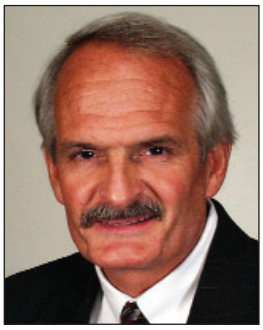
Carol Rees Parrish, R.D., M.S., Series Editor

Checking Gastric Residual Volumes: A Practice in Search of Science?

Carol Rees Parrish



Stephen A. McClave

Checking a gastric residual volume in enterally fed patients to protect against aspiration pneumonia has become routine practice to the point of habit. It has been well documented that there is poor correlation between gastric residuals and gastric emptying, yet many clinicians continue to be influenced by tradition allowing gastric residual volumes to guide clinical practice. In addition, checking gastric residual volumes has never been standardized, or proven to alter outcomes in clinical trials. The purpose of this paper is to challenge clinicians to think differently about the use of gastric residual volumes in the delivery of patient care.

INTRODUCTION

"A long habit of not thinking a thing wrong, gives it a superficial appearance of being right."

Thomas Paine
Common Sense, 1776

The practice of aspirating gastric residual volumes (GRV) mysteriously appeared in nursing texts several decades ago, years after enteral nutrition (EN) surfaced as a feeding modality and became the standard of practice. It is difficult to trace the origins of the practice to actual clinical data or a formalized study. The basic premise behind assessing GRVs is founded on several presumptions: 1) the belief that the practice helps distinguish normal from abnormal gastric emptying; 2) the concept that elevated GRVs only occur in situations of delayed gastric emptying and thereby indicates retention of enteral formula; 3) the assumption that accumulation of EN within the stomach, leads to aspiration; and 4) that aspiration of gastric contents invariably results in pneumonia. As a result of this line of thinking, elevated GRVs often lead to inappropriate cessation of EN. Ironically, very little scientific data exists to support any one of these presumptions. And because of the practice of GRVs, patients end up receiving less EN and their risk for pneumonia may actually increase (1–3). This article will review what is known about GRV from a physiologic as well as a clinical practice perspective.

Carol Rees Parrish, MS, RD, Nutrition Support Specialist, Digestive Health Center of Excellence, University of Virginia Health System, Charlottesville, VA. Stephen A. McClave, M.D., Professor of Medicine, Division of Gastroenterology/Hepatology, University of Louisville School of Medicine, Louisville, KY.

WHAT IS A GASTRIC RESIDUAL VOLUME?

In 1996, Payne, et al surveyed clinicians at 50 teaching hospitals in the United States and found that 48 of the 50 clinicians contacted reported that GRV was the primary determinant in slowing infusion rates or holding EN (4). The most commonly reported GRV considered for a "cut-off" value (a volume above which leads to automatic cessation of EN) was between 100 to 150 mL. Ten years later, a survey of critical care nurses found that 65% of respondents would delay EN if a GRV was found to be high, with 59% holding EN for GRVs in the range of 50 to 250 mL (5). In the literature, one can find a wide range of "cut-off" values for GRV demonstrating the lack of consensus in the medical community regarding what constitutes an unacceptable GRV (6–8).

Many clinicians believe or assume that there is tight correlation between aspiration of gastric contents and an elevated GRV. This assumption implies that when a cut-off value for GRV is increased, that aspiration of gastric contents will increase as well, leading to aspiration pneumonia. Conversely, this same assumption implies that when a patient is at high risk for aspiration (on the basis of clinical risk factors or co-morbidities), decreasing the "cut-off" value for GRVs will actually protect the patient against aspiration events. Yet, five separate studies which randomized patients to different GRV cut-off levels provided no data to support such an assumption. In fact, these five studies showed that raising or lowering the GRV cut-off level had virtually no effect on aspiration or gastroesophageal reflux (1,7,9,10,57). And furthermore, that lowering the "cut-off" value for GRVs simply resulted in patients receiving fewer total calories; which in one study led to a significant increase in pneumonia (1).

