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Incorporating the latest pediatric nutrition support guidelines into clinical practice

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Abstract: Optimal nutrition support in critically ill children is associated with improved outcomes and decreased mortality. Nutrition provision often competes with other care priorities in critically ill patients. The 2017 Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient supplement clinician knowledge and inform best practices for nutrition therapy in this vulnerable patient population.

Keywords: anthropometry, critically ill pediatric patients, enteral nutrition, Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient, immunonutrition, indirect calorimetry, nutrition guidelines, nutrition support, parenteral nutrition, pediatric patients

EVIDENCE FOR THE BENEFITS of nutrition support, particularly enteral nutrition (EN), in critically ill children is growing. Numerous publications describe the importance of optimizing nutrition provision in acute and critically ill children. It may be to modify the systemic response to infection or injury, mitigate immune system dysfunction, promote tissue repair, prevent loss of lean muscle mass and body weight, or potentially improve patient outcomes.[1-4] Following the initial stabilization of a critically ill child, clinicians must shift their focus to the delivery of multidimensional care that includes nutrition therapy. After addressing the patient's ABCs (airway, breathing, and circulation) during the acute illness presentation, clinicians should focus on D (diet).

Nurses have often led the clinical team and identified the need for nutrition support upon ICU admission. Ongoing nursing assessment is often key in identifying malnutrition in a patient admitted to the ICU. The use of stepwise, nurse-driven EN delivery algorithms has demonstrated a decrease in both time to nutrition initiation and avoidable interruptions of nutrition delivery.[5,6]

However, nutritional interventions often compete with other key management priorities in the critically ill child. There also are knowledge gaps in many aspects of nutrition therapy in pediatric critical illness, leaving much of clinical practice guided by consensus or low-level evidence. This article summarizes the key points of the recently published pediatric critical care nutrition guidelines and provides some practical tips to incorporate them into clinical practice.

Pediatric critical care nutrition guidelines

In the ever-evolving and complex ICU environment, numerous competing therapies and treatments, in addition to changing perspectives on best practices, can make remaining up-to-date on the latest recommendations and emerging evidence difficult. The Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient, collaboratively developed by the Society of Critical Care Medicine (SCCM) and American

Society for Parenteral and Enteral Nutrition (ASPEN), are intended to supplement and enhance clinicians' knowledge of best practices for nutrition support in critically ill children.[7]

During critical illness, a patient's individualized nutrition strategy includes assessment of energy requirement, macronutrient prescription development, diet composition, and the timing and route for nutrition delivery. Recognition of altered metabolism and nutrient utilization due to illness or injury is paramount to initiating nutrition support for critically ill children.[8,9] Understanding these altered metabolic processes is key to determining the optimal energy and protein requirements for individual patients.

Over the past decade, several incremental advances in best practices for nutrition support in the ICU environment have been made. To account for these advances, SCCM and ASPEN commissioned an interdisciplinary task force to develop guidelines for the provision of optimal nutritional therapies in the pediatric ICU (PICU). The team included experts representing the disciplines of medicine, nursing, nutrition, and pharmacy. Using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach, the team identified questions, which are listed below, to address eight practice areas relevant to nutrition support of the critically ill child.[10] Development of the Guidelines involved a rigorous literature review of more than 2,000 citations published between January 1995 and March 2016 across PubMed/MEDLINE and EMBASE databases, including 16 randomized controlled trials and 37 cohort studies, to answer the eight identified clinical questions.[7] The available evidence to support these Guidelines has limitations. For example, there is great variability in study design; most studies included a small sample size and large patient heterogeneity, which is not ideal for rigorous statistical analysis. Despite this, the panel developed recommendations to address the following eight questions:[7]

- What is the impact of nutrition status on outcomes for critically ill children?
- What is the recommended energy requirement for critically ill children?
- What is the minimum recommended protein requirement for critically ill children?
- Is EN feasible in critically ill children?
- What is the optimal method for advancing EN in the PICU population?
- What is the best site for EN delivery: gastric or small bowel?
- What is the indication for and optimal timing of parenteral nutrition (PN) in critically ill children?
- What is the role of immunonutrition in critically ill children?

The recommendations from the Guidelines can assist PICU nurses in advocating for optimal strategies for initiation, advancement, and assessment of tolerance of nutrition support for critically ill children. See *Practice pearls* for an abbreviated nutrition care guide PICU nurses should incorporate into their patient care plans.

