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Part I Enteral Feeding Barriers: Pesky Bowel Sounds & Gastric Residual Volumes

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Enteral nutrition (EN) is an effective way to nourish patients; however, many barriers prevent consistent and effective delivery of EN in the hospitalized patient. Many myths surround the use and delivery of EN. Unfortunately, the literature to date is still rife with varying definitions of EN "intolerance or complications." Identifying the root cause of EN "intolerance/complications" allows the clinician to intervene appropriately and decrease EN downtime to ensure that patients will receive the nutrition intended. Clinicians must focus on interventions that will make our patients comfortable while their EN is infusing. Part I of this four part series critically evaluates two of the most common barriers to EN: the use of bowel sounds to assess readiness for EN and gastric residual volumes to assess tolerance of EN. Strategies to manage such obstacles in the clinical setting will be provided.

Upcoming in the series:

- **Part II Enteral Feeding: Eradicate Barriers with Root Cause Analysis and Focused Intervention**
- **Part III Jejunal Feeding: The Tail is Wagging the Dog(ma): Dispelling Myths with Physiology, Evidence, and Clinical Experience**
- **Part IV Enteral Feeding: Hydrating the Enterally-Fed Patient—It Isn't Rocket Science.**

INTRODUCTION

Enteral feeding is an effective way to nourish those patients unable to meet nutritional needs by mouth alone. However, many barriers exist in the hospital setting that interfere with the delivery of the prescribed EN (Table 1). Confirming our clinical experience, many studies have demonstrated that patients routinely receive only 45-65% of EN ordered,[1-5] and only 84% was achieved in a recent study that set out to ensure a targeted level of EN was delivered.[5] To overcome this track record, we must carefully examine each aspect of EN delivery for potential barriers to adequate nutrition support. Many current practices surrounding the provision of EN are not evidenced-based, nor physiologically sound. One of the most common reasons for EN

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Table 1. Summary of Barriers to EN Delivery in the Hospitalized Patient

1. EN held for:
    - Some institutions may still perceive these as indicators of a non-functioning GI tract:
        - Lack of bowel sounds
        - Elevated gastric residual volumes
    - Surgery
    - Bedside procedures
    - Respiratory procedures
    - Diagnostic procedures
        - Endoscopy
        - Bronchoscopy
        - Central line placement
        - Radiologic
    - Extubation
2. Diprivan® (propofol) (calories from the lipid preparation must be calculated as part of the total kcal provided to prevent overfeeding [1.1 cal/mL infused])
3. Enteral access issues
    - Clogged tubes
    - Dislodged or migrated tubes
    - Delays in obtaining post-pyloric access (if needed)
    - Staffing unavailable to place tubes
4. Facilities that still hold EN for drug-nutrient interactions
5. Hypotensive episodes
6. Gastrointestinal bleeding
7. Patient is supine for any reason and EN is held
8. Miscalculation of EN requirements (orders unintentionally hypocaloric, etc.)
9. Conditioning regimes or therapies that require EN be turned off.
10. Transportation off the unit
11. Perceived or real "GI intolerance or dysfunction"
12. Inappropriate reasons
    - Planned procedure canceled after fasting since midnight...and happens 3 days in a row.

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to be held is "gastrointestinal (GI) intolerance." Many reports of 'GI intolerance" are based on unproven monitoring techniques and years of past assumptions about how the GI tract works. While it is true that hospitalized patients can have significant GI issues, little evidence exists to support many of the practices used to "monitor" tolerance to EN.

Developing a successful EN regimen requires the following:

- Full understanding of normal GI anatomy and physiology
- Knowledge of current evidence behind the practice of enteral nutrition
- Clinical experience as a bedside practitioner

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The goal of this four part series is to review basic GI anatomy and physiology, discuss how this relates to EN, identify common barriers to EN, and identify strategies to overcome these obstacles. With a better understanding of the GI tract and normal GI function, the clinician will be better equipped to address the root cause of EN delivery barriers and intervene appropriately to improve provision of EN. Part I critically evaluates two of the most common barriers to EN: the use of bowel sounds to assess readiness for EN and gastric residual volumes to assess tolerance of EN.

