Compensatory Increased Enteral Feeding Goal Rates : A Way to Achieve Optimal Nutrition

Kristen Lichtenberg, Patricia Guay-Berry, Angela Pipitone, Anna Bondy and Leo Rotello

Nutr Clin Pract 2010 25: 653

DOI: 10.1177/0884533610385351

Clinical Research

Nutrition in Clinical Practice
Volume 25 Number 6
December 2010 653-657

10.1177/0884533610385351
http://ncp.sagepub.com
hosted at
http://online.sagepub.com

Compensatory Increased Enteral Feeding Goal Rates: A Way to Achieve Optimal Nutrition

Kristen Lichtenberg, RD, LDN, CNSC; Patricia Guay-Berry, RD, LDN; Angela Pipitone, RD, LDN; Anna Bondy; and Leo Rotello, MD, FCCM

Financial disclosure: none declared.

Background: Traditionally, enteral nutrition (EN) goal rates have been calculated based on an intended continuous 24-hour infusion rate. Many factors in the care of critically ill patients result in interruption of EN infusions, often for several hours daily, which may lead to significant underfeeding. The objective of this study was to evaluate the difference of daily EN volume deficits between a traditionally calculated infusion rate and a compensatory, higher calculated infusion rate in which the 24-hour volume was delivered over a 20-hour infusion period. *Methods:* Data collection consisted of daily EN volume deficit (intended volume – actual volume infused), based on intensive care unit nursing flow sheets. The primary outcome was daily EN volume deficit from a standard 24-hour calculated goal rate, compared with volume deficit from delivery of the same volume over 20 hours. For the 20-hour group, the calculated daily requirement of EN was divided by 20 rather than 24 for the higher hourly rate but still delivered for 24 hours. *Results:* One hundred ten baseline (24-hour) EN days were evaluated with a mean infusion volume deficit of (±)247 mL/d. This compared with 158 patients in the 20-hour infusion group, in which the mean volume deficit was (±)45 mL/d ($P < .001$). Enteral nutrition was most often held for extubation or procedures. A higher level of overfeeding was noted in the 20-hour infusion group. *Conclusion:* Calculating and prescribing higher EN infusion rates, assuming 20 hours of actual infusion daily, promoted delivery of optimal nutrient provisions and avoidance of unintended malnutrition by significantly reducing caloric deficit from frequent EN holding. (*Nutr Clin Pract.* 2010;25:653-657)

Keywords: enteral nutrition; critical care; nutrition assessment; nutrition therapy; nutritional support

Although the debate surrounding early enteral nutrition (EN) and preoperative/postoperative nutrition support persists, one belief remains constant: patient outcomes are positively affected by the delivery of adequate nutrition and are negatively affected by inadequate nutrition.[1-12] Enteral nutrition is the preferred method by which critically ill patients who have functioning GI tracts but who cannot take nutrition by mouth should receive nutrition support.[1-7,9] Evidence exists that enterally fed patients in intensive care units (ICUs) are frequently underfed, which may contribute to impaired immune function, increased risk of infection, and greater mortality.[2-4,6-8,10] The discrepancy between prescribed and delivered daily volume of EN is a major factor in underfeeding.[2,6-9] Frequent, avoidable disruptions are often responsible for significant underfeeding, often by more than 50% of a patient's daily goal requirements.[1,2,6,7] Multiple standard calculations exist to determine a patient's daily nutrition requirements, but the method by which hourly infusion goal rates of enteral formula are established has remained constant: divide the intended daily volume of formula to be administered by 24.

We aimed to evaluate and address the daily caloric discrepancy from expected and unexpected feeding interruptions to develop a more effective means of delivering adequate EN. We hypothesized that a compensatory, higher calculated infusion rate based on 20 hours of administration would decrease the daily caloric deficit to more adequately meet the nutrition requirements of enterally fed ICU patients.

Methods

Suburban Hospital is a 220-bed, level II trauma center in Bethesda, Maryland. The ICU is a 24 bed medical-surgical unit staffed 24 hours daily by board-certified intensivists.

Observational retrospective and, later, prospective data were collected on patients admitted to the ICU over a 6-week period. All patients received EN support. Days

From the Suburban Hospital, Bethesda, Maryland.

