Notes from a Plumber's Helper—Clogs I Have Known (in Feeding Tubes)

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February 7, 2017

Nature of the Beast –
› Intact protein reacting with low pH
  – Elemental and peptide based proteins don’t react with acid
› Undissolved Solids (drugs/powdered nutrition/blender feedings)
› What Causes Clogs?
  – Inadequate fluid
› Multiple insults coming together.
› Tube design/distal site/internal size/kinks

Sticky Messes – checking residuals
› Standard of many nursing protocols
› Little justifications
› Varies between individual patients/practitioners
› Causes aspirations, erosion of tubes
› Gastric emptying is a function of feeding
› (See ASPEN: Safe Practices for Enteral Nutrition)

Tube-Occlusion Module
› Courtesy E. Frankel, C. Rollins
  – Checking residuals
  – Slow rate of Administration
  – Medication interactions
  – Inadequate flushing
  – Tube Design
› ASPEN module also suggested yeast?
  – Remove tube
  – Polyurethane better silicone
› Antacid/Sucralfate are reported to form clogs

Formulation Issues
› Extended release drugs should never be given through feeding tube
  – Besides running risk of toxic effects
  – Form clogs.
› Many formulations use wax-like PEG
  – Crushing wax matrix can release much higher amounts of drug
  – Slow Mag contains much more that written on label
› Slower release is often due to coatings
  – Removing PPI coating make drug immediate re
Definite drug clogs

- Products that clog tubes:
  - DO NOT USE in feeding tubes!
  - Potassium Tablets
  - Clarithromycin (Biaxin) Suspension
  - Phenytoin - generic
  - Ciprofloxacin Suspension
  - Vancomycin Capsules
  - Psyllium fiber (Metamucil) – Benefiber dissolves

- Suggest an alternative product

How sweet it is!

- Sugar coated shells/beads – provide acidic barrier
  - Mixing with water will become sticky
  - Mix with apple juice to keep beads intact
- Some drugs sprayed onto sugar to enhance dissolution (Emend)
  - Drugs will precipitate if mixed separately
- Mix all poorly soluble drugs in a syringe and make into a slurry. Give the mixture through the tube

Sugar makes the medicine go down

- It also provides an acidic pH for reactions
- Adds to higher osmolarity – causing diarrhea / cramping in intolerant patients
- Adds to viscosity/thickening of solutions
- Keeps drugs suspended more evenly

Pharmacy Compounding

- Pharmacists use Ora-Sweet Ora-Plus
  - Contains high sorbitol/parabens.
  - Suggest Syr-Spend, lower osmolarity
  - Or 0.5% Carboxymethylcellulose
  - Takes 1 day to mix from powder
  - Feeding-tube doesn’t need sweeteners, flavors

Select Drugs with Enteral Nutrition Study

<table>
<thead>
<tr>
<th>Drug</th>
<th>pH</th>
<th>Osmolality</th>
<th>I/C</th>
</tr>
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<tbody>
<tr>
<td>Acetaminophen Solution</td>
<td>4.4</td>
<td>4035</td>
<td>I</td>
</tr>
<tr>
<td>Acetaminophen Suspension</td>
<td>4.7</td>
<td>6425</td>
<td>I</td>
</tr>
<tr>
<td>Acyclovir Oral Suspension</td>
<td>5.8</td>
<td>4205</td>
<td>I</td>
</tr>
<tr>
<td>Aluminum Hydroxide Gel</td>
<td>7.2</td>
<td>1501</td>
<td>C</td>
</tr>
<tr>
<td>AIDC03, Mg(OH)2, Simethicone</td>
<td>7.8</td>
<td>990</td>
<td>C</td>
</tr>
<tr>
<td>Aminosuccinic Acid Solution</td>
<td>6.2</td>
<td>3405</td>
<td>C</td>
</tr>
<tr>
<td>Atosuqone Suspension</td>
<td>5.9</td>
<td>135</td>
<td>I</td>
</tr>
<tr>
<td>Azithromycin Suspension</td>
<td>9.5</td>
<td>3590</td>
<td>I</td>
</tr>
<tr>
<td>Calcolith Solution</td>
<td>7.8</td>
<td>NA</td>
<td>I</td>
</tr>
<tr>
<td>Calcium Carbonate Suspension</td>
<td>9.2</td>
<td>2490</td>
<td>C</td>
</tr>
<tr>
<td>Carbamazepine Suspension</td>
<td>3.7</td>
<td>4225</td>
<td>I</td>
</tr>
<tr>
<td>Cherry Syrup</td>
<td>2.8</td>
<td>6165</td>
<td>I</td>
</tr>
<tr>
<td>Dexamethasone Intensol</td>
<td>3.9</td>
<td>10600</td>
<td>I</td>
</tr>
<tr>
<td>Docusate Solution</td>
<td>6.5</td>
<td>3590</td>
<td>C</td>
</tr>
</tbody>
</table>

Question: “In your experience, which medications have caused enteral feeding catheter obstruction?”

