What’s in YOUR bottle? Evidence with thickening liquids in neonates.

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Disclosure Statement

• We have no relevant financial or non-financial relationships to disclose.
Objectives

• To understand the rationale of thickening for swallow dysfunction in premature infants
• To review the literature pertaining to thickened liquids and discuss implications of use in neonates
• To describe the thickening agents available that are being used in this population
• To understand the variations in thickened liquid based on type of thickener, method of thickening, etc.
Definitions

- **Rheology:** the science of dealing with the deformation and flow of matter; the ability to flow or be deformed and includes elasticity, viscosity, and plasticity.

- **Viscosity:** the internal friction of fluid causing it to resist the tendency to flow. The greater the friction of a fluid, the more force required to move the fluid.
Proposed Terms for liquids corresponding to viscosity ranges from National Dysphagia Diet

- Thin = 1-50 cP
- Nectar-like = 51-350 cP
- Honey-like = 351-1750 cP
- Spoon thick = >1750 cP

cP = centipoise
Swallowing Variation

- Correlation between swallowing and physical characteristics of food (Stuart, 2009)
- Regarding success and safety in infant feeding, bolus volume, temperature, speed of presentation, and viscosity are considerations.
- Viscosity is frequently considered in swallowing evaluation and therapy (Arvedson, 2002; Coster, 1987; Wolf, 1992).
Effects of bolus viscosity on swallow function

Dantas, 1990; Logeman, 1994

- Oral transit time
- Pharyngeal transit time
- Timing and duration of upper esophageal sphincter
- Duration and magnitude of hyoid and laryngeal movement
- Slows the flow rate thereby decreasing the incoordination of the suck or oral phase of swallowing (Alper, 1996)
- Increasing sensory input (Ylvisaker, 1998)
- (Potentially) normalizing the swallow pattern timing during respiration (Rempel, 2005)
Literature Review: Findings and Issues Related to Viscosity

• Viscosity/thickness of a thickened liquid can vary based on a number of factors (Stuart, 2005; Chaney, 2007; Cichero, 2000; Stuart, 2009; Garcia, 2008)
  – Product used to thicken
    • Powder versus gel and base product (carbohydrate versus gum)
  – The beverage the product is combined with
    • The natural viscosity of the base liquid, caloric density of base liquid
  – The temperature of the liquid at mixing
  – The length of time the liquid has been sitting following mixing
    • Some products continue to thicken
    • Other products thin over time (eg breast milk with rice cereal due to amylase)
• Stuart (2009) specifically analyzed thickened barium and thickened formula using common thickeners including baby cereals
  – Temperature controlled
  – Variables included:
    • Thin formula
    • Thin barium
    • Formula thickened with rice and oatmeal at 1 and 2 teaspoon/ounce
    • Formula thickened with pulverized rice and oatmeal at 1 and 2 teaspoon/ounce
    • Formula thickened with simply thick
    • varibar

• Findings:
  – Significant differences between barium mixtures and corresponding formula mixtures
  – Oat cereal mixed poorly (subjective)
  – Viscosity increased over time
  – Notable differences between cereal mixtures and pre-thickened barium or mixtures with commercial thickener
    • Cereal mixtures with much larger standard deviations than other thickeners
    • Oat cereal so variable P value was considered suspect
• Poor inter- and intra-rater reliability with SLP mixing liquids to their perceptions of nectar, honey, and pudding (Glassburn, 1988)

• Consistency with use of thickeners, recipes, etc.
  – Differences in fluids between fluids used in video swallow studies and mealtime fluids found among 10 metropolitan hospitals (Cichero, 2000)
  – Survey of 27 pediatric hospitals in U.S.
    • Majority used nectar and honey consistency
    • 16/27 used baby cereal to thicken formula and breast milk to nectar or honey consistency with typical recipe of 1-2 teaspoons/ounce

