Preventing Complications Associated with Tube Feedings

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Saint Louis University
Potential for Malpositioned Feeding Tubes

Scope of Problem:
- Over 1 million feeding tubes inserted annually
- Most by blind passage
- Usually placed by nurses
- Can easily be inserted into undesirable site

Outside the GI Tract:
- Lung
- Mediastinum
- Abdominal Cavity
- Brain

Within the GI Tract:
- Esophagus
- Stomach (if gastric emptying delayed)
Most Frequent Site for Malpositioned Tube

- Approximately 4% of blind tube insertions enter the respiratory tract
- Tip can end in the tracheobronchial tree or the pleural space
Studies Related to Feeding Tube Placement

1987-1989: Auscultation and pH


R01 NR01669 National Institute of Nursing Research
Auscultatory Method

- No distinction between sounds in stomach and small bowel
- Failed in 8 of 9 cases to identify tubes in lung

*Nursing Research, 1990*

*Heart & Lung, 1990*
Two RNs reported hearing air over epigastrium following air insufflation of tube in brain

Am J Nursing, 2002
<table>
<thead>
<tr>
<th>Source</th>
<th>Examples of Other Anecdotal Reports</th>
<th>Auscultation - Physician placed tube and tested placement by the ‘Whoosh’ test. Ignored nurses request for an x-ray to confirm tube placement. Feedings delivered – removed about 2 L of fluid from lung (death)</th>
</tr>
</thead>
<tbody>
<tr>
<td>London Evening Standard, Jan 8, 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest, 1981</td>
<td></td>
<td>Auscultation - tube in left mainstem bronchus. Sepsis and empyema after infusion of 4 L of formula (death)</td>
</tr>
<tr>
<td>Organization</td>
<td>Recommendation</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Am Assoc Crit Care Nurses (AACN): Verification of Feeding Tube Placement Practice Alert, 2010</td>
<td>Recognize air bolus method is unreliable</td>
<td></td>
</tr>
<tr>
<td>NHS: UK. Patient Safety Alert: Reducing Harm Caused by Misplaced Nasogastric Feeding Tubes in Adults &amp; Children, 2011</td>
<td>Never use the ‘whoosh’ test to confirm the nasogastric tube position</td>
<td></td>
</tr>
<tr>
<td>Group of radiologists and GI physicians: Gastroenterology, 2011; 141(2):742-765</td>
<td>Be aware that tubes in inappropriate locations may be mistaken as properly positioned by auscultation</td>
<td></td>
</tr>
<tr>
<td>National Association of Children’s Hospitals: Child Health Patient Safety Organization. August 2012</td>
<td>Immediately discontinue insertion of an air bolus to assess/verify NG tube placement</td>
<td></td>
</tr>
</tbody>
</table>
Rationale for pH Method

- Fasting gastric secretions normally have a low pH
- Intestinal secretions normally have a high pH
- Tracheobronchial secretions and pleural fluid normally have a high pH

Note: Patients fasting for at least 4 hours
## pH & Tube Site in Adults

<table>
<thead>
<tr>
<th>Tube Site</th>
<th>Mean pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach, no acid-inhibitors (n=235)</td>
<td>3.33 ± 0.10</td>
</tr>
<tr>
<td>Stomach, acid-inhibitors (n=445)</td>
<td>4.34 ± 0.14</td>
</tr>
<tr>
<td>Small Bowel (n=578)</td>
<td>7.14 ± 0.03</td>
</tr>
<tr>
<td>Pleural fluid, tracheobronchial secretions (n=280)</td>
<td>7.64 ± 0.03</td>
</tr>
</tbody>
</table>

Note: Patients fasting for at least 4 hours

*Am J Nursing, 2001*
Is age a factor?

In a study of 53 infants, the mean gastric pH was:

- 5.4 at 15 minutes after birth
- 3.1 at 1 hour after birth
- 2.2 by 5 to 6 hours after birth
## pH and Tube Site in Children

### Gastric pH According to Use of Gastric Acid Inhibitors

<table>
<thead>
<tr>
<th></th>
<th>Acid Inhibitor Absent (n=2482 aspirates)</th>
<th>Acid Inhibitor Present (n=1152 aspirates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 4.0</td>
<td>74.1%</td>
<td>55.1%</td>
</tr>
<tr>
<td>≤ 5.0</td>
<td>89.9%</td>
<td>76.7%</td>
</tr>
<tr>
<td>≤ 5.5</td>
<td>95.6%</td>
<td>84.8%</td>
</tr>
<tr>
<td>≤ 6.0</td>
<td>98.5%</td>
<td>93.1%</td>
</tr>
</tbody>
</table>

