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Enteral Nutrition in the Pediatric Intensive Care Unit

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Abstract

Background: Occurrence of malnutrition in critically ill children is associated with higher morbidity and mortality. Critically ill children have to face various challenges to meet adequate energy needs. It is important to identify patients who are already malnourished or might become so during their illness by appropriate nutritional assessment. The main purpose of this review article is to discuss various aspects of enteral nutrition in the pediatric intensive care units.

Methods: A literature search was conducted in the PubMed database using word combinations of controlled vocabulary (MeSH terms):'enteral nutrition' and 'critical illnesses'. The methodology used for literature retrieval has been discussed in details in the main text.

Results: To reach an optimal nutrition, target caloric and protein requirement should be calculated by indirect calorimetry (ideally) or by standard formulae (like Schofield or WHO equations). Nutrition (in critically ill children) should preferably be provided in the form of enteral nutrition as early as possible (if there are no contraindications). It is vital to know the indicators of feed intolerance and side effects/complications of enteral feeding. Feed interruptions are very frequently encountered in the pediatric intensive care units with most of them being (actually) avoidable interruptions.

Conclusions: All the available local data should be put together to develop locally-suited algorithms to initiate and maintain enteral feeding which should be implemented strictly by a multidisciplinary nutrition support team.

Keywords: Algorithm; Critically ill; Enteral feeding; Intensive care; Malnutrition; Mortality; Nutrition; Vasoactive agents.

Introduction

Optimal nutrition is a key feature in the management of all pediatric patients, especially those with a critical illness. This is required to deal with the increased metabolic needs in critical illnesses, to promote tissue repair and wound healing, to prevent loss of muscle mass, to alleviate the dysfunction of the immune system and to improve the functioning of the gastrointestinal system.[1] There are international as well as Indian studies depicting the incidence of malnutrition in the pediatric intensive care units (PICUs). De Souza et al. reported an incidence of 45.5% of malnutrition in a prospective study conducted in 385 children in the PICU.[2] Chaitra et al. from India showed that 55% of the critically ill children admitted in the PICU had a suboptimal nutritional status.[3] Nutrition delivery has been found to be inadequate in mechanically ventilated patients with an overall energy and protein intake of only

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38% and 43% of the prescribed goals (respectively) as reported by Mehta et al.[4] In critically ill patients, malnutrition develops rapidly due to acute phase responses, which promote catabolism and alter the response to nutritional support.[1] Poor nutrition in the form of over-nutrition or under-nutrition has been found to adversely affect the final outcome, the hospital stay and the incidence of hospital acquired infections.[2,5] Castillo et al. reported a mortality of 42.6% in malnourished children in their prospective observational study on 174 critically ill patients on continuous renal replacement therapy.[5] De Souza et al. reported that malnutrition was associated with a longer duration of mechanical ventilation and PICU length of stay.[2]

Therefore, timely assessment of nutritional status in critically ill patients is extremely important to prevent nutritional problems and to monitor adequacy of nutritional therapy. In addition, early nutritional screening is a key factor in initiating appropriate nutritional intervention that may reduce the length of ventilator dependency, the ICU/hospital stay and the mortality.[6]

The essential goals of appropriate nutrition in a critically ill child are accurate assessment of nutrition requirements, prevention of over-feeding and under-feeding, initiation of (early) enteral nutrition (EN) and monitoring for energy and protein imbalance.[7,8] Although nutrition in the ICU setting can be provided by enteral or parenteral methods, the scope of this article is limited to enteral nutrition only. The aim of this article is to discuss various aspects of enteral nutrition for pediatricians managing critically ill patients, postgraduate students and those interested in intensive care.

Methodology

A literature search was conducted in the PubMed database using word combinations of controlled vocabulary (MeSH terms):'enteral nutrition' and 'critical illnesses'. These controlled vocabulary terms were combined using 'AND' Boolean connector. The results were limited to studies available in English language. The age limit was set from birth to 18 years of age with a period from 2004 to 2019 (1678 articles hits seen) and purely neonatal articles (60) were excluded from the articles thus retrieved. Final list included 1618 articles which were finally shortlisted to 46 to include citations relevant to our review (we excluded the articles whose results were already incorporated in the guidelines and other reviews) with an emphasis on review articles, landmark articles and a couple of book chapters were also included.

