Gosa, Suiter, & Kahane 2014
  - Absence of full epiglottic tilting during swallows of infants
  - Anterior movement of arytenoids was sufficient for laryngeal closure

Epiglottic Inversion Physiology

- Adult Movement: 2 components
  - Thyrohyoid approximation = horizontal movement
  - Traction of the hyoepiglottic ligament = retroflexion
    (Van Daele, Perlman, Cassell 1995)
  - Is this even physiologically possible for infants/young children?

Video Swallow: Epiglottic Inversion?

Thank you!

It is not enough to do your best; you must know what to do, and then do your best.
—Attributed to W.E. Deming
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Barlow, S. M. (2009). Central pattern generation involved in oral and respiratory control for feeding in


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