Critical Care Nutrition Support following Cardiac Surgery in the Pediatric and Adult Population—A Review Article

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Abstract

Cardiac surgical patients in the intensive care unit certainly develop complex nutritional issues. Nutrition support is indicated in these subsets of patients and the same may be customized depending on individual patient characteristics. This review article that aims to examine the American Society for Parenteral and Enteral Nutrition guidelines for the use of parenteral and enteral nutrition in pediatric and adult cardiac surgical patients in cardiac critical care/intensive care unit evaluates the evidence related to the use of nutritional screening and nutritional assessment. The goal of this review is to enrich the discussion contained in the clinical guidelines and simplify the guideline statements to provide a platform for cardiac care providers to implement into their daily practice related to nutrition support in postoperative cardiac surgery patients.

Keywords
- nutrition
- nutritional assessment
- cardiac critical care
- intensive care
- pediatric
- adult

Introduction

The postoperative cardiac surgical patient provides us with unique challenges in management owing to the changes in physiology that the patient experiences and the complications associated with the condition and its treatment. With the advancements in the field of cardiac surgery and cardiovascular critical care, the boundaries of age are being pushed in both directions and accompanying that new standards of nutritional and metabolic support have been established in critically ill patients with a focus on early, combined enteral nutrition (EN) and parenteral nutrition (PN) along with intensive insulin therapy for tight glucose control and specific nutrients to modulate system and organ functions.[1]

A majority of the cardiac surgical patients have a 1 to 2 day intensive care unit (ICU) stay but a small fraction of them do progress to a more complicated and prolonged stay and are at a higher risk of complications owing to their already advanced disease process and hypercatabolic states given the surgical trauma and accompanying inflammation.

The American Society for Parenteral and Enteral Nutrition (ASPEN) has published several key recommendations regarding the safe use of PN and EN.[2,3] This manuscript will review several of the important papers about nutrition in cardiac surgical patients in the ICU, published in 2020 to 2021 by ASPEN. More in-depth information may be found in the original articles.

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Table 1 Guideline recommendations for pediatric patients

Question	Recommendation	Evidence GRADE	Strength of GRADE recommendation
Nutritional assessment			
Guideline question 1. What is the impact of nutrition status on outcomes in critically ill children?	A detailed nutrition assessment within 48 hours of PICU admission is recommended. Furthermore, weekly re-evaluation of nutrition status is suggested as patients are at risk of nutrition deterioration during hospitalization	Very low	Strong
Guideline question 2. What are the best practices to screen and identify patients with malnutrition or those at risk of nutrition deterioration in the PICU?	Weight and height/length are to be measured on admission to the PICU and z scores for body mass index for age (weight for length <2 years) or weight for age (if accurate height is not available) are recommended to be used to screen for patients at extremes of these values. In children <36 months old, head circumference must be documented	Very low	Strong
Energy expenditure and intake			
Guideline question 3. What is the recommended energy requirement for critically ill children?	It is suggested that indirect calorimetry be used to measure energy expenditure that can be used to determine energy requirements and guide prescription of the daily energy goal	Low	Weak
Guideline question 4. How should energy requirements be determined in the absence of IC?	If IC measurement of resting energy expenditure is not feasible, it is suggested that the Schofield or Food Agriculture Organization/World Health Organization/United Nations University equations may be used without the addition of stress factors to estimate energy expenditure	Very low	Weak
Guideline question 5. What is the target energy intake in critically ill children?	It is suggested that achieving delivery of at least two-thirds of the prescribed daily energy requirement by the end of the first week in the PICU is needed	Low	Weak
Guideline question 6. What is the minimum recommended protein requirement for critically ill children?	A minimum protein intake of 1.5 g/kg/d is recommended	Moderate	Strong
Guideline question 7. What is the optimal protein delivery strategy in the PICU?	Provision of protein early in the course of critical illness to attain protein delivery goals and promote positive nitrogen balance	Moderate	Weak
Guideline question 8. How should protein delivery goals be determined in critically ill children?	The optimal protein dose associated with improved clinical outcomes is not known. Hence, the use of RDA values to guide protein prescription in critically ill children is not recommended	Moderate	Strong
Enteral nutrition			
Guideline question 9. Is EN feasible in critically ill children?	EN is to be considered as the preferred mode of nutrient delivery to the critically ill child. It is feasible and can be safely delivered provided interruptions are minimized that include delayed initiation, perceived intolerance, and prolonged fasting around procedures	Low	Strong
Guideline question 10. What is the benefit of EN in this group?	Although the optimal dose of macronutrients is unclear, some amount of nutrients delivered as EN has been beneficial for gastrointestinal mucosal integrity and motility. Early initiation of EN (within 24–48 hours of PICU admission) and achievement of up to two-thirds of the nutrient goal in the first week of critical illness	Low	Weak