BOWEL SOUNDS

Auscultation of bowel sounds (BS) has historically been used to assess bowel function and readiness for oral diet or EN. Despite widespread use, the practice of auscultating BS has never been validated as a marker of GI function; hence its clinical value remains largely unstudied and subjective. In fact, no evidence exists supporting the correlation between bowel sounds and peristalsis, or the need to wait for BS prior to EN initiation.[6] To the contrary, two studies have demonstrated that there is a great deal of inter-rater variability among physicians when listening to BS, and that auscultation of BS are unreliable as an indicator of peristalsis and GI function.[7-8]

Enhanced Recovery after Surgery (ERAS) protocols are multimodal peri-operative protocols aimed at enhancing organ function and decreasing surgical complications resulting in earlier hospital discharge. Most ERAS protocols include early initiation of an oral diet (often post-op day 1). Assessment of BS is not included in any ERAS protocols. This is in contrast to conventional care protocols that hold oral and EN until 'bowel function returns'—most often assessed by BS or passage of gas.

The recent implementation and advancement of ERAS protocols demonstrate that early oral or EN is not only possible, but beneficial to patients. ERAS protocols have demonstrated.[9-11]

- Earlier return of bowel function & decreased incidence of post-op ileus
- Less nausea (through prophylactic nausea medication)
- Decreased complication rates and shorter hospital length of stay
- Earlier resumption of normal activities
- Increased patient satisfaction
- Significant cost savings

In summary, experience from ERAS protocols suggests that there is no benefit to using BS as an indicator of GI function and it should be removed as a potential barrier to nutrition supports goals.

ASSESSMENT OF GASTRIC RESIDUAL VOLUMES

Gastric residual volumes (GRV) for decades have been used to 'measure' tolerance of EN. A recent nursing survey of 582 nurses in 5 major hospitals found that 89% of nurses would terminate EN for GRVs > 300mL.[12] However, this practice is counterintuitive to normal gastric anatomy and physiology. The stomach is a reservoir and the idea that having some gastric residual is abnormal or a problem contradicts its physiologic role.

It is important to bear in mind that a GRV in an enterally-fed patient is not only comprised of EN (i.e. what goes in is not the only thing that comes out). The volume of endogenous secretions (salivary and gastric secretions) that pass through the stomach daily is approximately 2-4 liters (Table 2). Remember, when any volume is put into the stomach, the stomach responds by adding its own gastric juices as part of its physiologic role.[13,14]

Table 2. Absorption and Secretion of Fluid in the GI Tract[43]

GASTROINTESTINAL WATER MOVEMENT	
Additions	**mL**
Diet	2000
Saliva	1500
Stomach	2500
Pancreas/Bile	2000
Intestine	1000
Subractions	
Colo-intestinal	8900
NET STOOL LOSS	**100**

Borgstrom demonstrated a 3-5 fold dilution of a test meal from stomach into duodenum over a 4 hour period—500mL/625kcal test meal diluted to a volume of 1500-2500mL.[15] The total daily volume of endogenous secretions, oral intake, EN, medications, and water flushes can be > 6 liters per day (~ 230mL/hr) above the pylorus alone. With this volume in mind, one might argue that standard GRV thresholds (60-150mL) are less than endogenous secretions, and therefore, by definition, emptying must be occurring. When evaluating the significance of GRV, all the components contributing to that volume should be considered.

In addition to the physiologic aspects of GRVs, there are practical and institutional limitations, as well. No standard definition of a GRV exists because the volume that constitutes a significant GRV has never been prospectively studied in a randomized fashion. EN is often held based on an arbitrary number chosen by the hospital or found in textbooks. There is little agreement on how frequently GRV should be checked and whether the GRV should be returned to the stomach (and, if so, how much should be returned?).[16] The location of the tip of the feeding tube in the stomach will also affect the amount of GRV. For example, a PEG tube placed high in the stomach may not produce a significant residual because it sits above the air-fluid level of dependent gastric contents. Conversely, a nasogastric tube may produce more GRV simply due to its position in the stomach (see section on pooling effect below).