**Note:** Feedings absent for at least one hour at time of data collection

**Information from:** Gilbertson et al: *J Parenteral & Enteral Nutrition*, 2011
# pH Method: Measurements

<table>
<thead>
<tr>
<th>Method</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic pH meter</td>
<td>Accurate</td>
</tr>
<tr>
<td></td>
<td>Impractical in most clinical settings</td>
</tr>
<tr>
<td>Colorimetric pH strips (0-10):</td>
<td>Subjective</td>
</tr>
<tr>
<td>➡️ Calibrated in units of one</td>
<td>Point of Care testing requirements may be imposed</td>
</tr>
<tr>
<td>➡️ Calibrated in units of 0.5</td>
<td></td>
</tr>
<tr>
<td>➡️ Calibrated in units of 0.2 or 0.3</td>
<td></td>
</tr>
<tr>
<td>Litmus paper</td>
<td>Inappropriate</td>
</tr>
</tbody>
</table>
## Examples of Recommended pH Cut-Points

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK. National Health Service: Patient Safety Alert:</td>
<td>‘For determining correct placement of feeding tubes, pH testing is the first-line method’</td>
</tr>
<tr>
<td>Patient Safety Alert: Reducing the harm caused by misplaced NG feeding</td>
<td>‘Safe range is 1 to 5.5’</td>
</tr>
<tr>
<td>Gilbertson et al: <em>J of Parenteral &amp; Enteral Nutrition</em>, 2011</td>
<td>Cut point of 5.0 to distinguish between gastric and respiratory tube site.</td>
</tr>
</tbody>
</table>
Appearance of Aspirates

- Described over 800 aspirates from:
  - Stomach
  - Small bowel
  - Tracheobronchial Tree
  - Pleural space

Nursing Research 1994
RN 1998
Combination of pH & Appearance: Stomach vs. Small Bowel

- pH 7: Bile-Stained
- pH 2: Colorless
Appearance of Respiratory Aspirate (Pleural Fluid)

pH 7
Identify Tube Site by Viewing Aspirates?

Photographed 106 aspirates: Viewed by staff nurses who were able to identify approximately:

- 90% of gastric aspirates
- 70% of small bowel aspirates
- 50% of respiratory aspirates

_Nursing Research, 1994_
# Examples of Guidelines for Aspirate Appearance

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification of Feeding Tube Placement Practice Alert, 2010 (AACN)</td>
<td>Observe appearance of aspirates if feedings are interrupted for more than a few hours.</td>
</tr>
<tr>
<td>NHS Patient Safety Alert: Reducing Harm Caused by Misplaced Nasogastric Feeding Tubes in Adults &amp; Children, 2011</td>
<td>Do not observe the appearance of a feeding tube aspirate as an indication of placement of a NG tube</td>
</tr>
</tbody>
</table>
CO$_2$ Monitors

- Designed to detect tube placement in respiratory tract by showing presence of carbon dioxide
- Relies on tube’s ports being freely exposed to gas during insertion procedure

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample/Method</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gast Nsg, 2007</td>
<td>Device attached to ET tube and then to NG tube in 7 infants</td>
<td>Readings 0 mm Hg from NG tube, 32-61 mm Hg from ET tube</td>
</tr>
<tr>
<td>NCP, 2008</td>
<td>Colorimetric device used during 424 blind tube insertions</td>
<td>Correctly identified over 99% of gastric placements; failed to detect 2 of 4 tubes in lung</td>
</tr>
<tr>
<td>Source</td>
<td>Recommendation</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Practice guidelines for GI access for enteral nutrition; <em>Gastroenterology</em>, 2011</td>
<td>“After blind insertion of a tube, every patient should undergo radiography to confirm proper position of the tube before feeding is started”</td>
<td></td>
</tr>
<tr>
<td>American Association of Critical Care Nurses: Practice Alert – Verification of Feeding Tube Placement</td>
<td>“Obtain radiographic confirmation of correct placement of any blindly inserted tube prior to its initial use for feedings or medication administration”</td>
<td></td>
</tr>
</tbody>
</table>
### Guidelines that Refer to Use of Radiography as **Second Line Test**