<table>
<thead>
<tr>
<th>Medication</th>
<th>% of Responders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucralfate (Carafate)</td>
<td>31.3%</td>
</tr>
<tr>
<td>Potassium Chloride tablets</td>
<td>27.9%</td>
</tr>
<tr>
<td>Theophylline tabs/caps</td>
<td>12.3%</td>
</tr>
<tr>
<td>Fiber (Metamucil)</td>
<td>12.3%</td>
</tr>
<tr>
<td>Phenytoin Tab</td>
<td>11%</td>
</tr>
<tr>
<td>Enteric coated medications</td>
<td>10.4%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>29.2%</td>
</tr>
</tbody>
</table>

Avoiding clogs – by rinsing

› Rinse with water
- Some reports say pancreatic enzymes, other sodas, other cranberry juice.
- Feeding tubes degrade with all the above
  › Polyurethane are susceptible to lipid and strong acids
  - Nothing is superior to water to dissolve, clear or rinse
- Juices, soda are acidic and makes clogs worse.

Pharmacy Student project
- Each student selects 10 oral formulary medications
- Each drug is examined for solubility / excipient issues
- The drug is crushed using nursing device
- The volume water needed to dissolve
- The pH of the final mixture
- The Osmolality of the mixture
- The amount of undissolved powder on 100µm screen
- If pH is under 5, check for compatibility with formula
Over 300 medications evaluated for potential FT administration

Predicting Clogging

› Assumed that if drug particles were greater than 100 µm, they would occlude the screen and would also clog a feeding tube.
› Problem – ALL drugs tested left residue on screen.
› Many completely clogged screen as they contain cellulose that is insoluble in water
› Can an insoluble substance be given through a feeding tube without clogging?
  - If you dilute, mix well and rinse well

Thick as a brick

5 mg dissolved readily

Clogged syringe

Capsules do not dissolve
Hazardous drug

› Do not crush or open capsule Chemotherapy
  – USP 800 advises respiratory N-95 mask, double-chemotherapy certified gloves, gown and BSC
› Add drug to syringe and allow to dissolve in 15 ml Water.
› Capsules take long time to dissolve
  – Injection can be given
  – Through tube
  – Etoposide, Cytoxan

PPI’s and feeding tubes (Lansoprazole, Omeprazole)

› Pick one:
  – Open capsule, mix with juice, rinse well 60 ml - gastric
  – Mix capsule with sodium bicarbonate – gastric/jejunum
  – Use Orally Disintegrating Tablet (ODT) – mix with water 5-15 ml –gastric only
› Avoid
  – ODT to get “under-the-tongue” absorption Needs an intact GI tract to get drug to site of absorption
  – Mixing oral capsule content with water – mixes better with acidic juice (apple juice is best)
› PPI is one of most common drug clog reported
  – The beads adhere in water – avoid water
  – Never use tablet formulation – beads in stone

Slow movers

› Avoid less than 50 ml/hr into Gastric
› Laminar flow

› Velocity along edge is slower
  – Allows for retrograde clog
  – The clog formed by reactions with migrating acid along walls

Why doesn’t dissolve?

› Solid Drugs don’t dissolve readily when combine with nutrition
› Reduce particle size – crushing solids
› Suspensions are thick, add water to thin
› To improve dissolution add more water
› Surfactants improve dissolution
  – DSS (Colace) will allow mineral oil to be absorbed
  – Dangerous, as mineral oil will accumulate in lungs

Itsy bitsy pieces

› To improve dissolution – crush thoroughly
› Smaller particle, increased surface area
› Adding more fluid reduces clogs.
› Most drugs contain cellulose
  – Never dissolves
  – Thickens in acid
  – Expands extensively
  – Requires extra fluid to pass

Fun with Chemistry

› Most Pharmaceutical liquids are acidic
  – React with nutrition
› Drug clogs require acidic fluid to dissolve, but make protein clogs worse.
  – The jejunum is more basic than stomach.
  – Drugs must be dissolved first for absorption
  – Solid drug will not dissolve in jejunum as there is little fluid
Dr Harvey tells me she saw CAH on a pink remnant inside a feeding tube.

**Clogged Feeding tube**

**Optimal Feeding Tube**
- Interior lumen size.
  - 10 French minimum for solid drug administration.
  - Ideal is 16 French.
  - Many studies used 16 French as model to state drug is safe for that route.
  - 8 French can only accommodate commercial liquid feeding formula. No Drugs or blended diets can be administered.
- Poor Choice
  - Red rubber catheters. Clog easily, cracking common.
  - Foley catheters contain latex, have no interior coating and have tip design that leads to clogging.