Nutrition assessment

All patients should be screened for malnutrition (on admission to the PICU). In this way, those who are already malnourished at the time of admission, or those who are at-risk of becoming malnourished can be identified.[6] The SCCM (Society of Critical Care Medicine) & ASPEN (American Society of Parenteral & Enteral Nutrition) 2017 guidelines recommend nutritional assessment of all patients in PICU within 48 hours of admission and then once weekly to assess risks of nutritional deterioration in the PICU.[8] This assessment includes history, anthropometry, biochemical and immunological measurements.[9]

i. *History taking:* The first step in nutrition assessment is a complete history with special attention to nutrition history, acute presenting complaints, chronic illness/es, past hospitalizations and surgical procedures.[9]

ii. *Anthropometry*: Anthropometry measurements include weight for age, length or height for age, weight for height and Body mass index (BMI). Commonly recommended measurements by SCCM & ASPEN include BMI and weight for age in all children and head circumference in those less than 36 months.[8] In a multi-centric (over 90 PICUs) study conducted by Bechard et al., the BMI was correlated with outcome in mechanically ventilated patients in PICU.[10] Being underweight (BMI Z-score < -2) was associated with a higher chance of 60-day mortality and hospital-acquired infections; whereas obesity (BMI Z-score > 2) was significantly associated with longer hospital stay among survivors.[10] Lee et al. in their consensus statement on optimal nutrition (in the Asia Pacific and Middle East) recommend to use uniform reference standards within a country and international reference standards like WHO if robust regional data are not available.[9] The WHO terminologies for malnutrition (6 months to 5 years) include – Underweight (Weight for age <2 standard deviations of the WHO child growth standards median), Stunting (Height for age < 2 standard deviations of the WHO child growth standards median), Wasting (Weight for height < 2 standard deviations of the WHO child growth standards median) and Overweight (Weight for height >+2 standard deviations of the WHO child growth standards median)[11] (z scores are preferred over percentiles).

iii. *Biochemical markers*: These include albumin, pre albumin, transferrin, urea, triglycerides and retinol binding protein but biochemical markers are not commonly recommended to assess nutritional status of critically ill patients in PICU.[8,9] Hulst JM et al.[12] conducted a prospective descriptive study finding the association between abnormal biochemical marker and outcome and changes in anthropometric parameters. Abnormalities of biochemical parameters did not predict changes in anthropometric parameters. Children with hypertriglyceridemia on admission had longer ventilator dependence ($P<0.01$) and length of stay ($P<0.001$) than children with normal triglyceride levels. No other biochemical parameter was found to be significantly correlated with the outcome. Patients with fluid overload may have unreliable anthropometry measurements whereas the biochemical parameters may be affected in acute inflammation.[9] Accurate assessment of nutritional status should be taught to the PICU working staff.

In developing countries, enough resources may not be available for evaluating all patients. In these circumstances, screening tests may prove useful to identify the high-risk patients.[8] The subjective global nutrition assessment (SGNA) is a validated tool for assessing malnutrition in children comprising history and physical examination but not yet accepted as a standard screening scale in PICU patients.[13] Another screening tool for assessment of nutrition is Pediatric Nutrition Screening Tool (PNST), which consists of 4 simple questions devised by Australian dieticians.[14] In a study conducted by White et al., the PNST score was found to be a simpler and valid alternative to old nutrition scales like Screening Tool Risk for the Assessment of Malnutrition in Pediatrics (STAMP), Screening Tool Risk on Nutritional status and Growth (STRONGkids) and Pediatric Yorkhill Malnutrition Score(PYMS). A definitive screening test has still not been developed which can be used uniformly in all countries.[8]

Energy and protein requirements

After nutritional assessment, the next step is to determine the energy and protein requirements of the critically ill pediatric patients.