Address correspondence to: Kristen Lichtenberg, RD, LDN, CNSC, Suburban Hospital, 8600 Old Georgetown Road, Bethesda, MD 20814; e-mail: klichtenberg@suburbanhospital.org.

during which EN was initiated, advanced, discontinued; the goal rate was adjusted; or the patient was transferred were excluded. After initiation of EN by the intensivist, caloric requirement, based on clinical severity of illness using 25 to 35 kcal/kg/d, daily goal volume, and hourly goal rate, was established by a registered dietitian. Indirect calorimetry, when deemed necessary, was ordered by the registered dietitian and conducted by a trained respiratory therapist for measurement of the patient's daily caloric needs. All patients received continuous enteral infusions by means of a closed system. Hourly rate of infusion and strict intake/output records were documented for each patient by nurses on daily standardized ICU flow sheets. To avoid incomplete documentation, the nurses were informed and reminded throughout the study that data were being collected regarding each patient's hourly enteral infusion volumes. It was specified to the nurses that infusion holding for any reason, from extubation and even turning and bathing, needed to be reflected on the flow sheet.

For the initial retrospective baseline portion of the project, data collection consisted of review of ICU flow sheets to obtain the actual volume of EN infused during the previous day. This was compared to the volume of formula ordered, thereby revealing each patient's daily EN volume discrepancy (intended volume – actual volume infused).

For the intervention portion of the project, the registered dietitian calculated the patient's 24-hour requirement of EN and divided by 20 rather than 24 to establish a compensatory, higher hourly infusion rate.

The primary outcome was daily EN volume deficit from a standard 24-hour calculated goal rate (baseline) compared with the volume discrepancy from intended delivery of the same volume over a 20-hour period. Adequacy of EN for each regimen was designated as underfeeding/inadequate if less than 90% of the EN goal volume was met, adequate/appropriate if the volume delivered was ±10% of goal, or overfeeding if greater than 110% of EN goal volume was delivered. Ratio for EN adequacy was defined as: (actual volume infused/intended volume infused) × 100.

Statistical Analysis

Student's *t* test was used to determine significance of categorical, continuous variables.

Results

Two hundred sixty-eight patient days in 37 patients were evaluated: 110 patient days in the control group based on a 24-hour infusion goal rate (Figure 1) and 158 patient days in the intervention group that used the compensatory 20-hour infusion goal rate (Figure 2). All patients were fed via nasogastric, orogastric, or percutaneous gastrostomy tubes. There were not any days in which documentation on the flow sheet was incomplete; therefore, patient days did not have to be omitted.

The mean goal rate, as established by the registered dietitian, was 50 mL/h for the control group. The intervention group's mean goal rate was 47 mL/h. Mean daily volume for the control group was 79.7% of goal volume, whereas the study group received 97.3% of its mean daily volume. One hundred ten baseline (24-hour) EN days were evaluated with a mean infusion volume deficit of (±)247 mL/d, or 79% of goal calories. This compared with 158 patients in the 20-hour infusion group in which the mean volume deficit was (±)45 mL/d, or 97.3% of goal calories ($P < .001$). Enteral nutrition was most often held for pending extubation or for procedures (bronchoscopy, surgery, etc).

Table 1 shows the breakdown for the patients in each group who received inadequate nutrition support (<90% of goal), received adequate nutrition support (±10% of goal), or were overfed (>110% of goal).

Discussion

Interruption of continuous EN in critically ill patients remains an unavoidable reality of the complexity of their care. The impact of this, however, may be mitigated somewhat by development of protocols aimed at minimizing this situation. McClave et al[6] deemed cessation of EN for periods >4 hours before surgical procedures, endoscopic evaluation, or diagnostic tests "avoidable," and several other studies have shown improved patient outcomes when a protocol to increase delivery of EN effectively to deliver a volume of EN closer to the caloric and protein goal is implemented.[1,3,6,7,10] Physician and nursing education aimed at implementation of a protocol would be a natural next step for intended elimination of avoidable EN cessation, although it typically takes 2 to 3 years for full implementation of a protocol into practice patterns.[7] Infusion cessations >4 hours may be considered an "embedded" practice.[10]

By using our protocol of compensatory increased enteral feeding goal rates, we were able to significantly improve the ability of our patients to receive their goal nutrition requirements in a 24-hour period over the standard established method of calculating and delivering EN. This protocol was easily tolerated by patients, as opposed to other previous studies that reference high enteral feeding volumes and their association with nausea and abdominal cramping.[5,6] McClave et al[6] state that "smaller volumes of enteral tube feeding have been shown to result in more complete delivery." Other known protocols require the bedside nurse to double the patient's enteral feeding goal rate for the subsequent number of hours that