PHYSIOLOGIC CONSIDERATIONS OF GRV (11,12)

Endogenous Secretions

To fully appreciate all the factors that contribute to a GRV, one must consider both endogenous secretions as well as exogenous contributions (food, water flushes, enteral feeding, medications, etc.) that may share the gastric reservoir (Tables 1 and 2). In a 1997 paper, Lin emphasized that any value for a GRV "cutoff" less than 464 mL/hr might be incapable of distinguishing normal from abnormal gastric emptying (11). The calculations from Lin's paper, however, implied that 4,000 to 5,000 mL of endogenous salivary and gastric secretions per day passed through the stomach. In clinical practice, a number of factors may influence the overall volume of these secretions (Table 3). Patients on EN who are not chewing or who are unconscious and cannot smell or taste food would be expected to have less salivary output. Patients in the intensive care unit are frequently on proton pump inhibitors (ex. Prilosec, Nexium, Prevacid, etc.), which reduce the total volume of gastric secretions produced. A significant percentage of patients would be expected to have chronic atrophic gastritis (15% in adults over 25 years of age and >30% in adults over 60 years of age), with very little volume of gastric acid output produced (13). Feeding more distally in the GI tract (i.e., below the Ligament of Treitz) should result in a lower volume of gastric and pancreatic secretions than if food were ingested orally or infused directly into the stomach (14–17). These factors make it extremely difficult to estimate the total gastric volume that should be expected in the patient receiving enteral feeding.

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Table 1
Secretion of Fluid within the GI Tract

Gastrointestinal Water Movement

Volume Secreted/day	mL	mL	mL	mL
	Harig (43)	Ganong (44)	Nightingale (45)	Guyton (46)
Saliva	1500	1500	500	1000
Stomach	2500	2500	2000	1500
Bile	1000	500	900	1000
Pancreas	1000	1500	600	1000
Intestine	1000	1000	1800	1800

(continued from page 34)

Table 2
Constituents That May Contribute to the Gastric Residual Volume

- Endogenous secretions above the pylorus:
  - 500–1500 mL saliva
  - 2000–3000 mL gastric secretions
- Then add:
  - Tube feeding
  - Medication / water flushes
- Example:
  - 3 L endogenous secretions above the pylorus/24 hrs
    - Conservative estimate is ~125 mL/hr
  - EN infusing at 100 mL/hour
    - Typical flow rate
    - *Exclude* meds and water flushes for simplicity
  - 125 mL + 100 mL = 225 mL/hr × 4 hrs
    - Standard time frame between GRV checks
    - >900 mL GRV if ***no emptying*** has transpired

Table 3
Factors That May Increase or Decrease Gastric Residual Volume

- Use of proton pump inhibitors (Prilosec, Nexium, Prevacid, etc.)
- Narcotics
- Mechanical gastric outlet obstruction
- Diverting the level of EN infusion lower in the GI tract (feeding into the stomach versus below the pylorus)
- Cascade effect/ patient positioning
- Gastric emptying
- Medications Known to Delay Gastric Emptying (47,48)
- Saliva production
- Atrophic gastritis
- Ileal brake
- Hyperglycemia
- Sepsis

Gastric Emptying

Gastric emptying is a complex physiologic process, and abnormal gastric emptying studies do not always correlate to clinical symptoms (18). Gastric emptying is different for liquids compared to solids. The emptying of liquids from the stomach follows first order kinetics, a process related to fundic pressure. Infusion of a volume of liquid into the stomach increases fundic pressure which generates a rapid phase of emptying that gradually slows and tapers. The final amount of liquid is emptied at a slower rate. The emptying of solids follows zero order kinetics. Antral "grinding" contractions results in a fixed rate of gastric emptying of solids that does not change as the volume is moved from the stomach to the small bowel. All aspects of gastric emptying are impacted by critical illness (19), where small bowel motility is often preserved, but gastric motility tends to be decreased. Hyperglycemia, sepsis, and narcotic analgesic agents commonly impair gastric emptying.

Positional Effects (Cascade Effect)

There is concern, that when GRVs are measured, the entire volume of gastric contents may not be fully aspirated. Clearly, positioning the patient can affect the location and possibly the volume of liquid remaining in the stomach. A full faith in the practice of GRVs assumes that the liquid contents within the stomach pool together in a single volume, that the tip of the feeding tube is positioned within that volume, and therefore, the entire contents are aspirated at each q 4 hour bedside check. At least two separate issues in clinical practice negate or jeopardize these assumptions. If the tip of the tube always tended to reside in the antrum, then turning the patient onto their right side places the antrum in the dependent position which should facilitate uniform pooling of fluid and generate a higher, more reliable GRV (see Figures 1 and 2). Conversely, if the tip of the tube tended to reside in the fundus, placing the patient on their back puts the fundus in the dependent position and contents should pool in that part of the stomach. An abdominal film obtained shortly after placement of a nasogastric tube, then theoretically, would identify the location of the tip of the tube and give some guidance as to which position would yield the better, and more reliable, GRV. The first problem is that placing a patient on their back in the supine position may allow the stomach to "cascade" or "drape" over the spine, causing the fluid volume in the stomach to potentially split into two separate pools, thus leading to less accurate GRV even if the tube tip is in the fundus. The second problem, as demonstrated in a 1992 study, is that the tip of the tube migrates back and forth from the antrum to the fundus over the course of an 8 hour period (20). Hence, even if the position of the tip is documented by abdominal film post-placement, migration out of that position is common (and as a result, the