i. Energy requirements: Calculation of energy requirements for critically ill patients is difficult and varies through the ICU stay of the child. Measurement of resting energy expenditure (REE)with indirect calorimetry (IC) is the gold standard for calculation of energy requirement but requires a lot of expertise and specialized equipment.[8] It measures oxygen (O_2) consumption and carbon dioxide (CO_2) production.[15] It is a highly accurate and non-invasive method of determining the metabolic rate with an error rate of lower than 1%.[15] REE is calculated by the modified Weir formula[16]; REE (kcal/day):3.941(VO_2) + 1.106(VCO_2)] × 1440 where VO_2 is the volume of oxygen consumed and VCO_2 is the volume of CO_2 produced. This is not dependent on height and weight of the child. Chaparro et al. used indirect calorimetry to identify the energy requirement in critically ill children and noted that REE decreased with neuromuscular blockade and increased with rise in temperature in mechanically ventilated critically ill children.[17] If IC measurement of resting energy expenditure is not feasible/ available, the Schofield or Food Agriculture Organization (FAO) / World Health Organization (WHO) / United Nations University equations can be used (but without the addition of stress factors).[8] Studies show that this calculation/ formulae can lead to under-feeding or over-feeding. Mehta et al. reported that standard equations overestimated the energy expenditure leading to a high incidence of overfeeding (83%).[18] Sy et al. noted that the World Health Organization equation overestimated, and Schofield predictive equations underestimated the energy requirements (respectively) compared with those obtained by bicarbonate dilution kinetics.[19] Therefore, signs of over-feeding (like rapid weight gain, hyperglycemia, hypertriglyceridemia and increased CO_2 production) and signs of under-feeding (like weight loss, prolonged dependency on ventilation and increased PICU stay) should be monitored.[8,23] Underfeeding can lead to decreased respiratory muscle function and delayed wound healing while overfeeding can lead to increase in calories, which are converted to fat and cause more CO_2 production leading to increased work of breathing.[23] The Harris-Benedict equation used to calculate the basal energy expenditure is not recommended to calculate energy requirement in critically ill children as it is used for normal growing children and over predicts the energy requirements. The Schofield equation in males and females aged 0 to 3 years is $0.167W + 15.174H - 617.6$ and $16.252W + 10.232H - 413.5$ respectively.[20] The equations in males and females between 3 to 10 years are $19.59W + 1.303H + 414.9$ and $16.969W + 1.618H + 371.2$ respectively [where W is the weight (in kg) and H is the height (in cm)].[20] The WHO equations in males are $60.9W - 54$ between 0 to 3 years and $22.7W + 495$ between 3 to 10 years.[20] In females it is $61W - 51$ between 0 to 3 years and $22.5W + 499$ between 3 to 10 years.[20] Wong et al. in their survey reported that dieticians preferred to use Schofield equation whereas physicians chose total fluid requirement to develop the estimated energy goals.[21] Basal physiological processes in the body consume about 70% of the total energy requirements. Additional 10% energy is required for physical activity and 20% for digestion of macronutrients.[22,23] Addition of stress factors to resting energy expenditure can lead to inaccuracies.[20,21] There are certain situations where a percentage increase in the energy expenditure need to be calculated. These include fever (12%/*C above 37*C), cardiac failure (15-25%), major surgery (20-30%),burns (upto 100%) and severe sepsis (40-50%).[23]

ii. Protein requirements: The protein requirements in a critically ill child are much more than healthy children. Sick children have excessive catabolism which leads to a negative nitrogen balance due to proteolysis. Hence, it is necessary to start adequate protein intake early in the course of the illness to promote positive nitrogen balance which can lead to positive clinical outcomes.[8] Wong et al. reported (retrospective study) that early initiation of nutrition support and proteins was associated with lesser ICU mortality (p=0.002) and greater ventilator-free days (p=0.005) in ventilated children with acute respiratory distress syndrome (ARDS).[24] Similarly, Mehta et al. (observational prospective study) reported that adequate protein intake was associated decreased 60 day mortality in 985 patients (p<0.001).[25] Protein requirement can summarized (age-wise) as 0-2 years : 2-3 g/kg/day; 2-13 years : 1.5-2 g/kg/day and 13-18 years : 1.5 g/kg/day.[20]