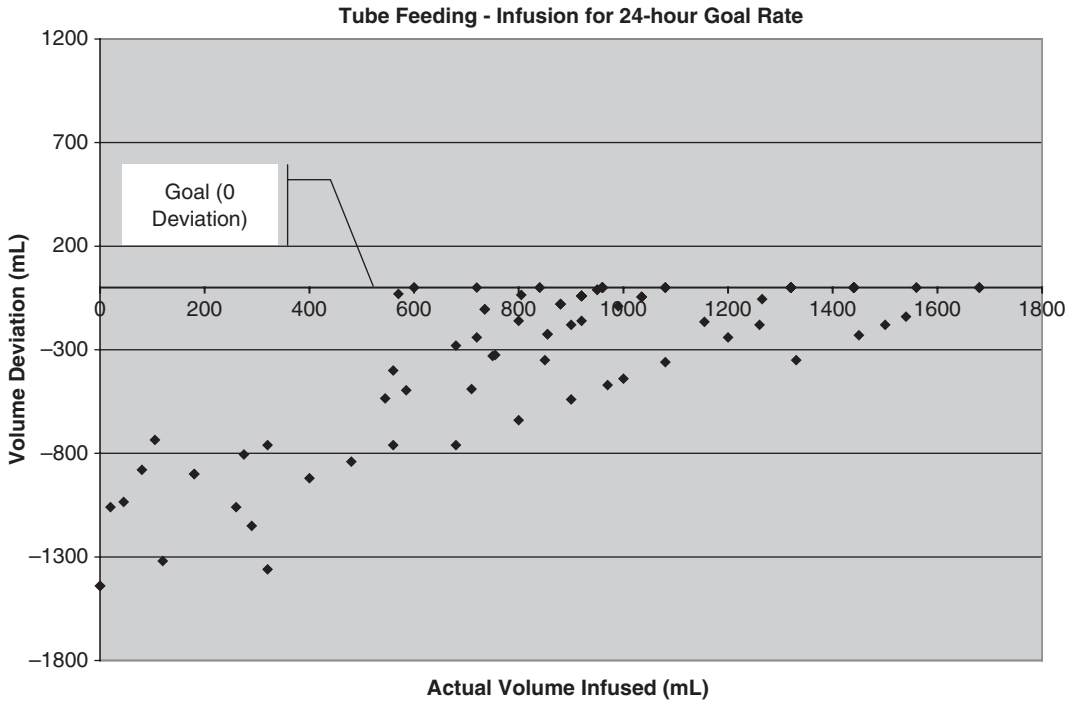

Figure 1. Daily enteral volume deficit based on 24-hour infusion goal rate.