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Health Service. Patient Safety Alert: Reducing Harm Caused by Misplaced Nasogastric Feeding Tubes in Adults &amp; Children, 2011</td>
<td>Radiography only used as a second-line test when no aspirate can be obtained or pH indicator paper has not confirmed position of the NG tube</td>
</tr>
</tbody>
</table>
AFTER feedings started, check tube location at 4-hour intervals:

- Observe for a change in length of the external portion of the feeding tube
- Review routine chest and abdominal x-ray reports to look for notations about tube location.
- If pH strips are available, measure pH of feeding tube aspirates if feedings are interrupted for more than a few hours.
- Observe the appearance of feeding tube aspirates if feedings are interrupted for more than a few hours.
Tests Used in Clinical Practice

- X-Ray
- Auscultation
- Aspirate Appearance
- pH
- Capnography
Question: “Does your ICU require radiographic proof of tube placement before it is used for the first time?”

Survey of American Association of Critical Care Nurses [AACN] n=2298

Am J Critical Care, 2012
Question: “What bedside methods are used to check tube placement prior to an x-ray?”

- Auscultatory method most common response
- Often used in combination with aspirate appearance and observation for distress

Am J Critical Care, 2012
AACN Survey (continued)

**Question:** ‘What single method would you use to test tube placement when x-ray not used?’

- 161 nurses responded
- Auscultation most common response

*Am J Critical Care, 2012*
National Survey of Pediatric Nurses (n=95)

Hospital Protocol

- Auscultation: 90%}
- Aspirate Appearance: 80%
- pH: 10%

Unpublished data, 2012
Reasons pH Method not Widely Used

- Confusion about reliable pH cut-point
- Point-of-Care Testing not allowed - or pH strips not available on unit
- Requires extra time and effort
Reasons Auscultation & Aspirate Appearance Widely Used

- Don’t require extra effort or time
- Don’t require extra equipment
- ‘Way its always been done’
Bringing About Change in Practice?

- Publications and guidelines: Minimal effect in discouraging use of auscultatory method
- Mandatory protocols needed:
  - Catastrophic event: Major incentive for hospitals to update protocols
  - Magnet Hospitals: More likely to adopt research-based protocols
### Other Markers for Tube Placement?

<table>
<thead>
<tr>
<th>Site</th>
<th>pH</th>
<th>Bilirubin</th>
<th>Pepsin</th>
<th>Trypsin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>![down arrow]</td>
<td></td>
<td>![up arrow]</td>
<td>![up arrow]</td>
</tr>
<tr>
<td>Intestine</td>
<td>![up arrow]</td>
<td>![up arrow]</td>
<td></td>
<td>![up arrow]</td>
</tr>
<tr>
<td>Lung</td>
<td>![up arrow]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*JPEN, 1997; Nursing Research, 1999*
Bedside Test for Bilirubin

- Used bilirubin standards to develop scale
- Tested on specimens from 626 patients:
  - Stomach, n=328
  - Small bowel, n=303
  - Trachea, n=177
  - Pleural space, n=32

Good predictive ability

*Nursing Research, 2000*
Large company developed prototype of device that could allow concurrent readings of pH, bilirubin, pepsin and trypsin.

- Simple algorithm provided good predictive ability

- Device not moved to production: Market survey of nurses showed they were satisfied with auscultatory method
What About Electromagnetic Guidance Placement Devices?

- Designed to allow visualization of tube’s track during the insertion procedure
- Multiple studies regarding efficacy in distinguishing between gastric and small bowel placement
- Relatively few studies refer to method’s efficacy in detecting tube placement in respiratory tract
- Question: Are these devices sufficiently accurate to preclude additional placement tests?
Collectively, device evaluated in over 1700 patients

No cases of pneumothorax

Majority of individuals who used the device in these studies had advanced skills and lengthy training

Search yielded reports of 2 deaths and 17 cases of pneumothorax

Database relies on voluntary reports – thus, other cases may have occurred and not been reported
### Warnings

<table>
<thead>
<tr>
<th>Source</th>
<th>Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. FDA letter to a manufacturer of an electromagnetic placement device, April 2013 (posted on internet)</td>
<td>Between January 10, 2012 and October 5, 2012, your firm received nine (9) complaints alleging “lung placement” while utilizing your system to aid and confirm the proper placement of nasogastric tubes. The majority resulted in pneumothorax.’</td>
</tr>
</tbody>
</table>
Studies Related to Aspiration