Enteral Nutrition (EN) therapy

The next step in nutrition management is the appropriate route of delivery. Nutrition can be provided by enteral or parenteral pathways. Enteral nutrition (EN) is the preferred mode of nutrition in patients with a functioning gastrointestinal system.[8] The functioning of the gastrointestinal tract is required to facilitate digestion, absorption and metabolism and to provide a barrier for infectious agents and toxins.[8] Factors affecting these functions include mucosal permeability, thickness and gut associated lymphoid tissue.[8] There are certain parameters that can assess the function of the gastrointestinal system like presence of bowel sounds, absence of abdominal distension and vomiting, absence of diarrhea after starting enteral feeds and absence of increase in abdominal girth by 10% from the baseline.[23]

i. *Benefits of enteral nutrition*: Enteral nutrition has been shown to improve the trophic stimulation of the gut and maintain the gastrointestinal barrier function.[8] It is also found to reduce the oxidative stress and reduce the metabolic and infectious complications. It prevents the translocation of bacteria and supports the gut associated lymphoid tissue. It is found to be safe, simple, economical and physiological.[8] Mehta et al. conducted an international prospective study in 31 PICUs in eight countries and followed patients during their PICU stay for a maximum of 10 days and subsequently followed them up until 60 days or till discharge.[4] They reported that enteral nutrition was started in 67% of the patients and a decreased incidence of 60-day mortality was observed in children receiving higher percentage of daily nutritional intake via the enteral route (p=0.002).[4]

ii. *When to start EN / initiation of EN*: It is recommended to start enteral nutrition early (within 24 to 48 hours of admission to intensive care) and reach up-to two thirds of the nutrient goal in the first week of the illness.[8] There have been various controversies regarding the role of early and delayed enteral feeding. In a retrospective study by Mikhailov et al. on 5105 patients, those receiving early enteral nutrition had an improved survival but did not affect length of stay or duration of mechanical ventilation.[26] A retrospective cross sectional study across six PICUS in the United States (US) conducted by Canarie et al. showed higher levels of respiratory support, increased severity of illness and gastrointestinal disturbances in patients as factors causing delayed nutrition.[27] Bagci et al. conducted a prospective observational study in nine PICUs in Turkey and stated that early enteral feeding is associated with early attainment of target enteral nutrition (patients who received more than 25% of the estimated energy requirement by enteral feeding within 48 hours of admission to PICU), which in turn improved the mortality.[28] Haney et al. showed that patients who received early enteral nutrition had a shorter PICU stay compared to those who did not.[29] Leroue et al. reported that 64% of the patients started enteral nutrition within 24 hours, with 72% achieving goal enteral nutrition rate within 72 hours and use of bi-level noninvasive positive pressure ventilation and continuous dexmedetomidine were independently associated with decreased likelihood of early enteral nutrition.[30] Early enteral nutrition has also been found to affect hospital charges. In a retrospective study conducted by Mikhailov et al., early enteral nutrition in critically ill children was associated with lower total and daily hospital charges in 859 patients in 2 centers.[31] Balakrishnan et al. conducted a retrospective multicentric study in 416 children with head injury admitted in 5 PICUs and reported that delayed enteral nutrition (>48 hours) was associated with worse functional status at PICU discharge (p=0.02) but was not associated with mortality or increased length of stay.[32] Enteral nutrition should be started as early as possible in critically ill patients, as long as there are no contraindications and given cautiously in high risk cases (like those with high doses of inotropic supports or with risk of aspiration).[8] There is relative hypoperfusion to the gastrointestinal tract in hemodynamically unstable patients which is further aggravated by the use of vasoactive agents (like epinephrine, norepinephrine, dopamine, dobutamine, vasopressin and milrinone) by causing splanchnic vasoconstriction.[33] This theoretically increases the risk of multi system organ failure due to perfusion-reperfusion injuries to the gastrointestinal tract.[29] Therefore, enteral nutrition is given cautiously in those with high doses of vasoactive agents.[33] However, Panchal et al. conducted a retrospective study of 339 patients over 18 months and reported no adverse effects with the use of vasoactive agents during enteral nutrition.[33] Fluid restriction in certain conditions like acute or chronic kidney disease and congenital heart diseases can cause inadequate energy and protein intake in critically ill children. In a cross sectional study by Tume et al., various factors found to be associated with reduced energy delivery included fluid-restriction (60%), the child just being 'too ill' to feed (17%), post-surgery (16%), nursing staff slow in initiating feeds (7%), frequent procedures requiring fasting (7%) and hemodynamic instability (7%).[34]