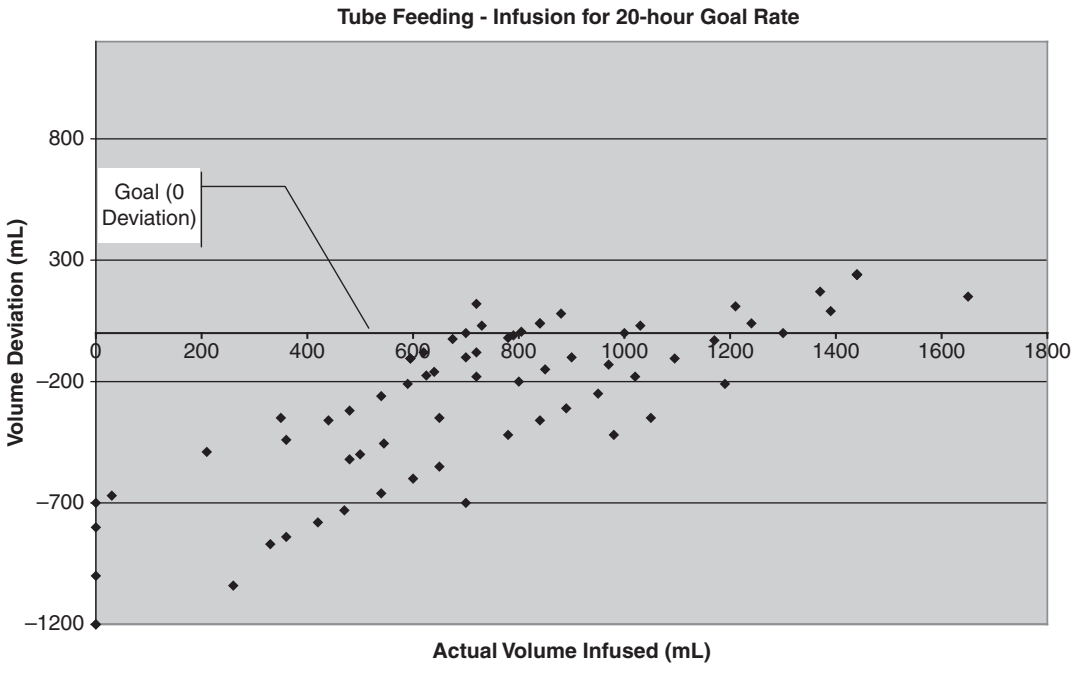

Figure 2. Daily enteral volume deficit using compensatory 20-hour infusion goal rate.

the feeding had been held, thereby making up for what had been lost feeding in as many hours. This may be problematic in that this approach could result in a significantly higher rate of GI intolerance considering the prevalence of gastric atony in ICU patients, as some EN rates may require up to a 150 mL/h compensatory rate to accomplish

Table 1. Categories of Nutrition Adequacy in Patients Receiving Standard Enteral Nutrition (EN) Infusion Goal Rates (Baseline) or Higher, Compensatory EN Infusion Goal Rates (Intervention)

	Inadequate: <90% of Goal Volume		Adequate EN: ±10% of Goal Volume		Overfed: 110%–115% of Goal Volume		Overfed: 116%–120% of Goal Volume	
Group	n	%	n	%	n	%	n	%
Baseline	45	41	65	59	0	0	0	0
Intervention	46	29	20	13	13	8	79	50

the goal.[13] By adding an anticipatory increase in volume during the initial calculation, based on historical average delays, we were able to deliver adequate EN without the requirement for frequent, large changes in volume during the day. This likely relates to better patient tolerance and a decreased nursing workload.

One negative consideration of this higher, compensatory infusion goal rate is the potential for overfeeding, which may result in increased physiological stress, manifested as hyperlipidemia, azotemia, hyperglycemia, fluid overload, hepatic dysfunction, and compromised respiratory status.[12] Typically, overfeeding is established as delivery of >110% of a patient's nutrition needs.[2,12] In the case of the 20-hour calculated infusion rate, a patient has the potential to receive up to 120% of his or her estimated or measured caloric needs if the infusion is continued for 24 hours without interruption. Although our data showed that patients in the 20-hour calculation group received a mean of 97% of their intended goal volume, the data also demonstrated a high rate of overfeeding, with 17 patients being overfed for a total of 92 patient days. Eighty-five (92%) of those days were attributable to patients who received EN from a more concentrated formula (≥1.2 kcal/mL). Of the 17 patients who received >110% of their estimated needs at least once during the intervention, 14 (82%) were on formulas that exceeded 1.0 kcal/mL. Reevaluation of our data, with elimination of those patients receiving a more concentrated formula, demonstrated a decrease in the overfeeding rate to just 9%.

We also found a relationship between overfeeding (>110% of estimated needs) and duration of therapy. Our data revealed that patients receiving >110% of their needs (more specifically, had <4 hours of EN withheld daily) were most commonly those who had a length of stay in the ICU ≥ 2 weeks. Seven of the 17 overfed patients (41%) achieved an ICU length of stay ≥ 2 weeks during data collection. This accounted for 45 days (49%) of overfeeding. This does counter the findings in a multicenter study by Montejo in which patients receiving longer courses of EN via nasogastric tubes failed to be effectively fed due to GI complications.[14]

One consideration in the implementation of this protocol to decrease the incidence of overfeeding would be to apply it only to patients receiving isocaloric feedings and limiting it to patients with less than a 2-week ICU length of stay. For this excluded population, a lower compensatory rate could be considered, such as basing the calculations on a 22-hour infusion rather than a 20-hour infusion.

Limitations of our study include the lack of ability to conduct indirect calorimetry on all patients, requiring us to determine the energy needs of patients using predictive estimation equations. Although using indirect calorimetry would have provided us with a definitive caloric requirement, we felt a 10% margin of error related to optimal caloric intake was a realistic goal when predictive equations are used for establishing a nutrition regimen.