Table 1 (*Continued*)

Question	Recommendation	Evidence GRADE	Strength of GRADE recommendation
	have been associated with improved clinical outcomes		
Guideline question 11. What is the optimum method for advancing EN in the PICU population?	A stepwise algorithmic approach to advance EN in children admitted to the PICU is recommended. The stepwise algorithm must include bedside support to guide the detection and management of EN intolerance and the optimal rate of increase in EN delivery	Low	Weak
Guideline question 12. What is the role of a nutrition support team or a dedicated dietitian in optimizing nutrition therapy?	A nutrition support team, including a dedicated dietitian, available on the PICU team, to facilitate timely nutrition assessment, and optimal nutrient delivery and adjustment to the patients is recommended	Low	Weak
Guideline question 13. What is the best site for EN delivery: gastric or small bowel?	Gastric route is the preferred site for EN in patients in the PICU. The postpyloric or small intestinal site for EN may be used in patients unable to tolerate gastric feeding or those at high risk for aspiration	Low	Weak
Guideline question 14. When should EN be initiated? R6B:	It is suggested that EN be initiated in all critically ill children, unless it is contraindicated with early initiation of EN, within the first 24–48 hours after admission to the PICU, ineligible patients	Low	Weak
Guideline question 15. What is the indication for and optimal timing of PN in critically ill children?	Based on a single RCT, we do not recommend the initiation of PN within 24 hours of PICU admission	Moderate	Strong
Guideline question 16. What is the role of PN as a supplement to inadequate EN?	For children tolerating EN, it is suggested for stepwise advancement of nutrient delivery via the enteral route and delaying commencement of PN	Low	Weak
Immunonutrition			
Guideline question 17. What is the role of immunonutrition in critically ill children?	The use of immunonutrition in critically ill children is not recommended	Moderate	Strong

Abbreviations: EN, enteral nutrition; PICU, pediatric intensive care unit; PN, parenteral nutrition; RCT, randomized controlled trial; RDA, Recommended Dietary Allowances.

Methods

A review of ASPEN papers related to PN published in 2017 to 2021 was conducted. Search terms included cardiac surgery, intensive care, critically ill, pediatric, and adult. Four papers were identified for inclusion in this review article. Current paper was defined as published within the past 5 years. A comparative narrative of chief guideline points in pediatric and adult is presented in ►**Table 1** and ►**Table 2**.[4]

Discussion

The benefits of early feeding (within 24 hour of surgery) versus later feeding on morbidity or mortality have been demonstrated in several meta-analyses and randomized controlled trials and form the basis of recommendations by the American Society for Enhanced Recovery and European Society for Parenteral and Enteral Nutrition.[5,6] In patients who meet the criteria for malnutrition and who are not anticipated to meet nutritional goals (>50% of protein/kcal) through oral intake, the guidelines recommend early EN or tube feeding within 24 hours.[6] In patients at risk for malnutrition and if nutrition goals are not met via EN, early PN (within 4 days), in combination with EN, is recommended.[6] EN and/or PN should be continued for patients who are not able to receive at least 60% of their protein/kcal requirements via the oral route.[6] Ideally, in malnourished patients, postoperative nutrition should continue for a minimum of 4 weeks.[6] Notably, recent data suggest that PN is not associated with increased risk of infectious complications; therefore, PN should not be withheld to reduce infection risk.[7–10]