• There is variability between liquids used in swallow studies and dysphagia diet foods (Chaney, 2007)…Liquids used in VFSS are more viscous (Cichero, 2000)
• Barium behaves differently than other liquids (Nicosia, 2007)
  – Line Spread Test as a simple tool for clinicians to assess thickened liquid consistency
  – Analyzed 26 liquids*
  – LST able to separate juices into nectar and honey
  – LST unable to separate barium mixtures into nectar and honey and unable to compare barium to juices

• So…following swallow studies with results and recommendations, how can we consistently carry over a plan clinically?
Considerations based on Literature

• There are many additional variables to consider regarding thickening liquids within the NICU environment
  – Temperature varies in warming procedures at bedside as well as for VFSS
  – Wide range of formula and breast milk combinations being used
  – Lot numbers of thickeners vary

• Infants rely on suck response to ingest liquids.
  – Impaired oral phase may increase the oral manipulation of the thickened liquid and cause further breakdown of liquid viscosity
Contraindications of thickening liquids

- Premature infants have highly immunoreactive intestinal mucosa which probably predisposes them to intestinal injury
- Feeding premature infants with xanthan gum-based ST not only stimulates the immature gut by increase in water, sugars, SCFA and bile acids in the distal small intestine and colon, it may also directly activate gut lymphocytes and macrophages to trigger an excessive inflammatory cascade (Woods, 2012)
- Decreased endurance/tone?
  - Benefit/energy expenditure relationship
- Medical history (Van Dahm, 2009)
  - Medically or surgically treated NEC
  - Previous bowel resection
  - Slow motility
  - Strictures or atresia
  - Poor liver function or Poor kidney function (sodium benzoate)
  - Any condition that may alter enteric blood perfusion
  - Severe feeding intolerance
Be Aware, thickened liquids are also used for reflux

- Thickened liquids have been used as a treatment of reflux for >50 years
- Thickened formula has been shown to reduce regurgitation, decreased crying time, improve sleep, and increase caloric retention (Orenstein, 1987; Vandenplas, 1987)
- Recommendation was to add 4 grams (1 tablespoon) rice cereal per 30 mL formula.
Systematic Review

- There are frequent anecdotal reports re: concerns of thickened liquids with infants
  - No impact on weight gain
  - Mixed results re: cough
  - No differences with diarrhea, constipation, or other complications
- Must use caution with thickeners in neonates
- Preferred intervention is to identify compensatory strategies other than thickening to support swallow function
How did we get here?

- There are challenges with thickening, how did we get here?
- Greater survival of preterm and sick infants (Hawdon, 2000)
  - Complications of prematurity (Gewolb, 2001)
- Increased periods of non-oral feeding with preterm infants
- Goals to reduce length of stay…Rushing to advance oral feeds and prepare for discharge?

- High referral rate for treatment of significant and persistent feeding problems
**Potential Clinical Signs of Swallowing Dysfunction**

- Coughing, choking while feeding
- Noisy, wet respiration associated with feeding
- Color changes
- Physiologic signs: apneic spells, bradycardia, increased respiratory rate
- Evidence of “staining” in tracheotomy tube
- Unexplained respiratory illnesses
Maturation versus Dysfunction

Must identify between typical maturational processes and true dysfunction

- Minute Ventilation reduced (by 52%) during feeding (Shivpuri, 1983)
  - Benefits of restricted flow rate?
- Oxygen Desaturation, Apnea, Cough (Mizuno, 2003)
  - 32-33 week infants 80-89%, brief apnea with feeding
  - SPO2 often >88% at 35 weeks
- Oxygen Desaturation events continues near discharge (Thoyre, 2004): 20% of feeding time with O2 levels <90%
Maturation versus Dysfunction, cont.