Gastric Emptying and the Pooling Effect

Normal gastric emptying is quite swift. Liquid emptying is preserved even in severe gastroparesis.[17] However, liquids empty from the stomach by receptive relaxation and gravity; therefore, the supine positioning of many hospitalized patients is not optimal for gastric emptying. In the supine position, the anatomy of the stomach is such that the fundus is in the most posterior/superior/left portion and the antrum is in the anterior/inferior/right portion. When the patient is supine or semi-recumbent, liquids can collect in the fundus because it is posterior. Hence, when a patient is supine or at low backrest elevation, the stomach "drapes" over the spine, and with the addition of gravity, gastric secretions may pool in the most dependent portion. When the patient turns to the right side down position, liquids move past the spine to the more anterior antrum and thus can pass into the duodenum. In the upright position, the fundus empties into the more dependent body and antrum and into the duodenum. Therefore, the stomach generally empties best when the patient is on the right side when lying flat or semi-recumbent, or when the patient is fully upright. For radiology photo images illustrating this concept, see also the 2008 article in the Practical Gastroenterology series on GRVs.[18]

Most nasogastric feeding tubes fall into the most dependent part of the stomach, the fundus, which is not contractile and furthest from the pylorus. Aspirating a GRV from the fundus may retrieve a much greater volume than from the antrum. Although anecdotal, one intervention that is used at UVAHS *s*hould a patient's residual be checked and be elevated beyond what the team is comfortable with, is to put the patient on their right side (while semi-recumbent) for 15-20 minutes, after which the residual is rechecked. Taking advantage of gravity by turning patients on their right side where the pylorus is located (while maintaining backrest elevation at 30 degrees or greater), may enhance liquid emptying from the stomach, and decrease the amount of GRV detected. For more information on this topic, ask your radiologist about how they perform a barium swallow (not to be confused with a modified barium swallow).

Back to GRVs

Monitoring of gastric residuals is often thought to reduce the risk of aspiration and pneumonia in higher risk, critically ill patients. However, several studies have shown that increasing the threshold for gastric residuals (up to 400-500mL) did not increase the incidence of pneumonia.[19,20] Several studies have also shown that raising the level of GRV and decreasing the frequency (or eliminating checks altogether) results in more EN received[21,22] without significantly increasing the incidence of ventilator associated pneumonia. The use of GRVs to prevent aspiration pneumonia suggests that only those patients who are enterally fed are at risk for aspiration. Do we check GRVs in patients on oral diets during the day, but supplemental EN overnight? What about patients receiving parenteral

Table 3. If Your Facility Still Checks GRVs, Suggestions to Treat Them

1. Wash your hands.
2. Confirm that the backrest elevation (BRE) is > 30-40 degrees. Maintain a semi-recumbent position with the BRE (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 4 hours after the first.
4. Clinically assess patient for:
   - ➢ Abdominal distension/discomfort
   - ➢ Bloating/Fullness
   - ➢ Nausea/Vomiting
5. Consider antiemetics or prokinetic as appropriate:
   - ➢ Ensure medication is scheduled vs. "prn"
   - ➢ If receiving, but still not doing well, consider higher dose, different agent, or combination
   - ➢ Tablet vs. elixir vs. IV
   - ➢ Evaluate route of medication delivery
6. Place patient on their right side for 15-20 minutes before checking a GRV again (to take advantage of gravity, and to avoid the pooling effect).
7. Assess for constipation—obtain abdominal film specifically for "stool burden."
8. Switch to a more calorically dense product to decrease the total volume infused.
9. Review and minimize ALL fluids given enterally including medications and water flushes.
10. Consider diverting the level of EN infusion lower in the GI tract (postpyloric).
11. Minimize use of narcotics, or consider use of a narcotic antagonist (e.g., naloxone, naltrexone) to promote intestinal contractility.
12. Verify appropriate placement of feeding tube.
13. Switch from bolus feeding to continuous infusion.
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 clear evidence of EN tolerance 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 altogether.
17. Consider a proton pump inhibitor (PPI) in order to decrease volume of endogenous gastric secretions (e.g., omeprazole, lansoprazole, pantoprazole, etc.) in the setting of gastric outlet obstruction/reflux symptoms, esophagitis, etc.
18. Initiate aggressive regimen for oral hygiene.

