Thickening liquids for dysphagia management: Challenges and opportunities

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“Thickening liquids has been and continues to be one of the most frequently used compensatory interventions [for dysphagia] in hospitals and long-term care facilities.”

Robbins, Nicosia, Hind, Gill, Blanco & Logemann, 2002

“The generally accepted clinical notion that manipulation of thicker (more viscous) substances reduces occurrence of aspiration, or modifies other bolus flow characteristics in dysphagic persons that produce an “improved swallow,” has little support, other than anecdotal, in the literature.”

Robbins, Nicosia, Hind, Gill, Blanco & Logemann, 2002

Studies of Viscosity Effects on Swallowing
What have we learned since 2002?

- Protocol 201 showed reduction of thin-liquid aspiration in videofluoroscopy:
  - By “Nectar-thick” barium 37% of the time;
  - By “Honey-thick” barium (probably more correctly labeled “spoon-thick”) 47% of the time.
- 3-month health status outcomes did NOT differ between use of thickened liquids and chin-down posture.

Clinical Questions (examples)

- How thick is nectar?
- Is ice-cream a thin liquid when it melts?
- Is ENSURE a nectar-thick liquid?
- Is barium a nectar-thick liquid?
  - Is today’s tomato soup TOO THIN for my patient?
-- What is the RIGHT thickness to make my patient safe?

The Current State

THREE MAJOR OBSTACLES IN THE WAY OF NEW KNOWLEDGE TO ADVANCE “BEST PRACTICE”
OBSTACLE #1: We lack common nomenclature

- runny
- syrupy
- viscous
- slurried
- nectar
- honey
- sticky
- spoon-thick
- watery
- thick
- thin
- stodgy
- slushy
- juicy
- oily
- mousse
- puree
- lumpy
- chunky
- mushy
- treacly
- starchy
- mealy
- rubbery

OBSTACLE #2: The targets are not defined

*What is the smallest clinically meaningful increment of increased viscosity?*

We do NOT know!

OBSTACLE #3: Variations in product preparation

Some recent steps forward on these issues:

1. Best practice with respect to nomenclature
2. New data regarding the viscosity boundary between nectar and honey-thick liquids
3. Exploration of simple, table-top methods for measuring viscosity
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North America (NDD)

Nectar-thick Fluids
51-350 cP @ 50 s⁻¹

Honey-thick Fluids
351-1750 cP @ 50 s⁻¹

Spoon-thick Fluids
>1750 cP @ 50 s⁻¹

Australia

Stage 1 “syrup”

Stage 2 “custard”

Stage 3 “pudding”

UK

Stage 1 “syrup”

Stage 2 “custard”

Stage 3 “pudding”

Cichero, J. A. Y., et al., (2007). Nutrition and Dietetics, 64(Suppl. 2), S53-S76.


Food Texture Categories:

B = Thin Purée Dysphagia Diet
C = Thick Purée Dysphagia Diet
D = Pre-mashed Dysphagia Diet
E = Fork Mashable Dysphagia Diet

*Note – definition of ‘thick’ purée
Makes flat shape on a plate or will form a column
Can be eaten with a fork because it does not move through the prongs.
The prongs of a fork cause a slight pucker on the surface.
It can be mixed, layered or mashed.
Cannot be pouched. Does not spread out if spilt.
Some recent steps forward on these issues:
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What is the SMALLEST increment of viscosity of clinical importance?

- Viscosity boundaries of “Clinical importance”:
  - should be reliably perceivable in sensory testing
  - should reliably elicit changes in swallowing motor behaviors, i.e. changes in tongue pressure parameters
  - “Sensory-Motor Tipping Points”
- Experiment 1: Nectar- to Honey-thick range
  - Healthy adults

Participants
Healthy adult volunteers:
- 40 “young” adults (21 F; age 18-39, mean 27 yrs)
- 38 “mature” adults (22 F; age 60-87, mean 70 yrs)

Exclusion criteria:
- Current or past swallowing difficulty
- Neurological diagnoses or prior major H & N surgery
- Insulin-dependent diabetes, current smokers

