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Volume-Based Feeding's Place in the Modern Intensive Care Unit



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Underfeeding in the intensive care unit (ICU) is a well-documented issue affecting patient outcomes. Volume-based feeding (VBF) represents a feeding protocol designed to mitigate the effects of frequent enteral nutrition (EN) interruptions by allowing adjustments to be made in the infusion rate to achieve a target volume for a desired caloric and nutrient delivery. Various VBF protocols exist, each differing in regimen and effectiveness. VBF protocols are safe with minimal adverse events reported. To enhance compliance, VBF protocols should be tailored to fit each institution's workflow. The development and implementation of VBF protocols should be done in collaboration with a multidisciplinary team.

INTRODUCTION

Malnutrition is associated with longer hospital stays, higher readmission rates, higher healthcare costs, non-routine discharges, and higher in-hospital mortality.¹ However, when comparing patients fed low versus high calorie goals in the first 7-10 days of ICU admission, the American Society for Parenteral and Enteral Nutrition (ASPEN) Guidelines for the Provision of Nutrition Support Therapy in the Adult Critically Ill

Patient reported no difference in mortality, length of stay, infections, or other clinical outcomes.²

Mortality is not an optimal metric to measure the utility of nutrition interventions as it requires extremely large sample sizes that no randomized controlled trial has achieved thus far.^{3,4} Meanwhile, one observational study demonstrated an association with improved mortality for patients who received more calories, after adjusting for age, Charlson Comorbidity index, APACHE II score, baseline SOFA score, primary admission diagnosis, admission category, BMI, and geographical region, as well as improved physical functioning scores

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in patients who required >8 days of mechanical ventilation with at least 2 organ failures.⁵ Factors such as the heterogeneity of patients, the universality of nutrition, and the practical biases (sicker patients are harder to feed),⁶ have limited the ability of the available data to clearly and distinctly signal what clinicians know to be sound: that patients should not be starved.

The question of optimal feeding targets in the ICU with regard to functionality and quality of life for ICU survivors has not been definitively answered with the current body of literature, but the observational data does suggest that 1) underfeeding remains a pervasive issue and 2) efforts should be made to enhance feeding practices.^{5,6} Traditionally, a rate-based feeding (RBF) protocol has been the

Table 1. Summary of Results from Single-Center Studies after Implementing VBF Protocols

Study Design	Protocol/ Institution	ICU Population	Results (all results summarized are statistically significant, $p < 0.05$)
Pre/Post Protocol Implementation	PERFECT ¹⁷	MICU, SICU	Increased provision by 13.4% of prescribed calories (pre: 87.9% + 13.8%, post: 101.3% + 11.7%), and 8.6% of prescribed protein (pre: 89.2% + 19.5%, post: 97.6% + 14.8%)
	FEED ME ¹⁶	SICU, trauma	Increased provision by 26% of prescribed calories (pre: 63% + 20%, post: 89% + 9%), and 0.13 g protein/kg (pre: 1.13 g protein/kg + 0.29 g protein/kg, post: 1.26 g protein/kg + 0.37 g protein/kg)
	FEED MORE ¹⁵	MICU, neurosurgery	Increased provision by 27% of prescribed calories (pre: 75%, post: 102%), and 19% of prescribed protein (pre: 68%, post: 87%), increase in patients receiving >80% target calories by 29% (pre: 42%, post: 71%)
	Carolinas Medical Center Protocol ²⁴	Trauma	Increased goal volume delivery by 8.3% (pre: 65%, post: 73.3%), increased patients receiving >80% delivery by 15% (pre: 17%, post: 32%)
	University of Virginia Health System Protocol ²⁵	SICU, trauma, burns	Increased provision by 11.1% of prescribed calories (pre: 73.4%, post: 84.5%), and 8.8% of prescribed protein (pre: 77.4%, post: 86.2%)
	Palmetto Health University of South Carolina ²¹ using PEP uP protocol	SICU, trauma	Increased provision by 963 calories/d (pre: 347.4 calories/d, post: 1310.4 calories/d), and 64.8 g protein/d (pre: 18.2 g protein/d, post: 83.6 g protein/d)
Comparison of VBF to RBF	FEED ²⁶	MICU, SICU, trauma	VBF group received 84% + 21% of prescribed calories and 90% + 25% of prescribed protein, RBF group received 73% + 11% of prescribed calories and 57% + 8% of prescribed protein
	University of Louisville Medical Center Protocol ²⁷	MICU	VBF group received 92.9% + 16.8% of prescribed calories, RBF group received 80.9% + 18.9% of prescribed calories
	Stanford Health Care Protocol ⁹	MICU, SICU, neuro, cardiac	VBF group received 93.1% + 11.3% of target volume, RBF group received 71.3% + 35.8% of target volume
	University of Maryland, St Joseph's Medical Center Protocol ¹⁹	MICU, SICU, cardiac (non-ECMO)	VBF group received 99.8% of target volume, RBF group received 67.5% of target volume