- **Swallow-Respiration Class** (Mizuno, 2003)
  - Swallowing is common during pauses in respiration at 32-33 weeks
  - With maturation, I-SW-E becomes more dominant pattern
- **Suck-Swallow Dyads**
  - With increased PMA (after 33 weeks), suck more consistently paired with pharyngeal swallow (Gewolb, 2001)
- **Coordination of Suck-Swallow-Breathe**
  - Suck-swallow-breathe coordination ~ 34 weeks (Rogers, 2005) to ~ 36 weeks (Wolff, 1968)
  - Complications of prematurity can affect neurological maturation and development of feeding and breathing control (Gewolb, 2001)
Maturation versus dysfunction, cont.

• Term infants
  – Many term infants in first 2 days after birth do not maintain regular breathing during oral feeding and there is no predictable relationship between phase of respiration and rhythmic swallow (Bamford, 1992).

• Development of control of breathing lags behind reflexes driving sucking and swallowing in preterm infants (Miller, 2004)
  – By term, coordination of breathing and feeding is >advanced but still not perfect.
Why is this important?

• Understanding of typical development of infant feeding and ages/stages of maturation of sucking, swallowing and coordination of suck-swallow-breathe is critical

• When instrumental studies are considered:
  – What are the criteria being used to determine the study is actually indicated? Are these criteria accurate/adequate?
  – How much experience does the infant have with oral feeding to ensure maturation via growth and experience?

• When study is completed, is it optimal for the infant?
  – Positioning
  – Timing of study to ensure hunger
  – Adequate imaging to identify function/dysfunction?
  – Effect of fatigue?
  – If laryngeal penetration exists, is it an indicator of dysfunction (no, according to Denzell, 1999)
  – If aspiration, why? At what point in the study? What are the impacts of strategies?
Swallow Assessment

• Standard swallow assessment involves observation and description of a person’s swallow in terms of:
  – bolus management;
  – immediacy of swallow; presence/absence of laryngeal penetration and aspiration;
  – clearance of bolus through the hypopharynx and into the esophagus.

• It involves making a summary assessment based on a combination of objective timing and subjective judgments.

• With infants, choices can include changes in positioning, flow rate, pacing, viscosity and assessment of impact and potential therapeutic use these changes can have in their feeding.
What strategies are available?

• Altering Position
  – Neutral head position, watch for extension and flexion
• Pacing
  – Certain number suck-swallows, impose pause
• Changing viscosity
  – Altering fluid thickness to slow rate of flow, facilitate organization of airway protection prior to swallowing
• Flow rate – nipple/bottle change
  – Alter rate of presentation
• Clearing “dry” swallows
  – To assist with hypopharyngeal clearance in between nutritive swallows
Issues with Viscosity

- How does barium react with thickening?
- Can “thin barium” be achieved for a study?
- What about higher concentration formulas?
- Human milk?
- Temperature of liquid
- Length of time liquid prepared?
- Can same viscosity be achieved at bedside?
- What does research tell us?
Instrumental Exam

• Are we measuring what we think we are measuring using barium?
• How much volume is enough in a study for confidence in the findings?
• How thick is too thick for infants?
• Follow up and long term information regarding use of thickened liquids in infants…planned repeat VSS?
Recommendations based on VSS or FEES

Findings

- Full oral feeding with specific supports/strategies
- Limited oral feeding with specific supports/strategies
- Therapeutic oral feeding
- Thickened liquids
- Tastes only
- NPO (try to avoid)
Summary

- Learning to feed and to coordinate all of the sensory information being presented with feeding and swallowing is a challenge.
- Care should be taken to promote positive steps toward oral feeding that are supportive.
- Allow the infant time to develop their skills with good clinical support.
- Remember that thickening is only one strategy, it is not a treatment.
- Plan for ongoing follow up post discharge.
- Non-oral feeding means NO practice to assist with development of coordination between muscle groups and loss of sensory feedback provided by feeding!
Cincinnati Children’s Hospital Medical Center

- Level III Medical/Surgical NICU
- Regional NICU, Fetal Care Center
- Wide range of GI, Airway, Neuro, Craniofacial, Cardiac diagnoses
- 3 primary SLPs, 4 primary OTs, 2 primary PTs
- Integrated model, therapists are full time in NICU
- Participate in monthly and annual feeding and development inservices as well as collaborative partnering on a daily basis
CCHMC NICU by the numbers

January 2011- May 2012

• # NICU admissions: ~1000
• # SLP Clinical feeding evaluations: ~500
• # Video swallow studies: 58
• # Swallow dysfunction/reduced airway protection: 17
• # Recommendations for thickening: 3
• Who had swallow dysfunction???
• Who did we thicken???
Thickeners: What’s out there?