1999-2001: Evaluation of aspiration detection methods

2002-2005: Identification of risk factors for aspiration

2006-2008: Evaluation of interventions to prevent aspiration

R01 NR05007, National Institute of Nursing Research
Aspiration

- Major risk in tube-fed patients
- Macro aspirations rare
- Micro aspirations common – difficult to detect clinically
- Lack of a simple test for aspiration has hindered research

Used 182 New Zealand White rabbits to evaluate 3 aspiration detection methods:

1. Blue Dye
2. Glucose
3. Trace amounts of Pepsin
**Methods**

161 anesthetized and ventilated experimental rabbits

21 anesthetized and ventilated control rabbits

3 forced small-volume aspirations:

- Dye-stained enteral formulas mixed with human gastric juice (experimental animals)
- Normal saline (control animals)

Suctioned every 2 hours over 6 hour period
Dye Method: Low Sensitivity

Dye visible in less than half of suctioned secretions

Dye method rarely used in recent years

CHEST, 2002
Demise of Blue Dye Method

- Photograph of 12 month old boy who received enteral formula tinted with FD&C blue dye #1 published in *New England Journal of Medicine*, 2000

- U.S. Food and Drug Administration (FDA) issued an alert in 2003 about possible toxicity with use of FD&C blue dye #1 in enteral feedings
Premise of Glucose Method

- Tracheal secretions normally contain little or no glucose
- Most enteral formulas contain sizable quantity of glucose
- Therefore, finding glucose in tracheobronchial secretions signals aspiration of glucose-rich enteral formula.
Glucose concentration in formula not significant (no variance according to low, moderate, or high G formulas)

Blood glucose major contributor to tracheal glucose

*MEDSURG Nursing, 2005*
Rationale for Pepsin Assay

Major Gastric Enzyme

Pepsin not normally found in lung

Pepsin in lung is proxy for aspiration of gastric contents
**Pepsin Immunoassay**

**High Sensitivity & Specificity**

- Can detect pepsin concentration as low as 1 µg/ml
- Multiple aspirations tested over 6 hours in 182 animals:
  - Sensitivity 93%
  - Specificity 100%
- Single aspiration detectable up to 6 hours

*J Parenteral & Enteral Nutrition, 2004*
Development of a Bedside Test for Aspiration (2009-2011)

Aim:
Develop a simple bedside immunoassay for pepsin in tracheal secretions

- Developed 5-minute assay that worked well on pepsin standards and serum

- However, not able to use test on tracheal secretions (due to presence of competing proteins)
Where to go from here?

Bedside Detection Methods?
- None currently available

Focus on PREVENTION
- Identify modifiable risk factors
- Evaluate interventions
Descriptive Clinical Study of Aspiration (2002-2005)

Objectives:

- Describe frequency of aspiration in 360 ICU patients
- Describe outcomes of aspiration in ICU patients
- Describe risk factors for aspiration in ICU patients

St Louis University Hospital

*Critical Care Medicine, 2006*
**RISK FACTORS**
- Decreased LOC
- Heavy sedation
- Low HOB
- Gastric feeding site
- High GRVs; vomiting

**ASPIRATION OF GASTRIC CONTENTS**
- Defined as presence of pepsin in tracheal secretions

**PNEUMONIA**
- Defined as Clinical Pulmonary Infection Score ≥ 6

**TUBE FEEDING**

**RISK FACTORS**
- Decreased LOC
- Heavy sedation
- Low HOB
- Prolonged MV
- Co-Morbidities ≥ 2
- Immunosuppression
Frequency of Micro-Aspiration

- Tested 5,857 tracheal secretions (31% were pepsin-positive)
- 320 of 360 (89%) patients aspirated at least once
- Separated into two groups:
  - High Aspiration (>25% pepsin-positive tracheal secretions)
  - Low Aspiration (<25% pepsin-positive tracheal secretions)
Relationship Between Aspiration and Pneumonia

- High Aspiration Group had **four** times greater risk for pneumonia.
- Incidence of pneumonia increased from Day 1 to Day 3 as aspiration events accumulated.

*Critical Care Medicine, 2006*
## Risk Factors for Aspiration

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Aspiration Group (n=175)</th>
<th>High Aspiration Group (n=185)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>53</td>
<td>52</td>
<td>0.5</td>
</tr>
<tr>
<td>Mean APACHE II Score</td>
<td>22.3</td>
<td>23.4</td>
<td>0.09</td>
</tr>
<tr>
<td>Mean GCS</td>
<td>7.5</td>
<td>6.9</td>
<td>0.03</td>
</tr>
<tr>
<td>% pts with HOB &lt; 30 degrees</td>
<td>56%</td>
<td>68%</td>
<td>0.02</td>
</tr>
<tr>
<td>Gastric feeding site</td>
<td>44%</td>
<td>56%</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Only 20 of the 182 gastric-fed patients had two or more GRVs $\geq 250$ ml.

