High-Protein Enteral Nutrition in a Pediatric Patient with Severe Traumatic Brain Injury

Konstantinos Boukas, MD[1], Jennifer N. Nguyen, MPH[1], Carla Caminos, RDN, LD[2], Upulie Nawaratne, MD[1]

[1]*Division of Critical Care Medicine, Department of Pediatrics, McGovern Medical School at UTHealth Houston*

[2]*Children's Memorial Hermann Hospital*

Introduction

Nutritional support is essential in the treatment of critically ill children, particularly those at high risk of malnutrition due to hypermetabolism and catabolic stress.[1,2] Children with severe traumatic brain injury (TBI) often experience significant metabolic disruption, resulting in increased energy needs that are challenging to meet during the initial stage of hospitalization. In the pediatric intensive care unit (PICU), early initiation of enteral nutrition (EN) has been associated with improved clinical outcomes, including enhanced recovery during ICU stays.[3] High-protein (HP) formulas may further support increased metabolic demands seen during the acute phase of critical illness.[1]

Methods

This case study describes the nutritional management of a 9-year-old male admitted to the PICU following a motor vehicle collision. Diagnoses included severe traumatic brain injury, left basal ganglia hemorrhage (L. BGH), intracerebral hemorrhage (ICH), and a left mandibular fracture. Upon admission, the patient's height was 140 cm, and his weight was 48 kg, corresponding to a BMI-for-age z-score of 2.01. His hospital course included 15 days of mechanical ventilation, open reduction and internal fixation of the mandible, and placement of tracheostomy and gastrostomy tubes on day 11. The total PICU length of stay (LOS) was 18 days, while the total hospital LOS was 46 days.

EN was initiated 60 hours post-admission using a high-protein, peptide-based formula (Peptamen Junior® HP, Nestlé Healthcare Nutrition Inc; [PJHP]) designed for critically ill patients. The formula included enzymatically hydrolyzed 100% whey protein, with 16% calories from protein and 60% of fat as medium-chain triglycerides, to optimize absorption and meet the protein needs of pediatric trauma patients.[4] This formula was intentionally selected for its ability to deliver high protein while preventing overfeeding—a key concern in ventilated patients where excess carbohydrate intake may increase carbon dioxide production and impede ventilatory weaning. This regimen was maintained for 14 days.

Indirect calorimetry (IC) was performed on PICU days 5 and 11 to assess energy expenditure and substrate utilization.

References

1. Kratochvíl M, Klučka J, Klabusayová E, et al. Nutrition in Pediatric Intensive Care: A Narrative Review. *Children (Basel)*. 2022;9(7):1031. Published 2022 Jul 11. doi:10.3390/children9071031
2. Tedeschi-Jockers F, Reinhold S, Hollinger A, et al. A new high protein-to-energy enteral formula with a whey protein hydrolysate to achieve protein targets in critically ill patients: a prospective observational tolerability study. *Eur J Clin Nutr*. 2022;76(3):419-427. doi:10.1038/s41430-021-00956-9
3. Srinivasan V, Hasbani NR, Mehta NM, et al. Early Enteral Nutrition Is Associated With Improved Clinical Outcomes in Critically Ill Children: A Secondary Analysis of Nutrition Support in the Heart and Lung Failure-Pediatric Insulin Titration Trial. *Pediatr Crit Care Med*. 2020;21(3):213-221. doi:10.1097/PCC.0000000000002135
4. Cook RC, Blinman TA. Nutritional support of the pediatric trauma patient. *Semin Pediatr Surg*. 2010;19(4):242-251. doi:10.1053/j.sempedsurg.2010.06.001