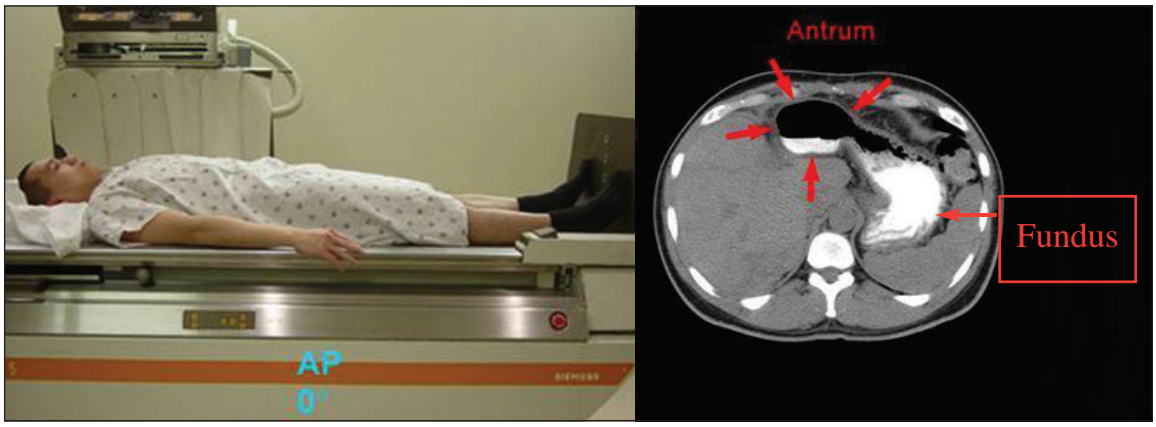

Figure 1. A. The patient is lying the in the supine position on the imaging table, which places the fundus in the dependent position. **B.** A cross-sectional computed tomographic (CT) image of the upper abdomen viewed from the foot of the patient. This shows that a majority of the white contrast material "cascades" or spills over the spine separating the gastric contents into two separate pools.

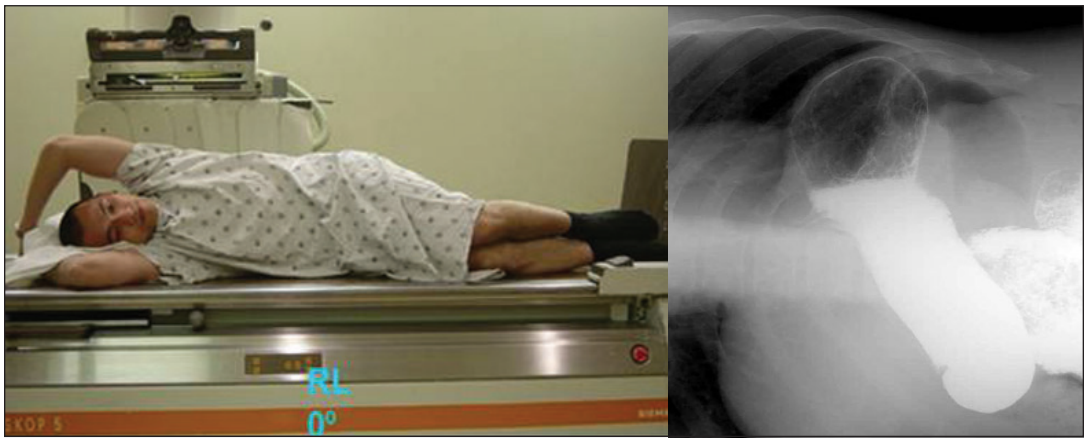

Figure 2. A. The patient is lying on the imaging table in the right lateral position. **B.** A frontal view of the upper abdomen with the patient lying on his right side shows that the contrast material gravitates into the gastric antrum, which is now the dependent part of the stomach.

Figures used with permission of the University of Virginia Health System
GI Radiology web site: http://www.med-ed.virginia.edu/courses/rad/gi/index.html

1992 study showed no difference in GRVs obtained from the supine or right lateral positions). Either way these two problems can lead to inaccuracy, inappropriately low GRVs, and a false sense of security.