15 of the 20 were in the High Aspiration Group, $p = .08$. 
Conclusions

Micro-aspirations common in critically ill, MV tube-fed patients

Frequent micro-aspirations associated with poor outcomes

Possible modifiable risk factors:

- Head of bed elevation
- Feeding tube location
- Residual volumes
Prevention of Aspiration (2006-2008)

Objective:
- Evaluate effectiveness of 3-pronged intervention (ARRP: Aspiration Risk Reduction Protocol)

Design
- Two-group quasi-experimental study
  - Usual Care Group, n=329 (2002-2005)

Setting:
- Same ICUs in both arms of study
Aspiration Risk Reduction Protocol (ARRP)

- Elevate HOB to $\geq 30$ degrees
- Place tube in small bowel, as indicated
- Implement algorithm for GRVs
HOB: Modifiable Risk Factor

- Encouraged physicians to write orders for elevated HOB (at least 30 degrees)
- Added space on chart for hourly HOB elevation notation
- Researchers present 16 hours/day to reinforce intervention
- Distributed HOB recommendations to staff
## HOB Elevation Recommendations

<table>
<thead>
<tr>
<th>Organization</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Clinical Practice Guidelines for Nutrition Support in Mechanically Ventilated Critically Ill Adult Patients (2003)</td>
<td>Elevate HOB to 45° unless contraindicated</td>
</tr>
<tr>
<td>CDC and Healthcare Infection Control Practices Advisory Committee (2004)</td>
<td>Elevate HOB from 30° to 45° unless contraindicated</td>
</tr>
<tr>
<td>Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition (2009)</td>
<td>Elevate HOB from 30° to 45° unless contraindicated</td>
</tr>
</tbody>
</table>
Effect of Intervention on HOB Elevation

% HOB >=30 degrees

Usual Care

ARRP

38.1

88.2
Feeding Site: Modifiable Risk Factor

For patients with:

- Slowed gastric emptying
- Poor tolerance to HOB elevation
- Low level of consciousness

Distal small bowel
Tube Placement Protocol

Physicians:

- Asked to write orders for small-bowel tube placements (when indicated by clinical condition)

Advance Practice Nurse:

- Present 40 hours per week to instruct RNs in ICUs on procedure for placing small bowel feeding tubes
Effect of Intervention on Tube Site

Nursing Research, 2010
Aspiration According to Feeding Site

- Stomach, n=209
- Prox Duod, n=102
- Mid Duod, n=85
- Dist Duod, n=32

J Parenteral & Enteral Nutrition, 2011
GRVs: Modifiable Risk Factor

**Algorithm**

- Instructions for use of prokinetics
- Instructions for moving tube to small bowel if needed
- Instructions for returning aspirate to patient

Defined high GRV as ≥ 250 ml
Effect of Intervention on GRVs

Unable to test algorithm

Physicians held differing views on how to handle GRVs

Nurses followed physician orders instead of algorithm
Effect of ARRP on Primary Outcomes

ARRP resulted in significant decrease in:

- % patients with at least one aspiration event
- % patients with pneumonia
Dangers of Esophageal Placement

- Significantly increases risk for aspiration

- Case Example:
  - 4 liters of bowel-prep solution administered via tube with ports in esophagus
  - Caused severe aspiration in both lungs

- Difficult to detect esophageal placement with bedside tests
  - Auscultation fails
  - pH fails (can be acidic if aspirate is refluxed gastric fluid, or can be alkaline if aspirate is swallowed saliva)
Gastrointestinal Intolerance

- High Gastric Residual Volumes
- Slowed Bowel Sounds
- Vomiting
Controversy about Significance of Gastric Residual Volumes
Possible Explanations for Disagreements

- Different outcomes?
  - Aspiration
  - Pneumonia
- Same outcome, different definition?
- Different sample sizes?
- Different types of patients?
- Measurement problems?
GRV Measurement Error?
645 dual measurements from 14-18 Fr multi-port tubes and 10 Fr single-port feeding tubes in 62 patients.

Large-bore tubes identified ‘high’ GRVs 3 to 6 times more often than 10 Fr feeding tubes.

However, at times, GRVs higher from 10 Fr tubes.