iii. *Contraindications to EN*: Common contraindications for enteral feeding include intractable vomiting, high gastric aspirates, upper gastrointestinal bleeding, and use of inotropic or neuromuscular blocking agents.[23] Enteral feeding should be avoided in intestinal obstruction, paralytic ileus and bowel perforations.[23] Various aspects need to be checked before starting enteral feeding to confirm adequate intestinal function. Presence of bowel sounds; absence of abdominal distension and vomiting are some of these.[23] In the presence of these contraindications, they should be started on parenteral nutrition.

iv. *EN Interruptions*: Common problems which can act as a hindrance to enteral nutrition in PICUs include delayed initiation, interruptions due to perceived intolerance, and prolonged fasting around procedures. Interruptions are common due to intolerance to enteral feeding (emesis, diarrhea and high gastric residual volume), feeding tube issues (displaced or blocked tube) and pre-/ peri-procedure fasting (bedside or operating room procedures and endotracheal intubations/extubation).[35] There should be minimum interruptions in enteral feeding as far as possible. In a retrospective cohort study by Haney et al. over a 30 months period, feeding was interrupted in 19% of patients (mainly due to procedures) and most patients who developed feed intolerance were on inotropic agents.[29] Mehta et al. reported an interruption of enteral nutrition in 30% of patients with 58% of these being avoidable interruptions, especially in infants and those on mechanical ventilation.[36] A common criteria for perceived intolerance is high gastric residual volumes (GRV). GRV measurement in intermittent bolus feedings is performed prior to each feeds or every four hours in continuous feeding.[20] GRV is considered significant if it is 5 ml/kg or 150 ml or more than half the previous feeding volume.[20] In case of a high GRV, repeat measurement is done after 2 hours without any change in rate or volume of the feeds. If two consecutive GRVs are elevated, EN should be withheld and GRV should be monitored every four hours till it decreases. After reaching this point, feeds can be started again at 50% of the previous rate and volume.[20] Upper GI dysmotility (like abnormal fundal relaxation, antral and pyloric activity) is common in critically ill patients, which results in delayed gastric emptying.[35] This may occur due to inflammation, hypoperfusion, electrolyte abnormalities or drugs like sedatives & muscle relaxants (e.g. opiates).[35,37]

v. *Optimal route of enteral feeding*: Enteral feeding can be provided by the gastric or transpyloric pathway. Gastric feedings are preferred as it is easier and does not require special expertise for insertion or feeding.[8] Transpyloric or postpyloric feeding is preferred when there is poor gastric emptying or failed trial of gastric feeding.[8] It decreases gastric aspiration and improves tolerance for feeding but requires great expertise.[8] Kamat et al. found no benefit in transpyloric over the gastric feeds and noted that those with transpyloric feeds had significant delays in initiating enteral nutrition due to the time required to insert the feeding tubes transpylorically.[38] Some patients may require long-term enteral nutrition by gastrostomy or jejunostomy.[8] Feeding can be given as bolus or continuous feeding.[23] Bolus feeding is more physiological, can allow movements of patients in between feeds and does not require infusion pumps.[23] Bolus feeding should be started at the rate of 10-15ml/kg every 3 hourly to a maximum of 20-30 ml/kg 4-5 hourly with an increase of 10-30 ml per feed.[23] Children aged 1-6 years should be given 5-10 ml/kg every 3 hourly increasing 30-45 ml per feed to a maximum of 15-20 ml/kg 4-5 hourly.[23] On the other hand, continuous feeding improves tolerance, absorption and adaptation but may require a pump for accurate delivery.[23] It can be started at 1-2 ml/kg/hour to a maximum of 6ml/kg/hour in infants. In children between 1-6 years, feeds can be started at 1ml/kg/hour with an increase of 1 ml/kg every 2-8 hours to a maximum of 5 ml/kg/hour.[23] Horn et al. noted no difference in feeding tolerance and gastric residual volumes between bolus (24 patients) and intermittent (22 patients) feeding groups.[39]