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nutrition (PN) or IV fluids (often our sickest patients)? Some studies have shown that patients receiving PN have a higher rate of pneumonia than those enterally-fed.[23,24]

Despite the lack of evidence to support monitoring GRVs, a great deal of nursing time is spent on this task, and patients miss a significant amount of EN for what may be a clinically unimportant (and arbitrary) reason. At least one study has also shown that frequent GRV checks may lead to more frequent clogging of feeding tubes.[25] Williams, et al. also concluded that reducing the frequency of residual checks saves nursing time, decreases risk of contamination of feeding circuit, and minimizes risk of body fluid exposure.[26] Ultimately, not checking GRV allows the nurse more time with their patients to focus on steps that have been shown to decrease aspiration pneumonia (good oral hygiene, backrest elevation, etc.), while allowing patients to meet important nutrition goals.

Time To Move On?

In 2016, the American Society for Enteral and Parenteral Nutrition (ASPEN) and the Society for Critical Care Medicine (SCCM) jointly came out with practice guidelines questioning the practice of checking GRVs. Their conclusions can be summarized as follows:[27]

- GRVs should not be used as part of routine care to monitor ICU patients receiving EN.
- For those ICUs where GRVs are still utilized, holding EN for GRVs < 500mL in the absence of other signs of GI intolerance* should be avoided. *GI intolerance is defined as:

  > "Vomiting, abdominal distention, complaints of discomfort, high NG output, high GRV, diarrhea, reduced passage of flatus and stool, or abnormal abdominal radiographs."

While GRVs are not an effective way to monitor tolerance to EN, it is still extremely important to monitor hospitalized patients for signs and symptoms of impaired gastric emptying which is common in the hospital setting. Clinicians should be aware of circumstances that put patients at risk for gastroparesis or altered GI function and develop an individualized plan accordingly. It is crucial to pay attention to abdominal symptoms such as distention, complaints of fullness, tenseness, guarding, firmness, bloating, pain, nausea or vomiting. Patients should also be monitored for constipation, especially in those on narcotics. If your institution does continue to check GRVs, see Table 3 for suggestions to intervene. Finally, see Appendix I for one institution's justification to phase out routine GRV checks.

Additional Considerations

Physiologic Response to Enteral Feeding Initiation and the Ileal Brake

An initial increase in GRV has been documented the first few hours of EN initiation, but this effect subsides rather quickly.[28] Kleibeuker provided 15 healthy volunteers with 200mL/hr of EN for 450 minutes (7.5 hours).[28] GRVs were checked every 30 minutes beginning at 120 minutes of EN infusion. The author found the highest GRVs occurred at 120 minutes, then decreased with continued infusion.

The ileal brake is a feedback mechanism within the ileum that regulates the passage of food through the gut.[29] When the distal intestine identifies nutrients that seem to have escaped absorption higher up in the small bowel, a signal is sent to slow peristalsis (including gastric emptying).[30,31] Therefore, it is not uncommon for patients to have an increase in nausea or other GI symptoms upon initiation of jejunal feedings if nutrients escape to the ileum.

In either circumstance above, if patients experience increased GRVs or an increase in nausea upon initiation of feeding, a brief decrease in rate with a slower advancement may help this transition. Use of a scheduled antiemetic for a few days can help also. However, patients should be able to quickly advance to goal flow as these mechanisms subside.

A Word About Backrest Elevation

While there is little evidence to support GRV checks, there is clear evidence available to support a decreased aspiration risk when backrest elevation (BRE) is maintained.[32-39] BRE of < 30 degrees is one of the most modifiable risk factors consistently and strongly associated with aspiration, especially

in bedbound patients with altered sensorium or impaired swallow. This seemingly simple (but underutilized) intervention is not easy to accomplish. Two studies reported that critical care nurses consistently over-estimated the BRE level.[37,40] Another study found that nurses self-reporting of BRE were consistent with observed levels of 28 degrees for intubated patients.[41] In all of these studies, actual BRE fell far short of the recommended 45 degrees regardless of the nurses' perceptions. A summary of studies evaluating BRE in hospitalized patients can be found in Table 4.