Some radiologists will not perform an upper gastrointestinal study unless the patient is able to be placed either on their right side or in the upright position to allow the barium to leave the stomach by gravity (21). This clinical experience has shown that placing a patient in the right lateral decubitus position, putting the antrum down in a dependent fashion, facilitates gastric emptying. Such a maneuver provides an interesting potential strategy for responding to or managing an elevated GRV.

Are All Residuals Created Equal?

Despite the widespread use of GRVs in the care of enterally-fed patients, the practice has never been standardized in clinical trials. In the nursing literature, there is a wide variation in the volume of GRVs obtained depending on the size of the aspirating syringe, the diameter of the feeding tube, the frequency of bedside checks, and the manner in which the aspiration force is applied

(handheld syringe, gravity drain, intermittent low wall suction). Higher GRVs are obtained with larger bore feeding tubes (22,23), a longer period of aspiration through a wall suction device, a shorter period of time between aspiration checks, and conceivably, a feeding tube with more ports at the distal tip.

The more important issue relates to whether the practice of GRVs *should* be standardized. The argument supporting standardization of the practice would first require defining the gauge of feeding tube, size of syringe, timing and manner of aspiration, and the patient position that should be used for all GRV procedures. Such standardization would allow comparison between GRVs obtained from different institutions or from different clinical studies. Increasing the diameter of the tube used for GRVs and utilizing intermittent 30-minute aspiration via low wall suction (instead of handheld syringes) might lead to a higher volume, "more reliable" GRV in the eyes of the clinician. The argument against standardization is that there is likely little to be gained by such an enormous effort with regard to clinical care and patient outcome. Use of GRVs has never been shown to improve patient outcome or reduce complications. In fact, vigorous use of GRVs can lead to increased tube clogging, inappropriate cessation of EN, under-delivery of nutrients, and the potential for worse patient outcomes (24,25,26,1).

The strongest argument against standardizing the practice is that it would further "empower" this evidence-seeking practice. Clinicians already invest excessive trust and reliance in GRVs and allow the use of GRVs to direct patient care. At the present time the data obtained from this practice is inaccurate, does little to protect the patient, and may in all actuality adversely affect patient outcome.

COST OF CHECKING GASTRIC RESIDUAL VOLUMES

Every aspect of patient care is associated with an expenditure of healthcare dollars. The nursing time required to check GRVs every four hours adds a considerable burden to the nursing workforce and allocation of healthcare resources. In a recent study at the University of Virginia Health System (27), 70 GRVs were checked over a two week period (every eight hours) and the nurses documented the time it took to complete the task. The mean duration of time to check a GRV was 5.25 minutes. Table 4 provides a sample calculation of a very conservative estimate of health care dollars that might be spent annually on this practice if only 100 patients from all 50 states were included. This cost does not include equipment used such as syringes, isolation gowns, etc., or sleep lost from pages to physicians in the middle of the night, loss of nutrients to patients due to held EN, etc. Now is the time to question whether checking GRVs is an appropriate utilization of nursing effort and our financial resources. In the long run, less time spent obtaining GRVs will allow nurses to focus on other patient care issues that truly do affect outcomes (28,29).

IN SEARCH OF EVIDENCE

Studies in the ICU setting demonstrate that there is a weak link between delayed gastric emptying in critically ill patients and high GRVs, aspiration, and clinical pneumonia (Table 5). This link is seen only in those studies where large numbers of patients are grouped together in a dichotomous fashion according to residual volume and a correlation is made to aspiration and development of pneumonia. For this reason, it is difficult for the medical community to completely abandon the practice of GRVs. The key issue is that in an individual patient, the value of the information obtained from GRVs has not been shown to correlate with adverse outcomes and clinicians should avoid excessive

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Table 4
Estimated Health Care Dollars Spent on a Conservative Number of GRV Checks in the U.S. (27)

6 GRV checks/day × 5.25 min/task = 31.5 minutes/day
RN salary based on Mercer* last year:
$0.40/minute – $2.10/check × 6 checks per day = $12.60/pt
- For 100 pts/day = $1260.00
- Per month = $37,800.00
- Per year = $453,600.00

If only 100 pts/year in all 50 states had GRVs checked q 4 hours, the health care cost would be: $22,680,000.00/year.**

*Mercer Integrated Health Networks Compensation Survey, median pay for RN's (mid-2006 and includes all participants across the country).
**This does not include the cost of syringes and other equipment needed for this purpose.