Practice pearls

- Accurate monitoring of patients' weight and height is essential throughout their PICU stay. Obtain anthropometric measurements (minimum of weight and height/length) as part of the nutritional assessment on admission and then serially during the PICU course for ongoing nutrition assessment.
- Recent data suggest that critically ill children may not require very high-energy delivery, and attainment of two-thirds recommended energy goal may be reasonable. The use of inaccurate equations to estimate energy requirements may result in cumulative imbalances. Where available, indirect calorimetry (IC) is the preferred accurate assessment method of energy requirements for critically ill children.
- Ensuring optimal protein delivery is crucial to maintain a positive nitrogen balance and may enhance patient outcomes. Early initiation of EN and minimizing feeding interruption will help optimize enteral protein delivery during acute critical illness.
- EN is the preferred route of nutrition delivery in critically ill children with an intact and functioning gastrointestinal (GI) tract. EN use and optimization of delivery can be enhanced by nursing knowledge of the feasibility and benefits of EN. Nurses must advocate for early and safe EN and are instrumental in limiting the number of and duration of EN interruptions, and in assessing feeding tolerance. Nurse-led EN delivery algorithms have successfully optimized enteral feeding in many ICUs.
- Early initiation of EN in critically ill children has been associated with decreased mortality and improved patient outcomes.
- When EN is not feasible or is inadequate, the clinical team should consider the use of PN; however, its use is not recommended within the first 24 hours of PICU admission. Supplemental use of PN should be carefully assessed and individualized to each patient.
- There is currently no evidence to support immunonutrition in critically ill children.

Nutrition assessment

The importance of nutrition status and assessment for malnutrition cannot be discounted in caring for critically ill children. The prevalence of malnutrition can be as high as 40% to 65% in this patient population and has been associated with increased length of hospital stay, increased mechanical ventilation duration, overall increase in resource utilization, and higher mortality.[11-15] The Guidelines recommend obtaining baseline weight and height, measured at PICU admission. Age-adjusted body mass index (BMI) z-scores

screen patients for malnutrition and may be used for targeting timely therapies.[7,16] If the patient is under age 2 years, weight-for-length is used in place of BMI. If length/height is not available or cannot be obtained, a weight-for-age z-score may be used to assess nutrition status.[7] BMI z-scores and weight-for-age z-scores (for undernourished and overnourished children) as well as regular anthropometric assessments are necessary to assess and screen children for malnutrition, and to inform the prescription of their nutritional therapy. It is important to note that weight during acute illness may not be reliable due to fluid overload. Using a systematic approach to nutrition assessment and documentation of nutrition status can help identify children who are malnourished when they present and who are at highest risk for a decline in nutrition status during a PICU admission.

In addition to anthropometry, the nutrition assessment should include a dietary history, determination of pre-illness weight, length/height, functional status, and a nutrition-focused physical exam.[7] Screening tools that incorporate anthropometry with simple questions have been developed and used at hospital admission to screen for vulnerable patients at risk for developing malnutrition. Currently, there is no validated screening tool for nutrition assessment in critically ill children.

Energy requirements vs. targeted energy needs

Current literature supports the use of IC to measure energy expenditure and determine energy requirements for critically ill patients. Using measurements of oxygen consumption and carbon dioxide production at the respiratory gas exchange interface, IC provides an insight into metabolic status and substrate utilization. Together, energy expenditure as measured using IC, the patient's clinical status, and a nutrition assessment inform an individualized prescription for optimal energy intake goals.

Specific protein requirements necessary for improved clinical outcomes in critically ill children are unknown.

Considered the most accurate method for determining energy requirements, IC measurements require a metabolic cart, specially trained personnel, and expertise in both execution of the test and interpretation of the results to render prescription recommendations. As such, using IC may not be feasible for many PICUs. Furthermore, mechanically ventilated children on high concentrations of inspired oxygen or those with a natural airway requiring supplemental oxygen may not be eligible for IC. In lieu of IC measurements, predictive equations can determine energy needs in critically ill children. Predictive equations were developed through measurements of healthy children and may not be accurate when applied to critically ill children. The Schofield or the Food Agriculture Organization/World Health Organization/United Nations University (FAO/WHO/UNU) equations are recommended by the Guidelines in settings where IC is not available.[7] However, the Guidelines caution that these equations (or any predictive equation) may lead to unintended underfeeding or overfeeding. The Guidelines particularly do not recommend use of the Harris-Benedict or Recommended Daily Allowance (RDA) equations to determine energy needs in critically ill children. Whether using IC or a predictive equation, a systematic approach with serial evaluations of energy requirements and an ongoing nutrition assessment is recommended.