There are a number of things that clinicians can do to help ensure that backrest elevation is maintained. First, educate all members of the team that they share this responsibility—it really does take a village. Education should not be a one-time event, but should be ongoing at regular intervals (e.g. quarterly). Note that it is not necessarily accurate to use the head of bed gauge since the gauge measures the level of the head of bed and does not measure the patient's level of BRE. For those who slide down in the bed, a technique might include elevation of the HOB to approximately 20-30 degrees, then changing the angle of the whole bed to assure BRE (i.e., reverse trendelenberg).

Table 4. Studies on Backrest Elevation in Hospitalized Patients[44]

Study	Patients / Observations	Results
Grap[45]	52 medical ICU patients/347 measurements	Mean BRE = 22.9 degrees; 86% were supine
Grap[46]	66 pulmonary ICU patients/276 patient days	Mean BRE = 21.7 degrees
Grap[47]	169 mixed ICU patients/502 measurements	Mean BRE = 19.2 degrees; BRE in ventilated patients was significantly less than non-ventilated patients ($p < 0.001$)
Van Nieuwenhoven[48]	221 mixed ICU patients randomized to supine position **or** BRE=45 degrees	Target of 45 degrees was not achieved 85% of the time; mean BRE = 12.5 degrees for supine group and 25.6 degrees for the "45 degree" group
Metheny[49]	360 ICU patients receiving mechanical ventilation	54% of patients had a mean BRE of < 30 degrees; BRE was not measured between midnight and 0800.
Reeve[50]	61 ICU patients/164 patient ventilator days	Most common BRE position was 15-30 degrees
Helman[51]	Before intervention: 100 med-surg ICU patient observations Intervention #1: BRE @ 45 degrees added to standard order sets Intervention #2: Education program for nurses and physicians	Before intervention: BRE was > 45 degrees only 3% of the time After intervention #1: percentage of BRE >45 degrees increased to 16 % After intervention #2: percentage of BRE >45 degrees increased to 29%; mean BRE = 34 degrees
Ballew[52]	100 cardio-thoracic ICU patients s/p various surgeries	Mean BRE = 25 degrees Mean BRE during day = 25 degrees Mean BRE for intubated patients = 20 degrees

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Appendix I. University of Virginia Medical Center Clinical Decision Tool for Transitioning Away From GRV Checks

TITLE: Adult Gastric Residual Check Guideline
This is a Guideline (recommended best practice)

OBJECTIVE:
The purpose of this guideline is to establish a set of evidence-based parameters for checking gastric residual volume (GRV) in an effort to reduce the number of unnecessary gastric residual checks in patients who are tube fed into their stomachs. This does not apply to patients who are enterally-fed into the small bowel.

PATIENT POPULATION:
- ✓ Adult Acute Care
- ✓ Adult Critical Care

PATIENT ASSESSMENT
Rationale:
Despite the lack of evidence to support checking gastric residual volume in enterally-fed patients, this practice has been used for years as a presumed surrogate for gastric motility and the potential risk for aspiration events.

The current evidence indicates:

- Minimal correlation exists between GRV and clinical signs of intolerance such as gastric emptying and abdominal distention.
- GRVs do not correlate with incidences of pneumonia, regurgitation, or aspiration.
- Use of GRVs leads to increased enteral-access device clogging, inappropriate cessation of enteral nutrition (EN), consumption of nursing time and healthcare resources, and may adversely affect outcome if volume of EN delivered is reduced through delayed or held feeds.
- Eliminating the practice of GRV checks improves delivery of enteral nutrition without jeopardizing patient safety.
- The Society of Critical Care Medicine and the American Society for Parenteral and Enteral Nutrition no longer recommend GRV be used as part of routine care to monitor ICU patients receiving enteral nutrition.