Table 2. Description of Various VBF Protocols

Protocol	Initiation of Feeding	Frequency of Rate Recalculation	Initial Formula Type	Maximum Feeding Rate (mL/hr)	Gastric Residual Volume Threshold (mL)	Unique Protocol Features
PEP uP ^{13,14,18}	Initiate at goal rate (option to start trophic for patients deemed unsuitable for high volume)	Upon feeding interruption	Peptide-based (Peptamen 1.5)	150	250	Initial use of Metoclopramide 10 mg IV q 6 hours and protein modulars 14g BID
PERFECT ¹⁷	Advance to goal rate within 6h and maintain RBF for the first day	Upon feeding interruption	Standard (Osmolite HP or Osmolite)	150	500	200 ml catch up bolus at the end of the day if feeding target not achieved
FEED ME ¹⁶	Initiate at 20 mL/hr and increase 10 mL/hr q 4 hrs to goal rate	Upon feeding interruption or as soon as NPO at midnight order is received feeds are increased assuming 12 hours left	Any	120	350	Initial protocol included bolus feeding which subsequently was removed from the protocol
FEED MORE ¹⁵	Initiate at 30 mL/hr and advance to goal rate after 4 hours, maintain RBF for the first day	At least once daily and after feeding interruption	Algorithm directed (Peptamen Intense VHP, Novasource Renal, Replete)	150	400	
FEED ²⁶	Not reported	Daily at 1600	Standard (Nutrison Protein Plus)	150	300	VBF included higher protein target of 1.5g/kg vs standard group 1.0 g/kg
University of Louisville Medical Center Protocol ²⁷	Initiate at 25 mL/hr and advance 25 mL/hr q 8 hours to goal rate	After feeding interruption	Not reported	Small bowel feeding: 150 Gastric feeding: 280	400	
Carolinas Medical Center Protocol ²⁴	Initiate at half rate and advance to goal rate after 4 hours	After feeding interruption	Any	150	500	
Stanford Health Care Protocol ⁹	Initiate at goal rate	Every time feeding volume is documented in the EMR (expectation is hourly)	Any	150	not routinely checked	Use of an automated rate catch-up calculator embedded into the EMR
University of Maryland, St Joseph's Medical Center Protocol ¹⁹	Initiate at 20 mL/hr and advance to goal rate at midnight	q 4 hrs (4am, 8am, 12pm, 4pm, 8pm)	Peptide based (Vital High Protein)	120	500 or two consecutive 250	
University of Virginia Health System Protocol ²⁵	Not reported	After feeding interruption and distributed over the next 24 hours	Not reported	120	500	

standard practice, in which a continuous infusion rate is calculated to meet the estimated calorie and protein needs of a patient, using an enteral formula selected with regard to patient condition, and calculated off a 24-hour duration. However, in the ICU, underfeeding is so rampant that some dietitians may routinely recommend EN regimens with a higher infusion rate to compensate for predicted interruptions to feeding. Interruptions to EN may include stopping feeds for various procedures or treatments,⁷⁻⁹ complications such as diarrhea, vomiting or aspiration,¹⁰ periods of hemodynamic instability, loss of enteral access,⁹ miscommunications between dietitians, nurses, and medical providers, or feeding may be overlooked entirely for patients who are unable to voice their discomfort. Slow initiation and advancement of EN has also been identified as a barrier to meeting feeding targets.^{9,11}

