A Field of Grey

Exploring the Evidence to Guide Infant Dysphagia Clinicians Through the Most Common Clinical Conundrums

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- Biogen, Phenotypes of Swallowing Physiology & Function Among Patients with Spinal Muscular Atrophy Type 1 (PI: McGrattan)

Disclosures
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- Avexis, Consultant
- Dr. Browns, Speaker
The Infant Dysphagia Clinical Conundrum...

Clinical Symptoms | Ambiguous Diagnostic Results | Unclear Treatment

Lecture Outline

I. Healthy Infant Swallowing & Aspiration

II. Clinical Significance of Penetration & Aspiration

III. Risks of Thickeners & Alternative Thickening Agents
Healthy Infant Swallowing & Aspiration

Normal Adult Swallowing

In a sample of 195 asymptomatic individuals 21-68 yrs. old

67% Of healthy adults initiate a swallow below the vallecula during sequential swallows

Garand, 2019

Daniels, 2000
### Neuromuscular Maturation

<table>
<thead>
<tr>
<th>Sucking Attribute</th>
<th>4 hours</th>
<th>4 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucks per Burst</td>
<td>10.27</td>
<td>21</td>
</tr>
<tr>
<td>Suck: Swallow Ratio</td>
<td>1:1</td>
<td>3:1</td>
</tr>
<tr>
<td>Sucking Rate</td>
<td>0.91 sucks/second</td>
<td>1.13 sucks/second</td>
</tr>
<tr>
<td>Volume ingested per swallow</td>
<td>0.231mL</td>
<td>0.438mL</td>
</tr>
</tbody>
</table>

Qureshi, 2002
Why would we expect an infant to swallow without occasional bolus airway entry?

Clinical Significance of Penetration & Aspiration
Thickened Liquids: *Reduce Penetration & Aspiration*

Studies examining the effect of thickened liquids show an overwhelming beneficial treatment effect on reducing bolus airway entry and feeding symptoms across populations:

**Cardiac (Single Ventricle: Post Stage 3 Palliation)**
- **45% Aspiration Reduction**
  - Nectar vs. Thin (p=0.006)
  - McGrattan, 2016

**Down Syndrome**
- **57% Aspiration Reduction**
  - Nectar vs. Thin
  - Jackson, 2016

**Laryngomalacia & Glossoptosis**
- **33% Aspiration Reduction**
  - Nectar vs. Thin (p=0.015)
  - Gasparro, 2017
- **31% Penetration Reduction**
  - Nectar vs. Thin (p=0.001)

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**Thickened Liquids: *Improve Symptoms***

**Participants**
- Aspiration (57%) or Penetration (43%) on VFSS
- Term aged 1-18 mths without structural deficits

**Treatment**
- 5% ¾ Nectar
- 63% Nectar
- 14% Half Honey
- 18% Honey
  - Simply Thick (41%)
  - Thick N Easy (59%)

*No difference in change based on penetration/aspiration*

**Effect of Thickened Liquids on Infant Symptoms**

- Wheezing
- Vomiting
- Respiratory Illness
- Resists Feeding
- Cough
- Congestion
- Blue/Dusky
- Apnea

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Post-Treatment</th>
<th>Pre-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheezing</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Vomiting</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Respiratory Illness</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Resists Feeding</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Cough</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Congestion</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Blue/Dusky</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Apnea</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

*Post-Treatment vs. Pre-Treatment: N=44

- *No difference in change based on penetration/aspiration*  
  
  - Krummrich, 2016
Thickened Liquids: *Improve Symptoms*

27% Gastric Side Effects
- Belly Bloat
- Loose Stool

*Switch from Thick N Easy to Simply Thick resolved in 3 cases*

Effect of Thickened Liquids on Infant Symptoms N=44

- Wheezing
- Vomiting
- Respiratory Illness
- Resists Feeding
- Cough
- Congestion
- Blue/Dusky
- Apnea

Post-Treatment vs Pre-Treatment

Krummrich, 2016

Significance of Laryngeal Penetration

Evaluation of outcomes among 137 infants <2 years old who exhibited isolated laryngeal penetration (no aspiration) on their first videofluoroscopy revealed:

26% Exhibited Aspiration on a Follow-Up Exam

- 137 Total subjects
- 55% (n=75/137) Received feeding intervention
- 45% (n=62/137) No feeding intervention
- 73% (n=55/75) Received thickening
- 27% (n=20/75) Change in flow rate
- 91% (n=59/65) Symptoms improved
- 36% (n=5/14) Symptoms improved
- 19% (n=11/57) Symptoms improved

Symptoms (P<0.001)
Total Hospital Admissions (P=0.035)
Pulmonary Hospital Admissions (P=0.032)

Duncan, 2019
Krummrich, 2017
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Penetration & Aspiration

When are Thickened Liquids Indicated?