Assessement:

- Do NOT check gastric residual routinely.
- Assess for enteral feeding tolerance every 12 hrs, see symptoms in algorithm below.
- If gastrically fed, the following patient populations* qualify for GRV checks until tolerance is established, per recommendations below:
  - Critically ill surgery patients
  - Critically ill trauma patients
  - Head injury patients
  - Abdominal surgery pts until tolerance established
  - Obtunded patients or patients in vegetative state initially

* The order set will indicate these patient populations may benefit from GRV checks. If GRV checks are clinically necessary, the LIP will order.

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ADULT TUBE FEEDING INTOLERANCE ALGORITHM

(Backrest elevation > 30 degrees)

ABDOMINAL SIGNS

- Distention
- Firm
- Tense
- Guarding
- Discomfort

- Hold Feeding
- Check for constipation
- Notify LIP

NAUSEA

- Antiemetics
- Minimize narcotics
- Check for constipation
- Notify LIP

EMESIS

- Hold feeding
- Check for constipation
- Notify LIP

GASTRIC RESIDUAL CHECKS MAY BE USEFUL IN SOME PATIENT POPULATIONS *(IF GASTRICALLY FED)*:

- Critically ill (ICU) surgery patients
- Critically ill (ICU) trauma patients
- Head injury
- Post op abdominal surgery
- Obtunded/Vegetative state

- **If so, FIRST: put patient on right side for 20 minutes, *WHILE* maintaining patient's backrest elevation of >30 degrees**
  - **Check GRV every 8 hours, or per ordered frequency**
- **Discontinue order for GRV checks after 48-72 hours if <500mL, and no abdominal signs present (see above)**
  - **If clinical status changes, resume GRV checks per LIP**

1) Confirm that the backrest elevation is >30–45°.
   - Maintain a semi-recumbent position with the backrest elevation >30–45°, or place patient in reverse Trendelenburg at 15-20° if no contraindication exists for that position.
   - Patients with femoral lines can be elevated up to 30°.
2) Assess patient for abdominal distension, discomfort, fullness, nausea, vomiting
3) Check GRV every 8 hrs or per ordered frequency. Place patient on their right side first (while backrest elevation remains at >30°) for 15–20 minutes before checking a GRV (to take advantage of gravity and to promote gastric emptying).
4) Flush tube with water after any GRV check, per Lippincott
5) If gastric residual is >500 ml on 2 consecutive residual checks, hold tube feeding and contact LIP.
6) Discontinue order after 48 to 72 hours, if < 500 mL, and no abdominal signs (see above)
   a. If clinical status changes, can resume gastric residual checks.

If GRVS are high on 2 consecutive checks:

1) Check for constipation.
2) Minimize use of narcotics, or consider use of a narcotic antagonist to promote intestinal contractility.
3) If on bolus feeds, switch to nocturnal or continuous infusion.
4) Consider post-pyloric feeding access.
5) Initiate aggressive regimen for oral hygiene.

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EDUCATION

Nurses and LIPs will be educated on this guideline through nursing huddle, PNSO newsletter, and medical staff communications.

OUTCOMES MEASURES

Validate adoption of practice change by reviewing charts for documented GRV and the presence/absence of a GRV order.

DEFINITIONS

EN: Enteral Nutrition
GRV: Gastric Residual Volume

RESOURCES

Lippincott: Enteral feedings
Lippincott: Enteral tubes safe care and maintenance

Guideline References

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Physician orders for backrest elevation may help with compliance. If not already a part of routine order sets, any member of the healthcare team can request such an order from the physician or nurse practitioner.

Finally, regular monitoring of institutional practices is necessary, as adherence with guidelines fluctuates over time.

SUMMARY

EN is an effective way to nourish patients unable to meet their nutritional needs, particularly in the acute inpatient setting. However, for EN to be effective, patients need to receive the goal ("dose") intended. Many barriers exist in the hospital setting that thwart patients from meeting key nutrition goals, without good evidence to support holding EN for these issues. Instead of perpetuating the myth that EN causes complications, clinicians must focus on the underlying conditions and interventions that will make our patients comfortable while their EN is infusing. This article specifically addresses bowel sounds, gastric residual volumes and backrest elevation, and provides the reader with an opportunity to reevaluate how one approaches these barriers in order to maximize nutrient delivery in the enterally-fed patient. ■

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