vi. *Complications of enteral nutrition*: Malpositioned feeding tubes may lead to perforation of pharynx, esophagus, stomach and sometimes even pneumothorax, which can occur at the time of insertion or later.[40] In some patients with high GRVs and gastric distention, there are chances of aspiration pneumonias.[40] Other side-effects include diarrhea, necrotizing enterocolitis and gastrointestinal hemorrhage.[40]

The SCCM &ASPEN guidelines (2017) recommend the use of parenteral nutrition (PN) as a supplement when children are not able to get enteral nutrition during the first week in the PICU.[8] In some critically ill children with intestinal failure, parenteral nutrition needs to be started immediately. It is important to use parenteral nutrition carefully as it is associated with complications like hyperglycemia, infection, hepatic and intestinal injury.[9]

For patients who are severely malnourished or at risk of nutritional deterioration, PN may be supplemented in the first week if they are unable to advance past low volumes of EN.[8] In stable patients, the total parenteral energy requirements can be calculated from resting energy requirements with adding constants for physical activity and catch-up growth. Lipid emulsions given intravenously is a major part of parenteral nutrition with a maximum limit of 3 g/kg/day. To prevent essential fatty acid deficiency, a minimum of 0.1 g/kg/day of linoleic acid should be added to the emulsion.[41] Immunonutrients (like glutamine, arginine, nucleotides, omega-3 fatty acids, fiber, antioxidants, selenium, copper, and zinc) are currently not recommended in critically ill children.[8]

Monitoring

After starting EN, continuous monitoring of patients for maintenance of optimum nutrition is required. Various clinical and biochemical parameters need to be monitored for checking for optimal nutrition.[8] Daily weight, caloric and protein intake, abdominal girth and change in frequency and consistency of stools are the clinical parameters to be monitored daily.[8,23] Various biochemical parameters which can be monitored include serum prealbumin, procalcitonin, blood urea nitrogen, transferrin, C reactive protein, blood gas, glucose, triglyceride and retinal binding protein.[8,20] Monitoring is important to assess the clinical efficacy of enteral nutrition and identification of early signs of nutritional deficiencies.

It is important to monitor signs of overfeeding and underfeeding while on enteral nutrition. In a retrospective study conducted by Larsen et al.[42] reported that children who were overfed had significantly longer PICU stay compared to those who were appropriately or underfed. Children who were underfed had significantly higher CRP compared to those children in the appropriately fed and overfed groups.

Developing protocols/ algorithms/ other miscellaneous issues:

It is important to develop guidelines for EN internationally, nationally and locally. There is a need to identify the problems with feeding at a local level so that they can be addressed as early as possible.[8] These guidelines should be taught to all the medical and paramedical (nursing) staff in charge of/

