



REVIEW ARTICLE

Nutritional stabilization in paediatric intensive care unit (PICU): A Literature Review.

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Article Citation: Khurshid A, Aziz MT, Talib MA, Iqbal I. Nutritional stabilization in paediatric intensive care unit (PICU): A Literature Review. Professional Med J 2022; 29(4):420-427. <https://doi.org/10.29309/TPMJ/2022.29.04.6143>

ABSTRACT... The subject of nutrition in intensive care is being discussed among the pediatric intensivists since long. The nutritional supplementation plays a vital role in treatment of pediatric intensive care patients. In recent past, due to technological advances the pathophysiology of critical diseases is being better understood so better nutritional strategies are being implemented in critical care units. As a result the prognosis of intensive care patients is improving resulting in decreased length of stay and less number of deaths of these patients. The metabolic stress in sick patients is an important factor to be considered while calculating the nutritional requirements of patients. The body's physiological mechanisms in the event of stress due to critical illness, need to be understood to make nutritional assessment of pediatric critical patients. The purpose of the current review is to recognize the recent nutritional supplementation guidelines of pediatric critical patients and to discuss any controversial issues. A meticulous study of the published literature regarding supplemental nutrition, energy calculation and algorithmic protocols for nutritional targets in pediatric critical population was done and areas in need of future research were identified.

Key words: Enteral Nutrition, Length of Stay, Paediatric Intensive Care Unit, Parenteral Nutrition, Trans Pyloric Feeding.

INTRODUCTION

Paediatric nutritional supplementation in intensive care units has not been studied in greater details and there are a lot of gray areas to be answered. The calculation and timely provision of proper nutritional support to children admitted in intensive care units is a fundamental goal of pediatric intensivists. Accurate calculation of energy needs of critical patients and use of the appropriate route to supply the calculated nutrients are the main steps in achieving this objective. Systemic inflammatory response syndrome poses additional requirements on the body's nutritional needs in critical illness like sepsis, trauma, surgery and burns.¹ The metabolic response of the body to different types of stresses like infection, inflammation injury or surgery is difficult to predict accurately and these metabolic responses vary in different stages of disease. Inability to supplement calculated optimal nutritional requirements during this phase of the illness not only leads to the deterioration of preexisting nutritional deficits but

also in malnutrition, resulting in worse prognosis of the patients. Different studies have shown that 24% to 55% of patients presenting in critical care units suffer from acute or chronic malnutrition on admission and furthermore the nutritional status of the patients further deteriorates during hospitalization due to a number of factors.²⁻⁴

The malnourished children already severely anorexic and are not able to take oral feeding for days to months even after discharge from critical care.⁵⁻⁶ Critically sick patients develop stress induced changes mainly increased basal metabolic rate coupled with excessive protein catabolism leading to risk of development of malnutrition. As a result the mortality rate is high in such patients.^{7,8} A number of factors have been shown to prolong the need for mechanical ventilation including high systemic inflammatory mediators, no physical activity, factors causing decreased tissue perfusion, severe muscle protein wasting and altered hormonal secretions.⁹

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Article received on: 10/10/2020
Accepted for publication: 27/02/2021

The occurrence of malnutrition in pediatric intensive care patients is attributed to the causative illness, the previous nutritional reserves of body and insufficient supply of adequate nutrients.^{10,11} Increased physiological instability and increased resource utilization are mainly responsible for malnutrition in hospitalized children leading to poor outcome in critical illness.^{12,13}

Overfeeding is also clearly hazardous as increased carbohydrate supplementation leads to increased carbon dioxide formation and impedes weaning of the patient from ventilator. Increased caloric intake increases fat deposition in body, including liver.¹⁴⁻¹⁶ Since 1970s the presence of malnutrition is seen in medical literature having a clear cut contribution to the higher likelihood of infections, development of pressure sores, decreased ventilatory drive and immunosuppression leading to high mortality and morbidity.¹⁷ Nutrient requirements must be made on individual basis keeping in mind the stages of illness. Careful consideration of the early start of feeding through the appropriate mode and then keeping a close eye on the progress and complications of the feeding protocol are important steps to be kept in mind in nutritional management of sick patients. Early nutritional supplementation after calculating the required nutritional goals decreases the problems associated with malnutrition.^{18,19}