Volume-based feeding is a nursing-driven feeding protocol in which the hourly EN infusion rate is adjusted with the aim of achieving a target daily goal volume. Implementation of VBF has been jointly recommended by ASPEN and Society for Critical Care Medicine (SCCM) to improve EN delivery in the ICU since 2016.¹² The first VBF protocol, named the Enhanced Protein-Energy Provision via the Enteral Route in Critically Ill Patients (PEP uP) Protocol, was implemented and

published by Heyland, et al. in 2010.¹³ Since then, several authors have adapted and expanded the original PEP uP protocol to meet the needs of their institutions.

Efficacy of Volume-Based Feeding Protocols

A survey conducted across 201 ICUs within 26 countries evaluated the nutritional adequacy of EN regimens administered to 3390 patients. On average, the patients received only 61.2% of the prescribed calories and 57.6% of the prescribed protein with a mean energy deficit of 695 kcal/day.⁶ Only 26% of patients achieved >80% of caloric targets.⁶ This data captures the rampant nature of underfeeding in ICUs across the world. In a recent meta-analysis, patients who were fed using a VBF protocol received 386.61 more calories per day, 31.44 more grams of protein per day, and achieved >80% of caloric goals more often (odds ratio: 2.84) when compared to RBF, with no difference in mortality, mechanical ventilation, diarrhea, emesis, feeding intolerance, or gastric retention.⁸ Table 1 describes improvements in feeding provision from single center studies after implementing a VBF protocol. Of the authors who assessed impact to glycemic control, most found no difference between VBF and RBF in blood glucose levels^{9,13-16} except for Brierley-Hobson who found a higher mean morning BG in the VBF

Table 3. Steps for Designing and Implementing a VBF Protocol

1. Form a multidisciplinary project team. Consider using medical students or dietetic interns to assist with data collection and educational material development.
2. Collect baseline data. Consider including data on age, gender, anthropometrics, primary team, admitting diagnosis, estimated calorie and protein targets, the EN prescription, and actual infusion of EN.
3. Analyze the data to determine the most impactful root causes of underfeeding.
4. Design a VBF protocol that integrates into existing workflows and targets the most impactful root causes.
5. Educate all impacted staff with educational materials targeted to their role in the protocol. Medical providers, nurses, and dietitians should each have tailored education.
6. Choose a date to implement the workflow and transition appropriate patients to the VBF protocol. Consider increasing staffing with project champions to provide real time support to all staff as they use the protocol for the first time.
7. Reinforce compliance with the protocol. Consider regular rounding on patients on the VBF protocol.
8. Repeat the data collection and compare pre and post protocol feeding adequacy.
9. Continuously monitor protocol compliance and address challenges.

group (8.0 mmol/L vs. 8.5 mmol/L, $p = 0.034$) but no difference in insulin prescription.¹⁷ No studies reported on changes to electrolytes.

Implementing Volume-Based Feeding Protocols

The original PEP uP protocol was designed to feed proactively and enhance feeding tolerance upfront, rather than wait for feeding complications and deficits to occur. Heyland and colleagues targeted the broadest ICU population possible with few exclusion criteria.^{13,18} As other institutions adopted their own VBF protocols, some of the original features of the PEP uP protocol were abandoned (no other protocols reported routinely using an initial prokinetic or protein modular), while other innovations were developed (building a rate catch up calculator into the EMR).⁹ Additionally, institutions may vary in their application of VBF protocols to meet various feeding targets recommended for the different phases of critical illness. Table 2 summarizes the various protocol designs that multiple institutions have used to implement VBF.