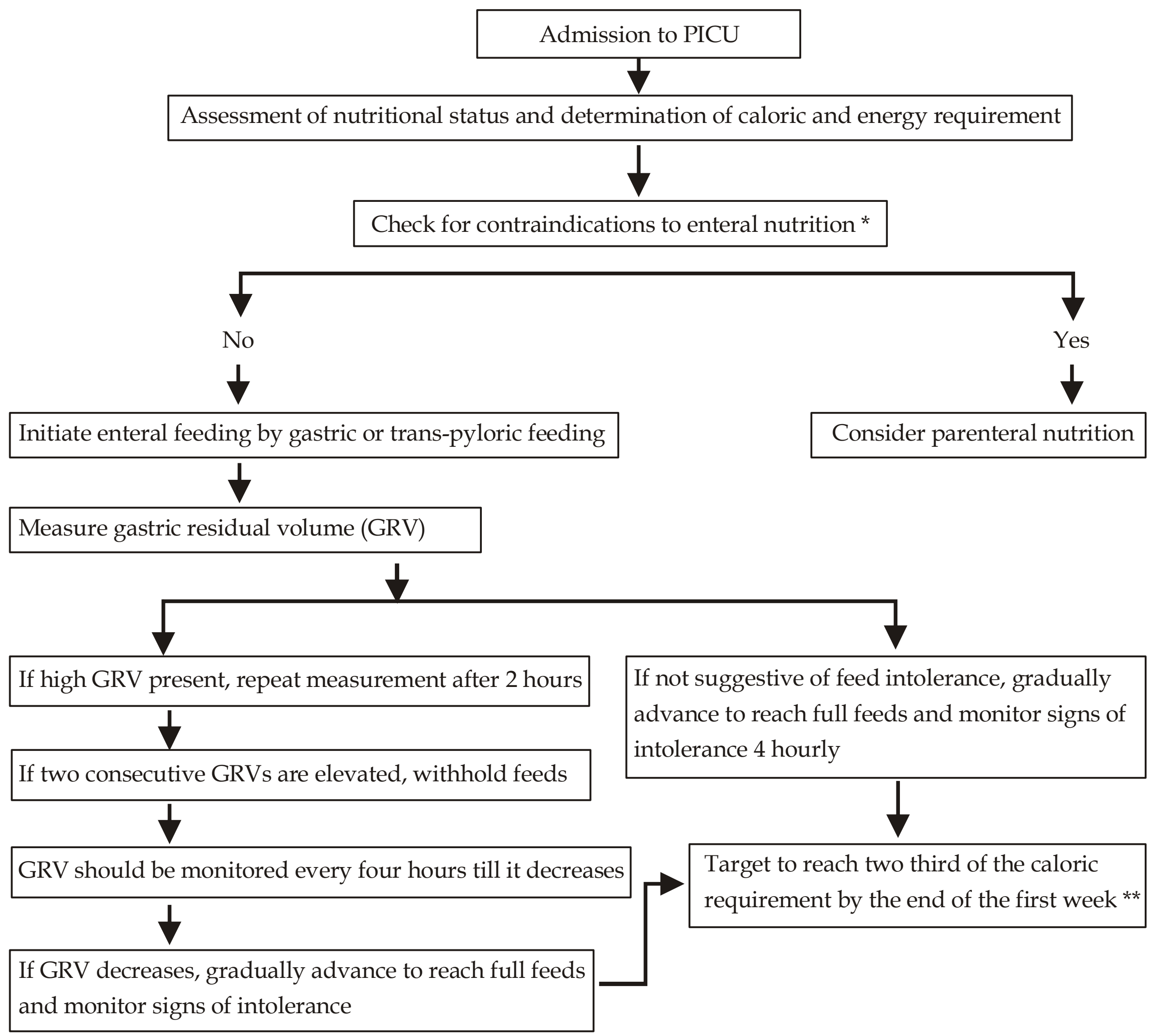

Fig.: Algorithm to follow enteral nutrition in the PICU.[36,37]

* Contraindications for enteral feeding: intractable vomiting, high gastric aspirates, upper gastrointestinal bleeding, and use of inotropic or neuromuscular blocking agents, intestinal obstruction, paralytic ileus and bowel perforation.

** Monitor for complications (malpositioned feeding tubes, aspiration pneumonias, diarrhea, necrotizing enterocolitis and gastrointestinal hemorrhage).

working in the critical care unit, with regular audits to evaluate adherence.[8] These stepwise algorithms should include bedside approach for increasing the rate of enteral nutrition and management of intolerance as well.[8]

A simple algorithm has been devised to be used for enteral nutrition in critically ill patients given in Figure 1.