Nutrition Therapy (NT) becomes mandatory in situations where the patients are not able to take orally for long periods. Enteral Nutrition (EN) is always preferred because it is physiologic, keeps the intestinal epithelium and flora healthy and decreases the translocation of bacteria and worsening of sepsis. Furthermore Enteral Nutrition has low incidence of complications and nominal cost.¹⁸⁻²⁰ Sometimes the digestive tract does not work at all, then Parenteral Nutrition (PN) is the only choice.^{21,22} Both the PN and EN may be combined in cases where EN alone is insufficient to fulfill the nutritional needs of the critically sick patient.²³⁻²⁵ Both the PN and EN may pose some complications. EN can sometimes lead to aspiration pneumonia. PN may lead to the disuse atrophy of the intestinal epithelium, hepatic function derangement, high

blood glucose levels and increase likelihood of infections.¹⁸ Delaying the nutritional therapy in the critically sick patients leads to adverse outcome including higher incidence of hospital acquired infections, prolonged ventilatory support, longer length of stay (LOS) in critical care, and more number of deaths.²⁶⁻²⁹ In pediatrics, we find a scarcity of valuable randomized control trials analyzing the relation of nutritional therapy and patient outcome.³⁰ In the intensive care population of both adult and pediatric patients, administration of macronutrients at the earliest possible time, preferably Enteral rather than Parenteral, is recommended.³¹⁻³³ The pediatric critical patients differ from adult critical patients in a lot of ways including higher metabolic rate, fast growth, fewer energy reserves and body reaction to critical disease. So the studies done in infants and children regarding provision of nutrition to intensive care patients are mandatory. One-third of the patients may become victims of malnutrition during hospitalization who were not actually malnourished.^{34,35}

This article reviews the existing scientific evidence of nutrition in the ICU and addresses the controversies regarding nutritional therapy. The current review recognizes the recent nutritional supplementation guidelines of pediatric critical patients and discusses controversial issues.

OBJECTIVES

To see the role of nutritional therapy including both Enteral and Parenteral nutrition on clinically important outcomes including mortality, morbidity and duration of hospital stay in Pediatric Critical Care patients.

MATERIAL & METHODS

We included studies of pediatric patients having the age range of one day to 18 years, admitted in pediatric critical care units and received some form of nutrition therapy during their hospital stay. The trials having both adult and pediatric patients in which separate data of pediatric patients was available were also included. All studies having adult patients were excluded. We searched the review articles, randomized controlled trials (RCTs), clinical trials, case series, uncontrolled

studies, surveys, expert opinion, consensus statements and guidelines, Medline, the Cochrane Central Registry of Controlled Trials, the Cochrane Database of Systematic Reviews and other appropriate reference sources.

To the best of our knowledge there have been no trials conducted in pediatric critical care units of Pakistan regarding the nutritional management of critically sick patients and its relation to the clinically important outcomes of these patients. The only trial available has been done in an adult ICU in Karachi Pakistan studying the nutritional support to patients of ICU using algorithmic approach for provision of nutritional therapy.

RESULTS

Paediatric critical care is an extremely sensitive area regarding the care of very sick patients and the implementation of nutritional protocols to these patients is a very challenging task. This

study found that the nutritional support of pediatric critical patients is still inadequate. Elizabeth JR et al showed that in infants undergoing cardiac surgery, provision of adequate nutrition becomes difficult due to restrictions in fluid intake.³⁶

In 2006 Petrillo-Albarano showed that the use of feeding protocols is helpful in achieving the target nutrition early and is also helpful in rapid Enteral feeding advancement in pediatric critical patients.³⁷ In 2009 the first comprehensive guidelines of nutritional support to pediatric critical care patients were presented by “The American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.)”.³⁸ This society comprises of a group of highly expert team having members from different fields including medicine, nursing, pharmacy, dietetics, and nutrition science. The main objective of this society is to enhance patient care by providing optimal nutritional management.