Viscosity Discrimination Acuity Triangle Test

Which one of these three is NOT like the others? Is it thicker or thinner than the other two?
Perceived Viscosity Boundary between Bostwick Levels 12-14 and 14-16

<table>
<thead>
<tr>
<th>Bostwick Flow Level (cm²/50 seconds)</th>
<th>Mean</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12</td>
<td>383</td>
<td>367</td>
<td>399</td>
</tr>
<tr>
<td>12-14</td>
<td>296</td>
<td>279</td>
<td>312</td>
</tr>
<tr>
<td>14-16</td>
<td>252</td>
<td>235</td>
<td>269</td>
</tr>
<tr>
<td>16-18</td>
<td>217</td>
<td>201</td>
<td>233</td>
</tr>
<tr>
<td>18-20</td>
<td>185</td>
<td>169</td>
<td>202</td>
</tr>
</tbody>
</table>

NDD boundary 350 cP @ 50 s⁻¹
Perceived boundary 270 cP @ 50 s⁻¹

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Bostwick Consistometry

The “Line-Spread” Test
Issues with Bostwick/Line-Spread Tests

- Messy
- Floor effects: do not work for thin liquids
- Ceiling effects: do not work for spoon-thick liquids
- Instruments require proper cleaning
- Flow depends on the volume (and height) of the sample and a level surface
- Walls may introduce drag effects

Could the “Fork-test” discriminate categories of liquid viscosity:

in a way that would be easy and accurate for patients and clinicians to use?

Rheological Tests on AR2000 Advanced Rheometer (TA Instruments)

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Bostwick Flow (cm/60 seconds)</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinner</td>
<td>A 10-12</td>
<td>393</td>
<td>39/362</td>
<td>36/399</td>
<td>399</td>
</tr>
<tr>
<td></td>
<td>B 12-14</td>
<td>290</td>
<td>23/290</td>
<td>27/312</td>
<td>312</td>
</tr>
<tr>
<td>Thicker</td>
<td>C 14-18</td>
<td>255</td>
<td>25/255</td>
<td>24/260</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>D 16-18</td>
<td>217</td>
<td>21/217</td>
<td>201/233</td>
<td>233</td>
</tr>
<tr>
<td></td>
<td>E 18-20</td>
<td>198</td>
<td>19/198</td>
<td>18/202</td>
<td>202</td>
</tr>
</tbody>
</table>

NDD Boundary between “honey-" and “nectar-" thick
Perceptual Boundary between “honey-" and “nectar-" thick (Steele et al., 2012)

Parameters of Interest:
1. Number of drips
2. “Time-to-first-drip” (i.e., time between initial touch to fork and first sign of liquid crossing beneath the prongs)
3. “Duration of first drip” (i.e., time between first sign of liquid crossing beneath the prongs and the liquid arriving in the collection basin)
4. Total duration of all drips
RESULTS

Significant Bostwick Effects?
• Time-to-first-drip? YES
  — COLD: $F(4, 25) = 7.915$, $p = 0.000$
  — ROOM TEMP: $F(4, 25) = 8.357$, $p = 0.000$
• Duration of first drip? YES
  — COLD: $F(4, 23) = 37.158$, $p = 0.000$
  — ROOM TEMP: $F(4, 25) = 8.192$, $p = 0.000$

Limitations
• Lower limit on temporal resolution of measures at 30 fps
• Liquids studied were in the nectar-to-honey-thick range
• Drip duration measure is likely dependent on drip height (i.e., 8.4 cm in this study)
• Does the fork matter? (Prong width/spacing)

Limitations (continued)
• Focus was on timing measures; spatial measures such as width/diameter of drip strand were not measured
• It is difficult to deliver controlled volumes to the fork
  — would lifting the sample from a cup be substantially equivalent?
• Timing differences in time-to-first-drip in the range of $\frac{1}{4}$ to $\frac{1}{2}$ second may not be easily and reliably measured using perceptual methods

Conclusions
Drip timing measures through a fork:
• hold general construct validity for differentiating liquid flow, particularly with chilled liquids
• may be feasible method of differentiating liquid flow in the kitchen or at the bedside
• similar methods like orifice cups may hold better promise for standardized method development