The institutions that have adopted VBF emphasized the importance of including multidisciplinary champions to ensure the success of the initiative.^{14–17,19–21} The teams often included a dietitian, a nurse, and a physician. Education and implementation of the protocols occurred through a variety of modalities: presentations at huddles and staff meetings, in-services, and distribution of a bedside tool that described how to determine catch up rates. PEP uP educational materials are available at criticalcarenutrition.com.¹⁴ Stanford

Health Care's protocol embedded the catch up rate calculation into the electronic medical record where the nurses were already doing their hourly charting, which eliminated the task of manual calculation on behalf of the nurse.⁹

Nursing compliance is critical to the success of VBF protocols. The bedside nurse executes the VBF protocol as nurses are managing the EN infusion throughout the day. McCall, et al. surveyed bedside nurses after the PEP uP protocol was implemented at multiple centers.²⁰ The registered nurse (RN) perception of the impact on workload was overall modest with 54% of RNs surveyed saying the protocol “increased workload a bit,” 36.6% responding “neutral,” and only 4.3% saying the protocol “increased workload considerably.”²⁰ Initial protocol implementation and education should depend on the needs and availability of the nursing staff. Following implementation, reinforcement of protocol compliance is also necessary. Table 3 outlines suggested steps and recommendations for implementing a VBF protocol.

There are many considerations for a VBF protocol design:

- Will the protocol be applied universally or only to selected patients?
- Who are the patients that are appropriate for the protocol?
- Does the protocol start upon initiation of EN, or when the patient is deemed to be more stable?

Table 4. Opportunities to Enhance Feeding Practices

- Establish clear protocols on when to start, wean, and pause EN.
- Initiate EN at goal rate and limit slow initiation and advancement practices to specific conditions (e.g., refeeding, hemodynamic instability, risk for GI intolerance, etc.).^{7,11}
- Consider other feeding modalities when medically feasible such as cyclic and bolus feeds which may be less affected by pausing EN.
- Establish a procedure for when to implement supplemental intravenous lipid emulsion infusion or parenteral nutrition.^{2,10}
- Audit feeding practices and feeding protocol compliance, share audit results widely and routinely.
- Add EN formulas and modulars to the medication administration record.
- Staff and train ICU dietitians²⁸ adequately and incorporate them into bedside rounds.

Table 5. Case Study

This case study demonstrates how VBF may improve feeding adequacy in a hypothetical patient.

A patient presenting in adequate nutritional status suffered a hemorrhagic stroke. The patient was intubated and deemed stable for VBF initiation. The decision was made to initiate feeding on the first day of hospitalization and orders and enteral access were placed by 2pm. The feeding regimen is determined by the dietitian to be 1440 mL (continuous rate of 60 mL/hour) of a standard formula.

The neurosurgeons decide that they will bring the patient to the operating room (OR) the following day. Institution specific protocols allow the patient to be fed up until departure to the OR. The patient is in the OR from 8am – 2pm and feeds are resumed upon returning from the OR. The following day the patient has no feeding interruptions. Table 5.a shows how much volume of formula the patient would have received if each institution's protocol was followed. Table 5.b shows the volume of formula the patient would have received, with the change that holding enteral feeding (NPO) is required at midnight prior to surgery.

The differences in Table 5.a and Table 5.b demonstrate that even with VBF, other feeding practices such as holding EN for hours before an operation, can thwart effectiveness of VBF.