It may be that a combination of recommended ICU nutrition guideline practices and our proposed higher compensatory EN goal rate may yield an ideal method to obtain and maintain adequate nutrition through a proactive approach. A 2008 editorial in the *Journal of the American Medical Association* discusses the achievability and value of implementing nutrition guidelines in the ICU.[11] The authors concluded that interventions in future studies should be based on a framework of behavioral change and that feeding within 48 hours of admission, goal rate advancement protocols and algorithms, in addition to reinforcement and reeducation of medical and nursing staff will yield the most positive results.[1,7,11]

At the present time, many nutrition professionals compensate for delays in EN via a variety of individual preferences and formulations, as a standard practice for ensuring adequate delivery of EN has yet to be established. Implementation of a rate advancement algorithm, combined with a higher, compensatory goal rate as established by a dietitian, as we have described, may prove an effective method to standardize, achieve, and maintain optimal enteral delivery for critically ill patients receiving EN.

Conclusion

We conclude that calculating and prescribing higher EN infusion rates, assuming 20 hours of actual infusion daily, in patients receiving isocaloric EN for less than 2 weeks promotes delivery of optimal nutrient provisions and

avoidance of unintended malnutrition by significantly reducing caloric deficit from frequent EN holding. As we noted, we did find a significant rate of overfeeding in our protocol population, and it would be prudent to develop adjunct processes to identify and prevent this from occurring in future derivations of the protocol.

References

1. McClave SA, Martindale RG, Vanek VW, et al, and the A.S.P.E.N. Board of Directors, American College of Critical Care Medicine, Society of Critical Care Medicine. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). *JPEN J Parenter Enteral Nutr*. 2009;33:277-316.
2. O'Leary-Kelley CM, Puntillo CA, Barr J, Stotts N, Douglas MK. Nutritional adequacy in patients receiving mechanical ventilation who are fed enterally. *Am J Crit Care*. 2005;14:222-231.
3. Mackenzie SL, Zygun DA, Whitmore BL, Doig CJ, Hameed SM. Implementation of a nutrition support protocol increases the proportion of mechanically ventilated patients reaching enteral nutrition targets in the adult intensive care unit. *JPEN J Parenter Enteral Nutr*. 2005;29(2):74-80.
4. De Jonghe B, Appere-De-Vechi C, Fournier M, et al. A prospective survey of nutritional support practices in intensive care unit patients: what is prescribed? What is delivered? *Crit Care Med*. 2001;29(1):8-12.
5. Btaiche IF, Chan LN, Pleva M, Kraft MD. Critical illness, gastrointestinal complications, and medication therapy during enteral feeding in critically ill adult patients. *Nutr Clin Pract*. 2010;25:32-49.
6. McClave SA, Sexton LK, Spain DA, et al. Enteral tube feeding in the intensive care unit: factors impeding adequate delivery. *Crit Care Med*. 1999;27(7):1252-1256.
7. Spain DA, McClave SA, Sexton LK, et al. Infusion protocol improves delivery of enteral tube feeding in the critical care unit. *JPEN J Parenter Enteral Nutr*. 1999;23:288-292.
8. O'Meara D, Mireles-Cabodevila E, Frame F, et al. Evaluation of delivery of enteral nutrition in critically ill patients receiving mechanical ventilation. *Am J Crit Care*. 2008;17:53-61.
9. Petros S, Engelmann L. Enteral nutrition delivery and energy expenditure in medical intensive care patients. *Clin Nutr*. 2006;25:51-59.
10. Barr J, Hecht M, Flavin KE, Khorana A, Gould MK. Outcomes in critically ill patients before and after the implementation of an evidence-based nutritional management protocol. *Chest*. 2004;125(4):1446-1457.
11. Jones NE, Heyland DK. Implementing nutrition guidelines in the critical care setting. *JAMA*. 2008;300(23):2798-2799.
12. McClave SA, Lowen CC, Kleber MJ, et al. Are patients fed appropriately according to their caloric requirements? *JPEN J Parenter Enteral Nutr*. 1998;22(6):375-381.
13. Mentes H, Dupont H, Bocchetti M, Cani P, Ponche F, Bleichner G. Upper digestive intolerance during enteral nutrition in critically ill patients: frequency, risk factors, and complications. *Crit Care Med*. 2001;29:1955-1961.
14. Montejo JC. Enteral nutrition-related gastrointestinal complications in critically ill patients: a multicenter study. *Crit Care Med*. 1999;28(8):1447-1453.