In addition, there should be a multidisciplinary team including a dietician to follow these guidelines.[8] Apart from this, there should be six-monthly audits to check for compliance to these protocols and guidelines in the hospital.[40] Hamilton et al. developed an enteral nutrition algorithm for their hospital and carried out a prospective study on 80 patients pre and post implementation of thisalgorithm.[43] Deane et al. reported a decrease in avoidable episodes of EN interruption (p=0.0001) and decrease in the median time to reach their energy goals (p<0.0001), with a greater number of patients reaching this goal (p= 0.01).[37] Kaufman et al. examined the role of a protocol on EN and identified that use of the protocol increased the number of patients reaching daily caloric goals from 50.1% to 60.7% and those reaching protein goals increased from 51.6% to 72.7%.[44] Meyer et al. introduced a series of enteral feeding protocols in a PICU over 9 years and reported that these protocols shortened the time to initiate enteral nutrition (from 15 hours to 4.5 hours), increased the number of patients receiving enteral nutrition (from 89% to 96%) and decreased the number patients receiving parenteral nutrition (from 11% to 4%).[45] Mehta et al. also reported a lower prevalence of hospital acquired infections in those patients admitted to PICUs following a feeding protocol independent of the amount of protein and energy intake.[4] A stepwise algorithm for enteral nutrition has been developed by Mehta based on the existing local nutritional practices.[40] In a survey conducted by Wong et al., only 13 (37%) of centers had a dedicated dietician in their PICU with anthropometry being the most common screening tool used by them.[21] Those centers with a dietitian had a regular assessment of their patients compared to those who did not ($p<0.001$).[21]

New home based enteral nutrition has also been started especially in the European countries where oral or tube feeding has been tried in patients with a neurodisability or those with a chronic illness to improve the physical and psychological condition of the child. It additionally reduces the costs of the hospital for these patients with chronic illnesses. Lezo et al. conducted a survey in Italy over 22 centers in the age group of 0 to 19 years and noted a dramatic increase in the number of patients using home based enteral nutrition.[46] A survey conducted by Diamanti et al. reported the use of home parenteral nutrition in pediatric patients of chronic intestinal failure like short bowel syndrome (SBS), Hirschsprung's disease and congenital intestinal pseudo-obstruction syndromes (CIPOS).[47]

The SCCM &ASPEN 2017 recommendations[8]:

There has been a recent update in the recommendation of ASPEN (in year 2017) with regards to nutrition in a critically ill child. These SCCM & ASPEN guidelines recommend that all patients in PICU should undergo a detailed nutritional assessment within 48 hours of admission with re-evaluation weekly while in the hospital, with anthropometry (z scores) being the main method to screen patients for malnutrition. Recommended energy requirement should be calculated by indirect calorimetry when available, or else by Schofield/ FAO/WHO equations with the objective of reaching two thirds of the prescribed daily energy intake by the end of the first week. Proteins should be started early in the ICU with a minimum intake of 1.5 g/kg/day. Enteral nutrition is the preferred mode of nutrition in critically ill children; especially those started on EN early (within 24-48 hours) and achieving two third of the nutrition goal in the end of the first week have better outcomes. They also suggest a stepwise algorithmic approach and a nutrition support team to initiate and maintain the enteral nutrition.

Conclusions

Optimal nutrition is important for critically ill children with enteral nutrition being the most common way of administering the same. It is important to assess patients at the time of admission by anthropometric and biochemical parameters. Enteral feeding should be initiated as early as possible by nasogastric or transpyloric methods. It is vital to identify the contraindications and side effects of enteral nutrition. To follow the recommendations, it is important to have a specialized dedicated nutrition support team and local protocol/ algorithm of initiating and maintaining the enteral nutrition.

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1 https://www.who.int/childgrowth/training/en/ (Accessed on 28th October 2019). [For Ref. No. 11].