When symptoms pose greater threat than negative effects of thickeners.
# Risks of Thickeners & Alternative Thickening Agents

<table>
<thead>
<tr>
<th>Thickener</th>
<th>Can Use on Breastmilk</th>
<th>Maintain Thickness Over Feed</th>
<th>Cohesiveness</th>
<th>Population Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Cereal</td>
<td>No</td>
<td>No Reduces Thickness</td>
<td>Separates</td>
<td></td>
</tr>
<tr>
<td>Oatmeal</td>
<td>No</td>
<td>No Reduces Thickness</td>
<td>Separates</td>
<td></td>
</tr>
<tr>
<td>Xanthan Gum -Simply Thick</td>
<td>Yes</td>
<td>Yes</td>
<td>Smooth</td>
<td>Full Term &gt; 12 mths old</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Contraindicated for preterm or children &lt;12 years if history of NEC</td>
</tr>
<tr>
<td>Carob Bean Gum - Gelmix</td>
<td>Yes</td>
<td>Yes</td>
<td>Smooth</td>
<td>Slightly-Mildly Thick</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;42 wks PMA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Moderate-Extremely Thick</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Must be greater than 1 yr PMA</td>
</tr>
<tr>
<td>Modified Corn Starch - Thick &amp; Easy</td>
<td>No</td>
<td>No Increases Thickness</td>
<td>Smooth</td>
<td>Thick &amp; Easy: 3+ yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thicken Up: 3+ yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not indicated for preterm</td>
</tr>
<tr>
<td>Foods</td>
<td>Yes</td>
<td>Yes</td>
<td>Separates</td>
<td></td>
</tr>
</tbody>
</table>
Arsenic

Metalloid element commonly found as a compound in water and food as a result of contamination.

- Natural deposits
- Mining
- Manufacturing Processes
- Metal Smelting

Artes et Amicitiae

Naujokas, 2013

Highest Health Hazard

Agency for Toxic Substances and Disease Registry Rankings (ATSDR)

Ranks chemicals based on numerous factors that generate a composite score for their overall public health risk:

- Frequency of occurrence
- Toxicity
- Potential for human exposure

Table 2. The ATSDR 2011 substance priority list.

This list was generated by the ATSDR (2011) using an algorithm that translates potential public health hazards into a points-scaled system based on the frequency of occurrence at NPL Superfund sites and on toxicity and potential for human exposure.

Naujokas, 2013
High Arsenic Exposure Effects

Cancer
- Lung
- Bladder
- Kidney

Respiratory
- Bronchiectasis Mortality
- Lung Volumes & Capacities
- Congestion
- Cough
- Lower Respiratory Infection

Cardiovascular
- Carotid Atherosclerosis
- Ischemic Heart Disease

Neurologic
- Neuropathy
- IQ
- Communication

Immune
- Infant Mortality from Infectious Disease
- Inflammation

Typical Latency 20-30 Years
Demonstrated Association Threshold
>100µg/L

4x ↑ Mortality
>850µg/L

Naujokas, 2013

Food & Water Contamination

Drinking Water Wells
Regulated in government managed water lines to be within threshold bounds but not in wells.

U.S. Environmental Protection Agency Threshold
10µg/L

Higher Infant Susceptibility

Food Exposure Rice
Present in low volumes in rice products, grains, and infant formula.

American Academy of Pediatrics
¾ Cup Rice per Day
36 tsp

Duncan, 2019
Carignan, 2015

If your child has a swallowing disorder (dysphagia) or gastroesophageal reflux disease and needs cereal thickeners added to formula or breast milk, the AAP suggests using oatmeal. Also, talk with your child’s pediatrician or a feeding specialist. Find details about oatmeal thickeners on the AAP Healthy Children website: http://bit.ly/22TiG23.

**Arsenic Exposure: Thin Liquids**

**New Hampshire Birth Cohort Study**
- 10% families had water exceeding 10µg/L
- Maximum 189 µg/L

7.5x↑ Arsenic in formula fed than breast fed infants

For every 1oz↑ in formula intake 2.6%↑ in arsenic level

Carignan, 2015
**Sources of Infant Arsenic Exposure**

- **Rice Cereal**: 54%
- **Water**: 18%
- **Other Solids**: 19%
- **Formula**: 9%

**Assumptions**
- Water: 0-10 µg/L
- Cereal: .0007 µg/L
- 6 tsp Daily Rice Cereal (4mth)

**Average Daily Dose of Arsenic**

*Figure 1. Average daily doses (ADDs) of As (mg/kg/d) from water and dietary sources for infants and toddlers between four and 24 months old.*

**Lifetime Cancer Risk: *Arsenic in Infancy***

- **World Health Acceptable Cancer Risk from Water**: $10^{-5}$
  - Much more research needed in acceptable low levels
- **Total Infant Intake Risk**: 6 tsp/day 4 mths
  - **Minimal Risk**: $10^{-5}$

**American Academy of Pediatrics**
- 36 tsp

**Higher rice intake paces infants at more than minimal risk ($10^{-6}$) for carcinogenic effects:**
- **Formula**..................4 oz/120mL
- **Feeds**......................6/day
- **Mildly Thick**.............1 tsp/20mL
- **Total Intake**.............36 tsp/day

**Increasing viscosity or fluid intake will place above APA**
Conclusions

**Similac Spit-Up**
Did not become a thickened liquid under clinical testing conditions

**Enfamil A.R.**

**Ready to Feed**
Consistently slightly thick (1/2 nectar) throughout duration of bottle feed

**Powder**
Increase in thickness throughout a feed
Achieves slightly thick (1/2 nectar) to Moderately thick (honey) based on caloric density and time into feed.

Science Stand
ScienceStand.org