Table 5a. Case Study: Feeding Delivery Provision (mL) on Various VBF Protocols

Institution Protocol	Day 1	Day 2 (OR day)	Day 3	Overall % goal volume
RBF Protocol*	540	1080	1440	71%
University of Maryland, St Joseph's Medical Center Protocol ¹⁹	200	1440	1440	71%
University of Louisville Medical Center Protocol ²⁷	660	1440	1440	82%
Carolinas Medical Center Protocol ²⁴	840	1440	1440	86%
Stanford Health Care Protocol ⁹	1440	1440	1440	100%

Table 5b. Case Study: Feeding Delivery Provision (mL) on Various VBF Protocols with the Practice of Holding EN at Midnight for non-GI Surgery

Institution Protocol	Day 1	Day 2 (OR day)	Day 3	Overall % goal volume
RBF protocol*	240	860	1440	59%
University of Maryland, St Joseph's Medical Center Protocol ¹⁹	200	1080	1440	63%
University of Louisville Medical Center Protocol ²⁷	300	1440	1440	74%
Carolinas Medical Center Protocol ²⁴	480	1440	1440	78%
Stanford Health Care Protocol ⁹	600	1440	1440	81%

* Rate based feeding (RBF) in these examples includes initiating at 20 mL/hr and advancing 20 mL/hr q 8 hours, restarting EN at last infused rate after interruptions, day starts at 7am

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- Does the protocol itself dictate how feeds are initially advanced?
- Does the enteral formula choice matter?
- Does the enteral route matter?
- What time of day does the rate calculation start and how often is it recalculated?
- What safeguards are necessary?
- Is there a maximum rate that should not be exceeded?
- How will the rate catch up be calculated and by whom?

Patient population, acuity, feeding culture, resource availability, multidisciplinary team culture, and existing workflows will all play a part in the shape of each institution's tailored VBF protocol.

Limitations of Volume-Based Feeding

A large majority of patients included in VBF protocols were admitted to medical ICUs (MICU) and a smaller proportion to surgical ICUs (SICU). Use in cardiac ICUs seems limited.^{9,14} The diagnoses of VBF patients is not explicitly described in several studies because primary clinicians were allowed to exclude patients deemed "not suitable" for VBF, without further elaborating on what the exclusion criteria were. Swiatlo, et al. described exclusion criteria from the VBF protocol as patients who were at risk for refeeding syndrome, at risk for severe GI intolerance, or were hemodynamically unstable.⁹ Often the patients deemed inappropriate for VBF may be the sickest, most at-risk patients.⁶ In order to optimize the feeding practices for all patients, other nutrition protocols such as reducing unnecessary enteral feeding interruptions and using

supplemental parenteral nutrition (PN) should be part of a well-rounded feeding culture.^{2,10}

Surgical patients seem to benefit less from VBF protocols. In an observational review of 150 ICUs, use of the PEP uP protocol did not result in higher calorie or protein delivery in SICU patients and overall, less calorie and protein delivery than MICU patients. Surgical ICU patients were more likely to receive trophic feeding, PN, or no nutrition at all compared to MICU patients.⁷ However, Table 1 shows that single centers may still have meaningful improvement with VBF in SICU populations. Single center success may be attributed to the wide variability in peri-procedural feeding practices, which is likely due in part to the lack of clinical guidelines around this topic.²² An in-depth discussion of other feeding strategies is beyond the scope of this review; however, opportunities to enhance a feeding culture are listed in Table 4.

Future Direction of Volume-Based Feedings

Volume-based feeding is a protocol that has commonly been limited to the ICU even though patients in all care settings may receive continuous EN. If patient instability is a primary reason that patients are excluded from VBF, it stands to reason that patients in lower acuity settings would be eligible for, and benefit from, VBF protocols. It may be advantageous to consider the nursing burden when designing protocols for areas that have higher nurse to patient ratios. Volume-based feeding protocols that involve fewer rate adjustments, at routine times of day, may lead to better adherence by bedside nurses who have more patients.

Most protocols summarized in Table 2 require manual actions by the bedside nurse, such as referencing a chart or calculating new infusion rates. Only one group leveraged technology



to streamline the process.⁹ In contrast, feeding pumps that automatically calculate and deliver VBF without any nurse manipulation have been developed and are being piloted in Europe.²³ Any innovation that reduces nursing burden with VBF protocol implementation is likely to contribute to greater compliance in executing the protocol. See Table 5 for a case study outlining VBF practices across different protocols.