J Parenteral & Enteral Nutrition, 2005
Examples of Conflicting Research Reports

**GRVs Don’t Matter**
- McClave et al: *Crit Care Med, 2005*
- Reignier et al: *JAMA, 2013*

**GRVs do Matter**
- Mentec et al: *Crit Care Med, 2001*
- Metheny et al: *Am J Crit Care, 2008*
<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample</strong></td>
</tr>
<tr>
<td><strong>Tubes</strong></td>
</tr>
<tr>
<td><strong>Primary Outcome</strong></td>
</tr>
<tr>
<td><strong>Methods</strong></td>
</tr>
</tbody>
</table>
(McClave et al, continued)

92% of aspirates ≤ 100 ml
Only 3.9% > 200 ml
Only 1.4% ≥ 400 ml
<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
</table>
| **Sample**  | Randomized multi-site study (ICUs)  
227 patients in intervention group; 222 in control group |
| **Tubes**   | Not described |
| **Outcomes**| Ventilator Associated Pneumonia  
Caloric Intake |
| **Methods** | Intervention group – no GRV monitoring. Fed at full rate until vomiting occurred.  
Control group – GRVs measured every 6 hours, 250 ml considered high |
| **Results** | No difference in pneumonia rates  
Intervention group had higher caloric intake  
Intervention group vomited more frequently |
Excluded patients who had surgery in the previous month – thus excluded an important segment of the critically ill population.

While nutritional intake was greater in the ‘not checking GRV’ group, differences were minimal.

Study may have been under-powered to rule out harm to patients from vomiting.

Clinicians providing care not blinded to group assignment.

Investigators did not report how many high GRVs were encountered in the control group – or how often feedings were interrupted.

Not clear that this study is adequate to convince clinicians to follow the investigators’ recommendation to stop measuring GRVs.
**Mentec et al, *Crit Care Med*, 2001**

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<td><strong>Tubes</strong></td>
</tr>
</tbody>
</table>
| **Outcomes**| (1) Upper Digestive Intolerance (one GRV > 500 ml, or two consecutive GRVs 150-500 ml, or vomiting)  
(2) Pneumonia (diagnosed by clinical signs) |
| **Methods** | GRVs measured every 4 hours during days 1 thru 5 and then every 12 hours |
| **Results** | 13% (n=20) had GRVs > 500 ml  
19% (n=29) had two consecutive GRVs 150-500 ml  
26% vomited  
Pneumonia: Group with intolerance had higher incidence of pneumonia (43% vs 24%, p=.04) |
<table>
<thead>
<tr>
<th>Sample</th>
<th>206 critically ill patients receiving gastric tube feedings (SICU, MICU, NICU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes</td>
<td>10 Fr (40%); 14-20 Fr (60%)</td>
</tr>
<tr>
<td>Methods</td>
<td>Followed for 3 consecutive days GRVs measured every 4 hours</td>
</tr>
<tr>
<td></td>
<td>Categorized into 3 overlapping GRV groups: (at least 150 mL, at least 200 mL, and at least 250 mL)</td>
</tr>
<tr>
<td>Outcome</td>
<td>Aspiration (pepsin-assay)</td>
</tr>
<tr>
<td></td>
<td>Categorized into High and Low Aspiration Groups</td>
</tr>
<tr>
<td></td>
<td>Compared GRVs to Aspiration Group</td>
</tr>
</tbody>
</table>
Backward regression:
- GRV categories
- Mean Glasgow Coma Score
- Mean sedation score
- Mean HOB elevation
- Mean APACHE II Score

Following categories remained in model:
- 2 or more GRVs of at least 200 ml
- 1 or more GRVs of at least 250 mL
- 2 or more GRVs of at least 250 ml
Relationship between percent aspiration and frequency of high GRVs

Recommend measuring GRVs although imprecise

Am J Critical Care, 2008
“Use of and Threshold for Gastric Residual Volumes”
March 2013

“Recommendation: There are insufficient data to make a recommendation for not checking gastric residual volumes or a specific gastric residual volume threshold.”

“Based on two level 2 studies, a gastric residual volume of either 250 or 500 mLs (or somewhere in between) is acceptable as a strategy to optimize delivery of enteral nutrition in critically ill patients.”
Preventing Tube Clogging

Compared efficacy of water, Coca-Cola, and cranberry juice in keeping feeding tubes patent.

Water & Coca-Cola work equally well (Nursing Research, 1988).

Funded by STTI, 1986

Cranberry juice usually causes tubes to clog.