Recommendation 1A.	Nutrition screening of the pediatric critical patients should be done to identify the patients having malnutrition and also find those who are at risk of developing malnutrition.
Recommendation 1B.	A supplemental nutritional plan should be made especially for patients who are at risk of malnutrition.
Recommendation 2A.	The energy needs of pediatric intensive care patients should be regularly calculated by measuring energy expenditure. The commonly used available standard equations often give incorrect results.
Recommendation 2B.	Indirect calorimetry (IC) should be used to calculate energy expenditure. Where IC is impossible, published formulas may be used. Overfeeding and underfeeding must be avoided.
Recommendation 3.	Macronutrient supplementation ratio needs to be determined yet. Protein, carbohydrate- and lipid metabolism should be kept in mind before providing these macronutrients.
Recommendation 4A.	Enteral nutrition (EN) is always preferred mode of nutritional supply whenever possible.
Recommendation 4B.	Interruptions in Enteral feeding must be recognized and treated early.
Recommendation 4C.	Sufficient evidence is not available for the preferential recommendation of gastric vs. trans pyloric feeding. When gastric feeding fails post-pyloric feeding may be considered
Recommendation 5.	Immunonutrition should not be used.
Recommendation 6.	The use of feeding protocols with the help of nutrition team support helps early achievement of nutritional targets and requires less use of Parenteral Nutrition.

Table-I. American society for parenteral and enteral nutrition recommendations for nutritional therapy of paediatric critical patients.

These comprehensive guidelines gave a breakthrough in the nutritional care of pediatric critical care patients. Since the first pediatric critical care nutrition guidelines (ASPEN) published in 2009, a significant number of new research studies were started regarding the subject of nutrition in pediatrics. The nutrient

delivery programmers have demonstrated good results on clinical outcomes such as mortality, infectious complications, and LOS of pediatric critical patients. Thus, careful calculation and supplementation of nutrient delivery is attempted in most ICU's. The field is moving toward uniform evidence-based strategies for nutritional practices

in the PICUs across the globe. New questions are arising and a lot others are still to be answered. Mehta et al showed in their study the high prevalence of malnutrition on admission, and a striking inability to deliver the prescribed energy and protein in critically ill children during their course in the PICU resulting in high likelihood of mortality. The institution of preformed protocol for provision and advancement of nutrition delivery resulted in less infectious complications in critically sick children. Sixty-day mortality showed a significant decrease with increased caloric intake of up to 66.7%. It was highly suggested that proper protocols for nutritional assessment, initiation and advancement are mandatory and it is associated with less infectious complications.³⁰ On the other hand applying one single strategy to all PICU patients is also challenging because of the differences in age, disease type, interventions and the baseline nutritional status of patients. PICU is a unique place in terms of the heterogeneity of patients in relation to age, disease type, interventions, co morbid conditions, and presenting nutritional status. It is therefore not possible to apply one strategy to all patients. Due to this diverse nature of the patients, nutritional support must be individualized for every patient keeping in mind the risks and benefits of the intended supplemental nutrition.

In July 2017 came the most recent and valuable first collaborated guidelines between two organizations, "American Society of Parenteral and Enteral Nutrition and the Society of Critical Care Medicine", to describe best practices in nutrition therapy in critically ill children.³⁹

These guidelines are being highly appreciated and followed in PICUs worldwide. Frederic et al raised some important key questions about the guidelines.³⁹ Although anthropometric nutrition assessment is recommended in guidelines, but weighing sick children remains problematic and inaccurate due to fluid shifts. At the same time measuring length is not accurate in children with various devices in place, dedicated screening tools must be developed.

Another question is that achieving energy target

in one week due to frequent stoppage of feeding is sometimes very difficult. Following predefined energy targets seems difficult to meet due to diversity of patients, so closely calculating nutritional intake seems more beneficial. Enteral feeding should not be delayed for 24-48 hours as the target goal achievement may become difficult. It is suggested that increase protein intake is associated with favorable results but we still do not know which type of protein (aminoacidogram) will really be helpful. To our knowledge no enteral solution is available on commercial basis to fulfill critically ill children's needs (lower energy, higher protein), so we need to know how to prepare such enteral nutrition composition. Similarly, the recommendations to start and increase Enteral feeding early does not tell us the type of most suitable Enteral formula for the patients (polymeric vs. semi-elemental, enriched versus iso caloric, fiber-containing or not). Delaying the initiation of parenteral nutrition after 8 days of admission may not be really justified especially for critically sick patients who are already suffering from malnutrition or those who are otherwise at high risk of developing malnutrition.³⁹ Due to the diverse nature of the pediatric intensive care patients an individualized approach to all patients for nutritional support is necessary for good clinical outcome. In this review we have discussed the important upcoming questions for future research that will help us develop future evidence based pediatric nutrition recommendations.