Recent data suggest that delivery of at least two-thirds of the prescribed energy requirement by day 4 or 5 of illness may be associated with improved outcomes in critically ill children.[3,7] Intake of up to two-thirds of the prescribed energy requirement may be adequate to support the PICU patient whose metabolic needs are reduced by mechanical ventilation, sedation with or without neuromuscular blockade, and limited mobility.[4] Serial assessment of overall requirements and nutrient intake will allow early detection and minimization of cumulative energy imbalances during critical illness.

Protein requirements and delivery

Current recommendations for protein as provided by RDA guidelines are intended for healthy, growing children. Specific protein requirements necessary for improved clinical outcomes in critically ill children are unknown. Protein is not stored in the body and must be provided through exogenous sources. In patients with acute or critical illness or injury, the metabolic stress response causes the breakdown of skeletal muscle into free amino acids used for tissue repair, enzyme production,

and glucose synthesis.[17,18] An extended period of inadequate protein intake during critical illness will result in weight loss and a decrease in lean muscle mass. It is therefore necessary to provide a source of protein by either the enteral or parenteral route. Protein delivery to meet metabolic needs combined with adequate energy intake has been associated with a positive nitrogen balance and decreased mortality.[7,19,20] The Guidelines recommend a minimum protein intake of 1.5 g/kg/day to avoid a protein deficit and a negative nitrogen balance in critically ill children.[7] It is important to note that infants and small children may require doses that exceed this minimum. Protein doses as high as 3 g/kg/day in children older than 30 days may cause elevated blood urea nitrogen levels and should be closely monitored.[7] More studies are needed to determine the optimal dose and best route for protein delivery. When feasible, the enteral route is preferred. Parenteral amino acids were recently associated with poor outcomes when delivered via an aggressive strategy of starting PN within 24 hours of PICU admission.[21]

Enteral nutrition

Based on the available literature, in the child with an intact and functioning GI tract, the enteral route is preferred for delivery of nutrition support.[7,9] Current evidence has associated early EN with improved patient outcomes, decreased mechanical ventilation days, and decreased length of ICU stay.[1,3,4] The literature supports use of EN in critically ill children with both medical diagnoses and surgical diagnoses (such as a bowel resection or Nissen fundoplication), including those receiving vasoactive medication infusions.[2] The use of EN in critically ill children is cost-effective, physiologically well tolerated, and has advantages including maintenance of GI mucosal integrity, mitigation of the stress response, and improved immune response to illness and injury.[22,23] Recent studies have demonstrated decreased mortality for patients receiving EN support when compared with those receiving parenteral delivery.[3,18]

Although EN is the preferred route in critically ill children, EN delivery remains challenging in some cases.

Although EN is the preferred route of nutrition support in critically ill children, EN delivery remains challenging in some cases. The most common barriers in EN delivery include delay in EN prescription, delayed initiation and advancement, prolonged fasting before and following procedures, potentially preventable interruptions in nutrition support delivery, and lack of awareness among clinicians of the benefits of EN in this population.[7] Additional barriers include fluid restriction, hemodynamic instability, and ambiguity in definitions of feeding intolerance.[22] Although there is no evidence-based definition of feeding intolerance, it is often described in terms of episodes of emesis, diarrhea, high residual gastric volume following intermittent feedings, or gastric distension. Presumed feeding intolerance can result in feeding interruption and/or cessation until the patient is deemed able to tolerate enteral feedings.

EN initiation, advancement, and site for administration

Answers to questions regarding when to start EN in critically ill children depend on provider knowledge, comfort level and preference, enteral access, and patient clinical status. Critical illness or injury can cause a shunting of blood from the splanchnic vascular bed and put the patient at risk for intestinal ischemia, which can lead to severe mucosal injury. Evidence has shown that delay in feeding an intact gut during critical illness can reduce the thickness of gut mucosa and ultimately contribute to intestinal dysfunction.[9] Based on the available evidence and expert opinion, the Guidelines recommend EN initiation in children with an intact GI tract who otherwise meet criteria for EN within 24 to 48 hours of PICU admission.[7] Further, the Guidelines recommend the use of stepwise EN delivery algorithms and institutional guideline to direct both the initiation and rate of EN increase. In one study, EN initiation and delivery of at least one-quarter of the prescribed EN goal within 48 hours following PICU admission was associated with decreased mortality.[1] The use of EN delivery algorithms, protocols, and/or guidelines for advancement is aligned with early initiation of EN. Evaluation of such tools has demonstrated earlier initiation of EN, improved EN delivery, decreased feeding interruptions, reduced use of PN, and early attainment of goal feeds.[5,6,24-28]