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Table 5
Randomized Studies Comparing Outcomes for Lower versus Higher Cut-Off Values for Gastric Residual Volumes (57)

Study	*Population/ Study Duration*	*GRV: Study vs Control*	*Mean % EN Goal Infused*	*Enteral Access*	*Pneumonia*	*Aspiration*	*GI Intolerance*	*Other Outcomes*
Desachy 2008	Mixed ICU (n = 100) 7 days	<300mL >300mL	76% vs 95%*	16–18 Fr NGT	NR	NR	Regurg Vomiting Colonic distension (no sign diff)	ICU & Hospital LOS ICU mortality In-Hospital (no sign diff)
McClave 2005	Mixed ICU (n = 40) 3 days	200 mL 400 mL	77.0% vs 77.8%	NGT (n = 20) (8,12 Fr) PEG (n = 20)	NR	21.6% vs 22.6%	35.0% vs 27.8% (GE Reflux)	
Montejo 2008	Multicenter Mixed ICU (n = 329) 5 days	200 mL 500 mL	82.8% vs 89.6%**	NGT	46/169 (27%) vs 45/160 (28%)	NR	107/169 (64%) vs 76/160 (48%)**	
Pinilla 2001	Mixed ICU (n = 80) 5 days	150 mL 250 mL	70% vs 76%	14–18 Fr NGT or 10 Fr OGT	0/36 (0%) vs 1/44 (2%)	NR	21/36 (58%) vs 20/44 (45%)	ICU LOS 13.2 vs 9.5
Taylor 1999	ICU Trauma, Head Injury (n = 82) 16 days	150/50 mL 200 mL	36.8% vs 59%**	OGT or NGT (14 study pts had SB tubes)	26/41 (63%) vs 18/41 (44%)	NR	NR	Infection 35/41 (85%) vs 25/41 (61%)** Complications 25/41 (61%) vs 15/41 (37%)** Hospital LOS 46d vs 30d**

NR = not reported; ICU = intensive care unit; LOS = length of stay; GI = gastrointestinal; NGT = nasogastric tube; OGT = orogastric tube; *$p < 0.0001$; **$p \leq 0.05$.

reliability on GRVs to direct care in a specific patient. In addition to the randomized studies outlined in Table 5, the following observational studies merit comment.

The first study evaluating the efficacy of checking GRV was performed in 1992 (20). McClave, et al compared GRV over an eight-hour period with physical exam and radiography as a marker for gastric tolerance of EN. EN was given to eighteen patients and twenty normal volunteers. Subjects fasted for 12 hours prior to initiation of the study period after which a full-strength, elemental formula providing 25 kcal/kg was administered. GRV was checked in the supine and right lateral decubitus positions at the beginning of the study and then every two hours during the eight-hour period. Physical exams were carried out during the last two hours that tube feedings were delivered. The examiners were blinded to GRV and abdominal x-ray results. No significant differences in GRV in the two different positions were noted. Physical examinations and radiographic readings did not correlate with GRVs. There was significant correlation between physical exam and radiographic findings. Of note, 40% of the volunteers versus 39% of the patients had at least one GRV greater than 100 mL after feeding commenced.

In a prospective study of 153 critically ill patients, Mentec documented the frequency, risk factors and complications associated with upper digestive intolerance (defined as: GRV between 150–500 mL at two consecutive measurements; a single episode where GRV >500 mL; or vomiting) during EN delivery started at goal rate (30).

Table 6
Studies Demonstrating Underutilization of Backrest Elevation (BRE) >30 degrees

- Evans measured BRE in 113 critically ill patients and found the mean BRE was 23°; patients receiving positive pressure ventilation averaged 19° (49)
- In an observational prospective study, Reeve et al recorded body position of 61 mechanically ventilated critically ill patients for 5 consecutive days in 4 ICU's. 15–40% of the time patients were <15°; the most common position was 15–30°; only 5–22% of the time were patients at >45° (50)
- In a pilot study, Grap sampled 347 BRE measurements in 52 critically ill patients—mean BRE was 22.9°; 86% of patients were supine (51)
- In 2003, Grap continuously monitored BRE in 169 ICU patients and obtained in 502 measurements (52). The mean BRE was 19.2° in all patients; BRE in ventilated patients was significantly less than non-ventilated patients
- In a follow up study of 66 patients in a pulmonary ICU, Grap measured 276 patient days and found a mean BRE of 21.7° (53)
- Van Nieuwenhoven randomized 221 ICU patients to BRE 45° versus supine (54). The target 45° was not achieved 85% of the time and the mean BRE was 12.5° for the supine group; 25.6° for the 45° group
- In an *observational* study, Metheny followed 360 ICU patients on mechanical ventilation and found that 54% of patients had a mean BRE of <30° (avg <21°) (31). BRE was not monitored during the hours between midnight and 0800
- Ballew randomly measured BRE of 100 adult intubated thoracic-cardiovascular patients; mean BRE was 23° (55)
- In another *observational* study by Metheny of 206 patients showed 64% of patients had a BRE <30°; again, BRE was not monitored during the hours between midnight and 0800 (23)