CONCLUSION

The importance of nutrition in pediatric critical care has been well understood since long. However, the appropriate selection of route for nutritional supplementation, enteral feeding, estimation of caloric needs, the use of Immunonutrition etc. have been studied and tested repeatedly in different settings. This paper shows the most recent guidelines and the new controversial issues about the nutritional therapy of pediatric critical patients. A lot of new queries have to be answered after systematic research.

Recommendation 1A.	Nutritional assessment of the pediatric critical patients should be done within 48 hours of hospitalization and then weekly afterwards.
Recommendation 1B.	Screening of the patients should be done at admission to critical care unit using Weight and height/length, z scores for body mass index (BMI)-for-age (weight-for-length, < 2 yr) or weight-for-age (if accurate, height is not available). Head circumference should be measured for patients of less than 3 years. New screening protocol should be formulated for the detection of patients who are at risk of malnutrition.
Recommendation 2A.	Indirect calorimetry (IC) is the method of choice to calculate energy expenditure and also to find out the energy requirements of the daily energy target.
Recommendation 2B.	If IC measurement of resting energy expenditure (REE) is not feasible, the Schofield or Food Agriculture Organization/World Health Organization (WHO)/United Nations University equations may be used "without" the addition of stress factors to estimate energy expenditure. The Harris-Benedict equations and the Recommended Daily Allowances (RDAs), which are suggested by the Dietary Reference Intakes, should not be used to determine energy requirements in critically ill children.
Recommendation 2C.	At least two thirds of the target daily energy should be delivered to the patient around first week of admission. All the patients should be individualized to determine energy requirements, commencement and achievement of energy targets, and energy balance to avoid over and under nutrition.
Recommendation 3A.	The daily protein intake of critically sick children should at least be 1.5 g/kg/day.
Recommendation 3B.	Protein supplementation should be done early to critically sick patients in order to reach daily protein targets and also achieve positive nitrogen balance in these children.
Recommendation 3C.	The amount of ideal protein supplemental daily dose is still unknown. The RDA of protein supplementation cannot be used for critical care patients as it cannot accurately estimate the needs of critically sick children.
Recommendation 4A.	EN is recommended as the best route of nutritional supplementation. The frequently seen hurdles to EN commonly are undue delay in starting, stoppage due to intolerance, and longer periods of fasting for different procedures. It is suggested that stoppage of to EN should be decreased to minimum to reach the nutritional targets early.
Recommendation 4B.	Although the optimal dose of all the macronutrients is still unknown, even small volumes of nutritional supplementation through EN leads to healthy intestinal mucosal epithelium .It is suggested to start the EN within one to two days of critical care admission and at least two thirds of the calculated nutritional target should be achieved by the end of first week of admission.
Recommendation 5A.	An algorithmic protocol should be devised to initiate and advance EN in critically sick children. This protocol should include the guidelines for the early detection and treatment of EN intolerance and also address the rapid increase of in EN.
Recommendation 5B.	The formation of a multidisciplinary nutrition support team including a dedicated pediatric dietitian is recommended for better nutritional assessment and delivery to the critically sick children.
Recommendation 6A.	Gastric route is recommended as the best route for the delivery of EN in pediatric critical patients. In patients who are unable to tolerate EN by gastric route, the trans pyloric or small intestinal route may then be used.
Recommendation 6B.	EN should be started in pediatric critical patients within the first 24–48 hours of admission. An algorithmic critical care protocol for the provision and progress of EN should be devised.
Recommendation 7A.	The provision of PN should not be started within 24 hours of Paediatric critical care admission.
Recommendation 7B.	In children who are tolerating EN well, the advancement of nutrition should follow a stepwise protocol and the start of PN should be delayed in these patients. In patients who present with normal nutritional status, the PN may be delayed up to one week of critical care admission. Those patients who are either unable to tolerate EN up to one week or not able to advance past low volume of Enteral feeding, the provision of PN is suggested.
Recommendation 8.	Immunonutrition provision in pediatric critical patients is not recommended.

Table-II. Recommendation from American Society of Parenteral and Enteral Nutrition and the Society of Critical Care Medicine.

The new nutritional recommendations enforce the role of nutritional assessment, especially the recognition of patients suffering from malnutrition who are the best candidates for early nutritional supplementation.




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