CONCLUSION

Volume-based feeding is an effective means to increase the provision of EN. For VBF to be effective, it must exist within a feeding culture that recognizes the importance of nutrition in optimizing patient outcomes and limiting the impact of malnutrition. VBF does not negate the need for other robust feeding protocols. However, when VBF is used in harmony with other evidence-based nutrition practices, it can lead to the maintenance and enhancement of the nutritional status of the most vulnerable patients. ■

References

1. Guenter P, Abdelhadi R, Anthony P, et al. Malnutrition diagnoses and associated outcomes in hospitalized patients: United States, 2018. *Nutr Clin Pract*. 2021;36(5):957-969.
2. Compher C, Bingham AL, McCall M, et al. Guidelines for the provision of nutrition support therapy in the adult critically ill patient: The American Society for Parenteral and Enteral Nutrition. *J Parenter Enter Nutr*. 2022;46(1):12-41.
3. Summers MJ, Chapple L, Anne S, McClave SA, Deane AM. Event-rate and delta inflation when evaluating mortality as a primary outcome from randomized controlled trials of nutritional interventions during critical illness: a systematic review. *Am J Clin Nutr*. 2016;103(4):1083-1090.
4. Fetterplace K, Ridley EJ, Beach L, et al. Quantifying Response to Nutrition Therapy During Critical Illness: Implications for Clinical Practice and Research? A Narrative Review. *J Parenter Enter Nutr*. 2021;45(2):251-266.
5. Wei X, Day AG, Ouellette-Kuntz H, Heyland DK. The Association Between Nutritional Adequacy and Long-Term Outcomes in Critically Ill Patients Requiring Prolonged Mechanical Ventilation: A Multicenter Cohort Study*. *Crit Care Med*. 2015;43(8):1569-1579.
6. Heyland DK, Dhaliwal R, Wang M, Day AG. The prevalence of iatrogenic underfeeding in the nutritionally 'at-risk' critically ill patient: Results of an international, multicenter, prospective study. *Clin Nutr*. 2015;34(4):659-666.
7. Declercq B, Deane AM, Wang M, Chapman MJ, Heyland DK. Enhanced Protein-Energy Provision via the Enteral Route Feeding (PEPuP) Protocol in Critically Ill Surgical Patients: A Multicentre Prospective Evaluation. *Anaesth Intensive Care*. 2016;44(1):93-98.
8. Wang L, Wang Y, Li HX, et al. Optimizing enteral nutrition delivery by implementing volume-based feeding protocol for critically ill patients: an updated meta-analysis and systematic review. *Crit Care*. 2023;27(1):173.
9. Swiatlo T, Berta JW, Mauldin K. A Quality Improvement Study: Comparison of Volume-Based and Rate-Based Tube Feeding Efficacy and Clinical Outcomes in Critically Ill Patients. *Nutr Clin Pract*. 2020;35(3):578-583.
10. Alsharif DJ, Alsharif FJ, Aljuraiban GS, Abulmeaty MMA. Effect of Supplemental Parenteral Nutrition Versus Enteral Nutrition Alone on Clinical Outcomes in Critically Ill Adult Patients: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Nutrients*. 2020;12(10):2968.
11. Dijkink S, Fuentes E, Quraishi SA, et al. Nutrition in the Surgical Intensive Care Unit: The Cost of Starting Low and Ramping Up Rates. *Nutr Clin Pract*. 2016;31(1):86-90.
12. McClave SA, Taylor BE, Martindale RG, et al. 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.). *J Parenter Enter Nutr*. 2016;40(2):159-211.
13. Heyland DK, Cahill NE, Dhaliwal R, et al. Enhanced protein-energy provision via the enteral route in critically ill patients: a single center feasibility trial of the PEP uP protocol. *Crit Care*. 2010;14(2):R78.
14. Heyland DK, Dhaliwal R, Lemieux M, Wang M, Day AG. Implementing the PEP uP Protocol in Critical Care Units in Canada: Results of a Multicenter, Quality Improvement Study. *J Parenter Enter Nutr*. 2015;39(6):698-706.
15. Holyk A, Belden V, Sirimaturos M, et al. Volume-Based Feeding Enhances Enteral Delivery by Maximizing the Optimal Rate of Enteral Feeding (FEED MORE). *J Parenter Enter Nutr*. 2020;44(6):1038-1046.
16. Taylor B, Brody R, Denmark R, Southard R, Byham-Gray L. Improving Enteral Delivery Through the Adoption of the "Feed Early Enteral Diet Adequately for Maximum Effect (FEED ME)" Protocol in a Surgical Trauma ICU: A