- Gum Based (Gels or Powders)
  - Xanthan Gum (Simply Thick, Hydra-Aid)
  - Locust Bean/Carob Bean Gum (Carobel, Gelmix)
  - Guar Gum (Bob’s Red Mill)
- Commercial Food Based
  - Applesauce, pudding, yogurt, cereals (wheat, maize, rice)
- Starch Based
  - Corn Starch/Potato Starch (Thicken Up, Thick It, Thixx, Thick & Easy)
- Pectin
- Specialty formula
  - Enfamil AR, Similac Sensitive for Spit-Up
Thickeners: What to consider

- Consistency
- Reliability (mixing technique, temperature)
- Stability over time
- Effectiveness to achieve desired result
- Patient acceptance
- Cost
- Safety
- Complications of use (calorie addition, feeding fatigue, anecdotal reports of diarrhea and constipation)
Gum based Thickeners
(Xanthan Gum, Carob bean gum)

Benefits

• Specific mixing instructions on packaging
• Can be pre-mixed, frozen then thawed, warmed
• Gluten free, carbohydrate free
• Works well with breastmilk
• Smooth, homogenous result
• No change in taste or smell

Limitations

• Cost
• Insurance does not always cover
• Addition of sodium benzoate
• Clark & Robinson: acute onset of NEC with carob bean gum
• Woods et al. (2012): late onset colonic NEC in 3 infants
• May 2011 FDA warning
• June 2011 Simply Thick voluntary recall
Food or Starch Based Thickeners  
(Rice cereal, pudding, potato flakes, cornstarch)

**Benefits**
- Costs less
- Readily available in stores
- Canned thickeners have specific mixing instructions on packaging

**Limitations**
- Add calories, protein, sodium, iron, carbohydrates
- For cereal, nutrient content varies by brand
- Starches are thicker at colder temperatures
- AAP recommendation to delay cereal until 6 months AA
- Food allergy concerns
- Irregular consistency
- Amylase enzymes in breastmilk break down (hydrolyze) starches
- “Mixer” error is high, clog nipples
- Changes taste, thickens over time
Collaborative effort led by gastroenterology
Task force created after 2011 FDA statement regarding Simply Thick
Goal was to develop CCHMC’s position on use of thickeners for infants and children with identified swallow dysfunction
Members included neonatology, dietary, speech pathology, gastroenterology, nutrition, pharmacy
Outcome:
  - Simply Thick only for infants >37 weeks GA until 60 weeks PCA
  - Preference is no Simply Thick under 1 year of age
  - Medical team drives the bus…all team members part of discussion
Thickeners: Considerations for SLP

• Thickened liquids only recommended when fluoroscopic evidence of swallow dysfunction is reduced with use of specific recipe
• Thickened feeds not offered via tube
• Thickened feeds should be considered temporary treatment strategy with periodic re-evaluation needed. Not a “cure” for dysphagia
• Thickened feeds are typically last resort “Overuse/indiscriminate use of thickening agents without documented reason is a concerning practice.” (Van Dahm, 2009)
Summary Points

• Thickening liquids following the identification of swallow dysfunction may be beneficial when used appropriately and judiciously.
• There are complications that can occur with thickening liquids, especially in the infant population. Caution is critical.
• Ongoing follow up is required to manage.
• Small number of patients. Not typical ‘pathway’ patients.
References


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