GRV was measured before starting EN and every four hours the first five days, then every 12 hours on days 6–20. Primary outcomes, monitored until discharge from the ICU, included vomiting and nosocomial pneumonia. In this observational study, elevated GRVs were shown to correlate significantly with male gender, use of catecholamines or sedation, and number of days in the prone position. While no association was seen with GRVs alone, nosocomial pneumonia did correlate significantly with upper digestive intolerance (combination of elevated GRVs and/or vomiting). Pneumonia was also shown to correlate with increasing levels of sedation and longer ICU length of stay. Days to initiation of EN and back rest elevation (BRE) were not reported. These results would emphasize the fact that patients requiring catecholamines, sedation, and prone positioning warrant close monitoring.

In a prospective, observational study of 360 critically ill patients, the presence of pepsin in tracheal secretions was used as a marker for aspiration of gastric contents. Metheny described the frequency and outcomes associated with aspiration, focusing on predisposing risk factors (31). Many factors were shown to correlate with aspiration of gastric contents: a low BRE, emesis, gastric feedings, gastro-esophageal reflux, and a Glascow Coma Score <9. The most significant independent risk factors for pneumonia identified were frequency of pepsin (+) secretions, use of paralytic agents, and a high sedation level. The author stated that, "increased GRVs did not significantly correlate with aspiration or pneumonia." Of note, the mean overall GRV reported was 41 mL in the "high aspiration" group and 31 mL in the "low aspiration" group. The study did not specify how patients were fed (bolus versus continuous) or how much EN was provided. Additionally, BRE was <30° in 54% of patients, not including the hours between midnight and 0800.

In a subsequent study of similar design, Metheny described the association between GRVs and aspiration of gastric contents over a 3 day period. Patients (n = 206) were divided into three groups based on highest single GRV obtained: ≥150 mL, ≥200 mL, and ≥250 mL. GRVs were checked every four hours from 0800–2400 along with tracheal aspirates for pepsin (again serving as proxy for aspiration of gastric contents) (23). High GRVs and low level of consciousness were associated with aspiration (not pneumonia). It is important to note that the mean GRV for the total sample was 37.1 ± 36.6 mL (range was 0.2 to 192 mL). Additionally, 65% of patients had a BRE <30° and the mean infusion rate of EN for the whole group was 54 mL/hr. The authors stated that they "found no consistent relationship between GRVs and aspiration."

Two other studies are also worth mentioning. Landzinski evaluated gastric emptying based on the acetaminophen absorption method in 30 critically ill patients. Patients were described as having "limited" tolerance (*cumulative* GRV ≤120 mL/24 hours; n = 10) versus intolerance (single aspirate ≥150 mL within 24 hour period preceding enrollment; n = 20) of intragastric feeding via an 18 Fr tube. Either metoclopramide or

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Table 7
Barriers to Semirecumbency—Real and Perceived (41)

- Alternative positions that may be required
  - Supine position
  - Trendelenburg position
  - Lateral position
  - Prone position
- Contraindications to semirecumbency
  - Hemodynamic instability
  - Intra-aortic balloon pump
  - Low cerebral perfusion pressure
  - Unstable cervical spine or pelvis
  - Use of femoral lines
- Potential risk of harm
  - Potential for developing decubitus ulcers
  - Potential for dehiscence of abdominal incisions
- Safety
  - Potential to slide or roll out of bed
  - Potential to become severely agitated
  - Potential to lose central venous catheter access
- Lack of resources
  - Insufficient nursing staff available to position patient
  - Insufficient nurse/patient ratio to carefully monitor semirecumbent patient
  - Insufficient specialized beds and chairs that facilitate semirecumbency
- Other
  - Clinicians underestimate backrest elevation
  - Physician orders do not specify backrest elevation

Modified with permission from: Cook D, Meade MO, Hand Le, et al. Toward understanding evidence uptake: semirecumbency for pneumonia prevention. *Crit Care Med* 2002;30(7):1472-1477.