Questions of gastric versus postpyloric and continuous versus intermittent feeding persist as a source of

variance related to EN delivery for critically ill children. Beyond clearly identifying EN as the preferred route for nutrition delivery, the available evidence is limited in guidance as to the site and mode for provision of EN. Although intermittent gastric feeds are more physiologically appropriate, some evidence suggests that continuous postpyloric EN provision results in delivery of a larger proportion of prescribed energy and protein.[29] However, initiation of postpyloric EN may be delayed because of the need for proper placement of the feeding tube distal to the pylorus. Feeding tubes placed in a postpyloric location (duodenal or jejunal) are not immune to mechanical problems that can in turn delay and/or interrupt EN delivery. Because of the dearth of evidence for gastric versus postpyloric EN delivery, and for continuous compared with intermittent feeds, the Guidelines do not recommend one mode of enteral feeding over the other. They do, however, recommend a frequent and consistent evaluation of feeding practices to determine which method is most feasible for the given institution.

When is PN appropriate?

Children for whom EN is not feasible or not adequate to meet energy and protein requirements should start receiving PN by at least day 4 or 5 of illness to meet nutrition and metabolic needs.[7] To date, only one randomized controlled trial exists related to the timing of PN in critically ill children.[21] This study, a large international trial that enrolled more than 1,400 pediatric patients, demonstrated less infection, shorter PICU stay, decreased ventilator days, and decreased mortality for the children who were started on PN on day 8 of their PICU stay (late PN) when compared with children who were started on PN within 24 hours of PICU admission (early PN).[21] Most children in the study received significant EN by day 4 and may have been able to fully meet energy and protein requirements via the enteral route if a feeding algorithm had been used as part of the study protocol. In addition, more than 70% of children were discharged from the PICU prior to day 8 and were not present to receive the late PN phase of the trial. Based on results from this study, the Guidelines do not recommend starting PN within 24 hours of PICU admission.[7]

Further, the Guidelines recommend careful consideration for best timing to initiate supplemental PN when EN is insufficient or contraindicated; supplemental PN must be individualized to the nutrition status and clinical condition of the patient. The Guidelines advocate for a stepwise approach to optimize EN delivery whenever possible. Supplemental PN may be required early in vulnerable patients such as neonates and severely malnourished children; however, a team approach is needed to individualize nutrition therapy for these patients.[7]

Immunonutrition

Immunonutrition, immunonutrient-enhanced diet, and immune-modulating nutrition describe diets enriched with micronutrients in various components and amounts that have been used to replete or supplement micronutrients depleted because of the stress of critical illness or injury. However, trials evaluating immunonutrition are not similar and superiority of immune-enhanced nutrition formulations over standard formulas has not been demonstrated. Based on current available evidence, the Guidelines do not support the use of immunonutrition in critically ill children.[7]

Advocating for nutrition support

The Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient were based on a small number of randomized controlled trials, large observational and cohort studies, and studies in heterogeneous populations with variability in severity of diseases. As a result, these Guidelines, which are based on evidence and combined with expert opinion, provide practical guidance on many aspects of nutritional therapy at the bedside. The PICU nurse has a critical role in promoting and ensuring optimal nutritional therapies for the critically ill child and can be the principal champion for sound nutrition practice in the PICU.

The PICU nurse can advocate for nutrition support in critically ill children by initiating and contributing to discussions with the clinical team related to nutrition support, assisting in nutritional status assessments, identifying vulnerable and malnourished patients, helping determine the appropriate mode and location of nutrient initiation and advancement, facilitating the efficient and accurate placement of enteral access delivery devices, continually assessing the patient for EN tolerance, and engaging in accurate documentation. Once the ABCs have been addressed, the PICU nurse is uniquely positioned to focus the care team discussion on D (diet). The Guidelines are a useful tool for nurses to facilitate nutrition care delivery to critically ill children. ■

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