Table 2 Guidelines for the provision of nutrition support therapy in the adult critically ill patient[4]

Question	Recommendation	Evidence GRADE	Strength of GRADE recommendation
Guideline question 1. In adult, critically ill patients, does the provision of higher vs. lower energy intake impact clinical outcomes?	No significant difference in clinical outcomes was found between patients with higher vs. lower levels of energy intake. It is suggested to feed between 12 and 25 kcal/kg in the first 7–10 days of ICU stay	Moderate	Weak
Guideline question 2. In adult, critically ill patients, does the provision of higher as compared with lower protein intake impact clinical outcomes?	A new recommendation beyond the 2016 guideline suggestion for 1.2–2.0 g/kg/day cannot be made based on relatively limited data	Low	Weak
Guideline question 3. In adult, critically ill patients who are candidates for EN, does similar energy intake by Parenteral vs. Enteral as the primary feeding modality in the first week of critical illness impact clinical outcomes?	There was no significant difference in clinical outcomes. Because similar energy intake provided as PN is not superior to EN and no differences in harm were identified, it is recommended that either PN or EN is acceptable	High	Strong
Guideline question 4. In adult critically ill patients receiving EN, does provision of SPN, as compared with no SPN during the first week of critical illness, impact clinical outcomes?	There was no significant difference in clinical outcomes. Based on findings of no clinically important benefit in providing SPN early in the ICU admission, it is recommended not to initiate SPN prior to day 7 of ICU admission	High	Strong
Guideline question 5A. In adult critically ill patients receiving PN, does the provision of mixed-oil ILEs(i.e., medium-chain triglycerides, olive oil, FO, mixtures of oils), as compared with 100% soybean-oil ILE, impact clinical outcomes?	Because of limited statistically or clinically significant differences in key outcomes, it is suggested that either mixed-oil ILE or 100% soybean-oil ILE be provided to critically ill patients who are appropriate candidates for initiation of PN, including within the first week of ICU admission	Low	Weak
Guideline question 5B. In adult critically ill patients receiving PN, does the provision of FO-containing ILE, as compared with non–FO-containing ILE, impact clinical outcomes?	It is suggested that either FO- or non–FO-containing ILE be provided to critically ill patients who are appropriate candidates for initiation of PN, including within the first week of ICU admission	Low	Weak

Abbreviations: EN, enteral nutrition; FO, fish oil; ILE, injectable lipid emulsion; ICU, pediatric intensive care unit; PN, parenteral nutrition; SPN, supplemental parenteral nutrition.

Conclusion

Screening methods might allow limited resources to be directed to high-risk patients who are most likely to benefit from early nutrition assessment and interventions. Validated screening methods for the pediatric ICU population to identify patients at risk of malnutrition must be developed. The human body does not contain large protein stores and considering the large protein requirements in many acutely ill patients, the need to ensure adequate protein support in these patients is vital. Adequate protein along with caloric intake has been correlated with benefits on mortality and quality of life. Given that guideline recommendations indicate that (for most acute care patients) daily protein intakes should be approximately 1.2 to 2.0 g/kg body weight, it is mandated to ensure that patients receive appropriate protein intakes during their stays in the ICU. The effects of adequate provision of protein extend beyond the early prevention of morbidity and preservation of mortality to effects on prevention of muscle loss and ICU acquired weakness; such that addressing these last points contributes to improvements in post-ICU quality of life (QOL). Post-ICU QOL must become a treatment goal for our patients. Early or in the acute phase, the provision of proteins prioritizes over the provision of a higher number of calories. To meet these increased protein intakes, while minimizing excessive caloric and fluid intakes, new high protein EN and PN solutions have been developed. Incorporation of these newer solutions

into clinical practice may lead to improved early and late patient outcomes.

Authors' Contributions

All authors contributed equally to the conception/design of the work.

Conflict of Interest

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