erythromycin was used to enhance gastric emptying in those patients deemed intolerant (32). This study used a cumulative GRV over a 24 hour period of ≤120 mL (with each q four hour measurement ≤30 mL) to define tolerance of EN, which is a much more conservative definition than has been described previously in the literature. Findings demonstrated that 100% of those patients with elevated GRV had impaired gastric emptying based on acetaminophen absorption. However, 70% of those patients with minimal GRV and presumed "tolerance" still had abnormal gastric emptying studies. Adding prokinetic therapy in patients with elevated GRVs improved gastric motility, but only 35% of these "intolerant patients" actually normalized their gastric emptying study with the promotility agents. The rate of EN in the intolerant group increased from 36 mL/hr to 44 mL/hr after prokinetic dosing. In a very similar study at the same institution, MacLaren compared the efficacy of metoclopramide versus erythromycin in facilitating gastric emptying using the acetaminophen absorption method in patients deemed intolerant to gastric EN (based on a single GRV ≥150 mL) (33). At study entry mean baseline GRVs were 122 and 103 mL for the metoclopramide and erythromycin groups, respectively. In both groups, GRV dropped to 21–36 mL and rate of EN delivery increased from 14–17 mL/hr up to 44–45 mL/hr after the last dose of prokinetic. One might argue that prokinetics were not indicated in these patients with low GRVs. Although the authors noted that "no serious adverse outcomes were observed during the study period," the study was not designed to measure clinical outcomes. These two studies fail to address the more important question as to whether checking GRV correlates with improved clinical outcomes."

A BIRD IN THE HAND

Backrest Elevation—How Well Do We Achieve >30° in the Clinical Setting?

A dichotomy exists between the attention paid to GRVs and that paid to backrest elevation of head of the bed. Nursing service spends an exhaustive number of hours obtaining and monitoring GRVs, a practice that has not been clearly linked to adverse outcomes. In contrast, we see significantly less attention to elevation of the head of the bed, which appears to be more clearly associated with reducing the likelihood for pneumonia (34–39). Yet, despite the evidence for maintaining semirecumbency >30 degrees, this effective, affordable prevention strategy is too often under-utilized in practice (Table 6).

Clinicians often underestimate the angle of BRE when using simple bedside observation. Even worse, while the bed may be at 30°, the patient may have slid so far down that only the head is elevated or "cocked" (which raises abdominal pressure and may increase gas-

troesophageal reflux) (40). Many barriers exist which interfere with the effort made by nurses to maintain a BRE >30°. These barriers include hemodynamic instability, placement of femoral lines, and the potential for sheer forces causing skin tears/breakdown (Table 7) (41).

The time and attention spent checking GRVs might be better spent developing easy to use gauges or monitors on the bed to indicate the angle of elevation (42). Strategies also need to be developed for patients in whom BRE may be difficult to achieve (patients with decubitus ulcers and chafing skin, or clinical conditions such as brain injury or orthopedic injuries that require supine positioning).

SHOULD WE EVER STOP CHECKING GASTRIC RESIDUAL VOLUMES?

An important issue, which is rarely discussed, is at what point in a particular patient's hospitalization should checking GRVs be stopped. GRVs tend to be higher at the initiation of enteral feeding and lower as tolerance increases (11,20), intestinal contractility is restored, and the patient improves clinically. Should GRVs be stopped if they remain relatively stable for 48 hours? In the patient who is conscious, alert, and can communicate, our practice would defer use of GRVs to a simple interview of symptoms regarding bloating, abdominal distention, passage of stool or gas, and nausea or vomiting. In the patient on an oral diet during the day with nocturnal tube feeds, it may never be appropriate to check GRVs. See Table 8 for what is known about checking gastric residual volumes.

Table 8
What We Know About Checking GRV

- Alternative positions that may be required
  - Supine position
  - Trendelenburg position
  - Lateral position
  - Prone position
- GRVs do not correlate with gastric emptying, and as such, are unpredictable as a marker
- Worldwide, checking and responding to an arbitrary GRV causes the withholding of a tremendous amount of nutrition delivery
- Some gastric residual volume is *normal*
- The contents of the gastric reservoir are determined by exogenous fluid volume (EN, meds, food, water flushes, etc.) and endogenous secretions (saliva, gastric acid, etc.)
- Patients who would otherwise be eating and controlling their own intake should not have GRV monitored
- Small bore feeding tubes occlude more often when GRV's are checked
- Checking GRVs is a time intensive practice done 4–6 x/day in many institutions

SUMMARY

How Should Clinicians Utilize and Respond to Gastric Residual Volumes?

Based on the poor sensitivity, specificity, and accuracy with which GRVs identify poor gastric emptying and predict aspiration pneumonia, clinicians should avoid excessive reliance on this marker to direct patient care.