Results

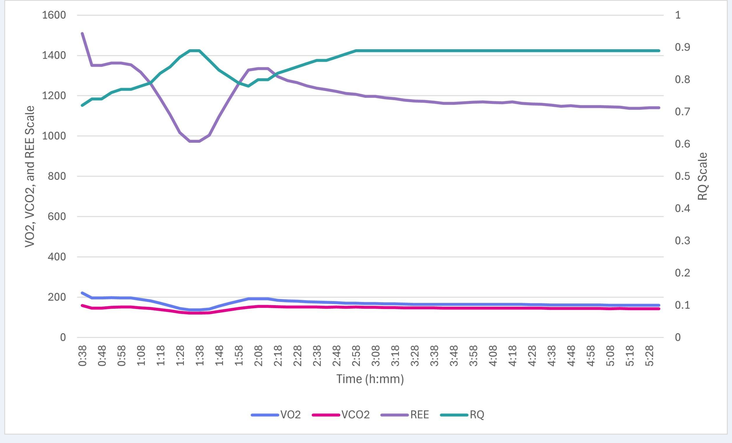
Indirect calorimetry revealed persistent hypermetabolism throughout the patient's PICU course (Figures 1 and 2). On day 5, the measured resting energy expenditure (MREE) was 1,198 kcal, exceeding the 1,070 kcal provided; by day 11, the MREE remained elevated at 1,156 kcal, while intake had decreased to 864 kcal. The calculated energy expenditure was 1,585 kcal/day, further emphasizing the patient's heightened metabolic demands. The respiratory quotient (RQ) remained stable at 0.86 in both studies, indicating a mixed substrate utilization and an optimal metabolic state. This value falls within the optimal range for critically ill patients (0.8–0.9), thereby avoiding concerns associated with RQ > 1.0 (excess carbohydrate intake and increased CO_2 production) or RQ < 0.82 (inadequate caloric provision). The decline in the coefficient of variation from 10% to 5% suggested improved metabolic stability over time.

Weight declined from 48 kg to 43.5 kg during the acute phase, likely due to fluid shifts and catabolism, before rebounding to 46 kg at discharge (net loss: 2 kg). This 4.1% weight loss illustrates metabolic stress and early nutritional challenges. Notably, no malnutrition diagnosis was made at discharge despite the high risk in similar cases.

Gastrointestinal intolerance was mild and transient, with diarrhea occurring on days 2, 5, 6, and 9, but resolved without requiring a formula change. No emesis was reported.

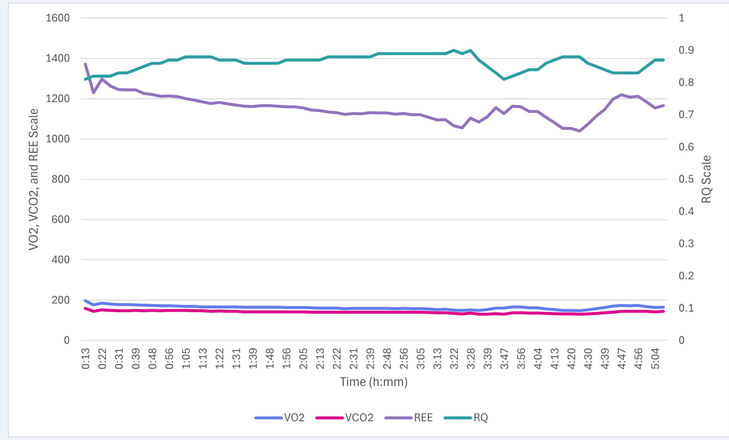
Laboratory markers supported the presence of hypermetabolism and catabolic stress. Blood urea nitrogen (BUN) trended from 15 → 1 → 25 → 11 mg/dL, indicating initial dilution from fluid resuscitation, subsequent diuresis, catabolic stress with increased protein intake, and later improvement in nitrogen balance and metabolic stability. Albumin fluctuations from 2.0 → 2.6 → 3.2 → 2.5 g/dL were consistent with an acute-phase response rather than nutritional status. Prealbumin was not measured.

Figure 1. Indirect Calorimetry Findings on Day 5.



VO2 (mL/min): oxygen consumption; VCO2 (mL/min): carbon dioxide production; REE (kcal/day): resting energy expenditure; RQ: respiratory quotient.

Figure 2. Indirect Calorimetry Findings on Day 11.



VO2 (mL/min): oxygen consumption; VCO2 (mL/min): carbon dioxide production; REE (kcal/day): resting energy expenditure; RQ: respiratory quotient.

Conclusion

The patient experienced hypermetabolism, negative nitrogen balance, and weight loss during the acute phase of severe TBI. Early initiation of high-protein, peptide-based EN supported metabolic stabilization, mitigated excessive loss of lean body mass, and contributed to partial weight recovery. Indirect calorimetry findings confirmed efficient nutrient utilization and appropriate caloric provision without evidence of overfeeding. Although mild gastrointestinal symptoms occurred, the HP formula was well-tolerated and provided balanced macronutrient support.

The patient was ultimately discharged to a rehabilitation facility on a tracheostomy collar and enteral feeds. Ongoing specialized EN during rehabilitation remains critical to aid neurologic recovery, restore lean body mass, and promote catch-up growth. This case highlights the importance of early, targeted nutritional intervention in pediatric patients with severe TBI and highlights the value of indirect calorimetry in guiding individualized nutrition therapy.

Disclosures

This research was sponsored by Nestlé Health Science.