- Quality Improvement Review. *Nutr Clin Pract*. 2014;29(5):639-648.
17. Brierley-Hobson S, Clarke G, O'Keeffe V. Safety and efficacy of volume-based feeding in critically ill, mechanically ventilated adults using the 'Protein & Energy Requirements Fed for Every Critically ill patient every Time' (PERFECT) protocol: a before-and-after study. *Crit Care*. 2019;23(1):105.
 18. Heyland DK, Murch L, Cahill N, et al. Enhanced Protein-Energy Provision via the Enteral Route Feeding Protocol in Critically Ill Patients: Results of a Cluster Randomized Trial*. *Crit Care Med*. 2013;41(12):2743-2753.
 19. Bonomo A, Blume DL, Davis K, Kim HJ. Implementing Volume-Based Feeding to Optimize Delivery of Enteral Nutrition. *Crit Care Nurse*. 2021;41(2):16-26.
 20. McCall M, Cahill N, Murch L, et al. Lessons Learned From Implementing a Novel Feeding Protocol: Results of a Multicenter Evaluation of Educational Strategies. *Nutr Clin Pract*. 2014;29(4):510-517.
 21. Prest PJ, Justice J, Bell N, McCarroll R, Watson CM. A Volume-Based Feeding Protocol Improves Nutrient Delivery and Glycemic Control in a Surgical Trauma Intensive Care Unit. *J Parenter Enter Nutr*. 2020;44(5):880-888.
 22. Sparling JL, Nagrebetsky A, Mueller AL, et al. Preprocedural fasting policies for patients receiving tube feeding: A national survey. *J Parenter Enter Nutr*. 2023;47(8):1011-1020.
 23. Kagan I, Hellerman-Itzhaki M, Bendavid I, et al. Controlled enteral nutrition in critical care patients—A randomized clinical trial of a novel management system. *Clin Nutr*. 2023;42(9):1602-1609.
 24. Sachdev G, Backes K, Thomas BW, Sing RF, Huynh T. Volume-Based Protocol Improves Delivery of Enteral Nutrition in Critically Ill Trauma Patients. *J Parenter Enter Nutr*. 2020;44(5):874-879.
 25. Krebs ED, O'Donnell K, Berry A, Guidry CA, Hassinger TE, Sawyer RG. Volume-based feeding improves nutritional adequacy in surgical patients. *Am J Surg*. 2018;216(6):1155-1159.
 26. Fetterplace K, Deane AM, Tierney A, et al. Targeted Full Energy and Protein Delivery in Critically Ill Patients: A Pilot Randomized Controlled Trial (FEED Trial). *J Parenter Enter Nutr*. 2018;42(8):1252-1262.
 27. McClave SA, Saad MA, Esterle M, et al. Volume-Based Feeding in the Critically Ill Patient. *J Parenter Enter Nutr*. 2015;39(6):707-712.
 28. Heyland DK, Heyland RD, Cahill NE, et al. Creating a Culture of Clinical Excellence in Critical Care Nutrition: The 2008 "Best of the Best" Award. *J Parenter Enter Nutr*. 2010;34(6):707-715.



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