Until better data is available, it may be appropriate to check GRVs in the critically ill patient when initiating delivery of EN. After 48–72 hours of successful feeding, if GRVs are consistently low, it may be appropriate to stop checking GRVs. Use of GRVs may be inappropriate in fully awake, communicative patients who can provide verbal communication regarding tolerance issues. Use of GRVs should be questioned in a patient on an oral diet who also receives supplemental, nocturnal tube feeding. Use of GRVs in the patient receiving small bowel feeding is controversial. Values for GRV should be persistently low in these patients, but their use may be helpful to detect displacement of the tube tip back into the stomach (when a subsequent rise in the GRVs is obtained).

The bigger issue involves changing the clinicians' response to interpretation of GRVs. One should not interpret GRVs "in a vacuum," isolated from other aspects of monitoring and beside assessment of tolerance. It is appropriate to indicate in a protocol that GRVs up to a specific volume should not be used for cessation of EN "in the absence of other signs of intolerance." GRVs should always be interpreted along with a careful history for symptoms of intolerance (bloating, abdominal pain, nausea, vomiting) and a careful bedside physical exam (physical signs of intolerance such as abdominal distention, vomiting, and failure to pass stool or gas). Because a high GRV has been shown to be an isolated event 80% of the time, a single, high, GRV above any designated "cutoff" value should not be used for automatic cessation of EN. It is appropriate for a single high value to initiate a series of steps to reduce fur-

Table 9
Appropriate Responses to an Elevated GRV

1. Wash your hands.
2. Confirm that the BRE is >30–40°. Maintain a semi-recumbent position with the backrest elevation (shoulders) elevated >30–45°, or place patient in reverse Trendelenburg at 30–45° if no contraindication exists for that position. Patients with femoral lines can be elevated up to 30°.
3. Do not consider automatic cessation of EN until a second high GRV is demonstrated at least four hours after the first.
4. Clinically assess patient for:
   – Abdominal distension/discomfort
   – Bloating/Fullness
   – Nausea/Vomiting
5. Place patient on their right side (while >30°) for 15–20 minutes before checking a GRV again (to take advantage of gravity and to promote gastric emptying).
6. Consider diverting the level of infusion of EN lower in the GI tract (postpyloric).
7. Switch to a more calorically dense product to decrease the total volume infused.
8. Avoid constipation.
9. Review and minimize *ALL* fluids given enterally including medications and water flushes.
10. Minimize use of narcotics, or consider use of a narcotic antagonist given enterally to promote intestinal contractility.
11. Verify appropriate placement of feeding tube.
12. Switch from bolus feeding to continuous infusion.
13. Initiate prokinetic therapy (or leave standing orders to allow nurse to initiate Rx prn). Typical doses for available prokinetics:
   – Metoclopramide—5–20 mg qid (may need to give IV initially)
   – Erythromycin—125–250 mg qid
   – Domperidone—10–30 mg qid
14. Consider raising the threshold level or "cut-off" value for GRV for a particular patient.
15. Consider stopping the GRV checks if the patient is *clinically stable*, has no apparent tolerance issues, and has shown relatively low GRVs for 48 hours. Should the clinical status change, GRV checks can be resumed.
16. If consideration is given to increasing the time interval between GRV checks to >6–8 hours, then the clinical situation may warrant cessation of GRV checks.
17. Consider a proton pump inhibitor (PPI) in order to decrease volume of endogenous gastric secretions (e.g., omeprazole, lansoprazole, esomeprazole, pantoprazole, rabeprazole).
18. Initiate aggressive regimen for oral hygiene.

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ther risk, but an order for automatic cessation should be applied very carefully and probably only after a second high value 4–6 hours later is obtained.

Reduced time allotted to practice of GRVs may be better spent in more constructive ways. Any intensive care unit or other hospital unit that houses patients on EN should have protocols in place to avoid prolonged periods of NPO, to rapidly attain enteral access, to promote early initiation of EN, and to ensure rapid ramp-up toward goal calorie provision within 24–48 hours. The protocol should designate the appropriate GRV for that institution and patient population, should dictate the responses to high GRVs, and should contain specific strategies to reduce risks should high GRVs be obtained. Any time spent performing GRVs should be met with at least equal time devoted to oral hygiene and confirming that the patient remains with BRE at 30–45 degrees. In addition, protocols should include when it is acceptable to stop checking GRVs.

Despite the paucity of evidence to support the practice of checking GRVs, clinicians are not likely to cease using GRVs in the care of critically ill patients on EN anytime soon. The best effort at improving practice is to change the interpretation and response of the clinician to GRVs. Table 9 provides suggestions for better utilization of GRVs. ■

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