**Feeding tubes – Learning French**
- Size is important.
  - Wider (20 Fr) and shorter tube (PEG/PEJ) clog less.
- Tube design – distal port
  - Single exit is ideal, stronger flow.
  - More exits – softer flow, more clogs.

**Tube issues**
- Only a designated feeding tube should be used for feeding.
  - Avoid Foley's, urinary catheters, red rubber tubes.
  - Hydromer coating can erode on tube, allowing more clogs.
  - Avoid mercury weighted tubes.
  - Never use tubes with leur-lock connections.

**EnFit Difference**
- A 24 French tube for Bolus has internal diameter 4.65 mm.
- Same size Enfit opening is 2.95 mm.
- For the very large tubes, there is reduced flow.
- Majority of GI service is 20 French.
- EnFit tube can vary small to large, but the EnFit opening is standardized.
  - Acts as a constriction. In theory interference is minimal.
ISMP - Inaccuracies

Figure 3: Detailed views of ISMP icons for errors in labeling, transcription, and administration.
Figure 6: Detailed views of ISMP icons for errors in labeling, transcription, and administration.

Dead-Space errors (ISMP)

Figure 1: Feeding tubes are prone to clogging.
Figure 7: The ISMP error icon (black block) must be displayed.

Post Pyloric Administration

- Feeding past pylorus reduces aspiration risk
- Tubes are generally smaller than gastric and prone to clogging
- Increase in number of PEJ/PEG Feeding tubes at MSKCC
- Drug absorption completely different. Many drug require acid to dissolve.
  - If drug doesn't dissolve, it cannot be absorbed
  - Mix these drugs in acidic juice to dissolve first
- Little clinical data available to guide choices

Food for thought

- Intact protein – will react with acids to for clogs
- Blender diet – press through cheesecloth to avoid clogs — leave out the walnuts/raisins
- Fats congeal – dissolve with ethanol
  - Fat reacts with salt to form soaps
  - Oils react with Ca and Mg to form soaps
- Ethanol is a lubricant and dissolves
  - Fats congeal – dissolve with ethanol
  - Fats react with salt to form soaps
  - Oils react with Ca and Mg to form soaps
- Elemental diet – individual amino acids – require mixing, stink and have high osmolarity
- Supplements are often powders that require extensive mixing to avoid clogs

Fizzies – agents to unclog tube

- Mountain Dew, Club Soda, Coca-Cola, cranberry juice
  - All acidic – great to dissolve weak base drugs
  - Will make protein-based clogs worse
  - Sticky – strong acid – pH 3-4
- Meat tenderizer, MSG, papain – no documented success
- Best remedy – warm water
- Dissolves everything – eventually
- Biggest issue getting the agent to the clog

Pancreatic Enzymes

- Best documentation of success
- Most are Enteric coated – must remove coating with sodium bicarbonate and heat
  - May take 30 minutes
- Viokase (Viokace) is only FDA approved agent for this use
  - Need bicarbonate to activate enzyme
  - May make clog worse
  - Will erode silicone tube if over-used
Formula Issues

Review the enteral formula and its preparation
- Intact protein will form clog with acids
- Improperly mixed powdered formulas will form clags
  (This is a more frequent issue with pediatric and neonatal formulas.)
- Blenderized foods may form clogs
  - Check if foods used are appropriate for tube administration
  - This method of preparation is discouraged
  - Foods used in formula must be thoroughly blended for tube administration

Other clog removers
- Clog-Zapper™, DeClogger
  - Requires introducer to get enzymes to site of clog
- Failed remedies
  - Papain (meat tenderizer)
  - Carbonated beverages, cranberry juice

Vibbbbbbbration
- Tube-Clear sonication
  - Jack-hammer for your clog
  - Has an introducer taps on clog
  - Small vibrations can loosen clog
  - Maintain patency of tube
  - Safer than using brushes (only for PEG/PEJ)

Rinse and Rinse again
- The best remedy it to avoid the clog formation
- Dissolve all medications with ample water
- No lumps in food / even blenderized

Recommendations
- Liquid Drug forms preferred
  - If hypertonic, viscous, thick dilute w/50-60mL water (3 times the volume)
  - Do NOT crush sustained-release drugs
- Mix tablets / hard gelatin capsules with 10-15mL water
- Most clogs are drugs

Recommendations (cont.)
- Do not add drugs to container or formula
- Continuous feeding stopped (0-30min.) and tube flushed with 15-30mL water
- Administer each dose separately and flush with 3-5mL between doses
- Flush tube with 15-30mL water after last dose