Malnutrition in Hospitalized Children: A Responsibility and Opportunity for Pediatric Hospitalists

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Poor nutrition is an underrecognized cause of significant morbidity in hospitalized children. In addition to presenting with poor nutrition at the time of admission, children often suffer worsening of their nutritional status during the course of a hospitalization, often due to providers’ underrecognition of ongoing poor intake (see Fig 1). Pediatric hospitalists can and should play a central role in recognizing and treating this common comorbid condition.

In this article we highlight the important issue of malnutrition in hospitalized pediatric patients and propose a general approach to nutritional assessment and supplementation for the pediatric hospitalist.

DEFINITION OF MALNUTRITION

Malnutrition is defined as a state in which a deficiency (or excess) of energy, protein, and other nutrition causes measurable adverse effects on the body and on growth (in children), and may impact clinical outcome. The term “nutritional deterioration” has been used to describe significant weight loss in hospitalized children, a precursor to acute malnutrition. Although the term malnutrition includes both overnutrition (obesity) and undernutrition, in this article we focus specifically on undernutrition.

MALNUTRITION IN HOSPITALIZED CHILDREN: INCIDENCE AND OUTCOMES

Recent studies in developed countries have estimated the prevalence of malnutrition in hospitalized children as 12% to 24%. Despite many medical advances over the past 20 years, the prevalence of malnutrition among hospitalized children has not decreased. Malnutrition is known to have detrimental effects on clinical outcomes. For example, in children with bronchiolitis in PICUs, poor nutritional status is significantly related to increased length of stay and duration of mechanical ventilation. Malnourished children experience more complications, such as infections after surgery, than well-nourished children, also leading to increased length of stay.

Malnutrition also affects growth. Growth depends on a permanent increase in fat and lean body mass, which requires positive energy and nitrogen balance. An increase in nutritional demands due to illness or injury competes with these specific needs of growth. Infancy and adolescence are especially high-risk periods when sustained undernutrition during illness may inhibit growth. Initially, children may show an absence of weight gain.
followed by weight loss. Over time, they will have retarded height. Early on, weight-for-height is an important way to diagnose chronic malnutrition.7

In infants, early malnutrition is associated with delayed physical as well as intellectual development.9 Emond et al9 associated early poor weight gain (diagnosed by 8 weeks of age) with later IQ deficits of $\sim 3$ points as compared with controls.

CONVENTIONAL MEASURES OF NUTRITIONAL STATUS

Several conventional measures of nutritional status may be unhelpful in the acute evaluation of the hospitalized child, such as growth curves, changes in weight, weight-for-height, serum biomarkers, and handgrip strength. For example, although growth curves are an ideal way to measure children’s longitudinal nutritional status,10 acute changes in nutritional status are not well represented on a growth curve. Acutely, weight loss or gain often reflects changes in fluid status rather than true nutritional changes.

Serum albumin has been used as a measure of nutritional status. However, albumin has a long half-life (14–20 days) and is affected by many other clinical factors, including sepsis, dehydration, trauma, liver disease, and albumin infusions, thus making it a poor marker of visceral protein status. On the other hand, prealbumin has a half-life of 24 to 48 hours and may be a good marker for the visceral protein pool. However, prealbumin may be diminished in liver disease and falsely elevated in renal failure. In addition, prealbumin does not accurately reflect nutritional status during inflammation.11 For example, in children with burns, C-reactive protein (CRP) and prealbumin are inversely related (ie, as CRP rises, prealbumin falls).11

A recent review of 16 pediatric studies examining the association of biomarkers with outcomes in critically ill children showed that none, including serum proteins (albumin, prealbumin, transferrin, total protein), electrolytes (calcium, magnesium), and triglycerides, were associated with clinical outcomes, such as length of stay, duration of mechanical ventilation, and mortality.12 This finding is consistent with adult studies.13

Although nutritional biomarkers may not be effective in predicting outcome, it is important to screen malnourished patients with serum potassium, phosphorus, magnesium, and glucose during the first week of refeeding because of metabolic alterations seen in the nutritional recovery syndrome (ie, refeeding syndrome).14

Handgrip strength remains a possible future screening tool in pediatric patients; benefits include that it is noninvasive, is not sensitive to fluid status, and is an easily reproduced measure (high interrater reliability). In one study of hospitalized pediatric patients older than 6, handgrip strength was correlated with BMI z scores.15 Currently, however, there are no reference values for handgrip strength in children, making it difficult to generalize use as a nutritional screening tool.

MEASUREMENT OF NUTRITIONAL RISK

In practice, assessment of hospitalized patients’ nutritional status is difficult, and often, even when done well, it serves to identify patients who are already malnourished. Several authors argue that a more important assessment is that of nutritional risk, because such a measure allows intervention such as early and timely nutritional support to prevent the short- and long-term consequences of malnutrition on clinical outcomes, growth, and development.5,16

The Nutritional Risk Score and STRONGKids are 2 suggested tools for risk assessment. The Nutritional Risk Score is a measure that can be calculated at admission and identifies a population of hospitalized patients with an increased risk of hospital-acquired malnutrition.
During hospitalization, there is no evidence better estimate energy requirements.\textsuperscript{23} Indirect calorimetry is recommended to variable, making estimation imprecise.

For obese children, assessing malnutrition and presence of weight loss or absence of weight gain (see Table 1).\textsuperscript{19}

**OBESITY**

For obese children, assessing malnutrition risk is very difficult, because nutritional calculations require an estimation of lean body mass. In obesity, the percentage of lean body mass for each additional kilogram above ideal body weight is highly variable, making estimation imprecise. Indirect calorimetry is recommended to better estimate energy requirements.\textsuperscript{22} During hospitalization, there is no evidence to support hypocaloric feeding for obese children. Therefore, nutritional goals for pediatric obese inpatients should be similar to their nonobese counterparts.\textsuperscript{23}

**NUTRITIONAL SUPPLEMENTATION**

For hospitalized children who are malnourished or at risk for malnutrition, the pediatric hospitalist will often have a role in treatment or prevention of malnutrition via supplementation. For those children with inadequate oral intake of food, oral nutritional supplements may be considered. In general, oral supplements should be selected based on age (formula classifications include preterm infant, full-term infant, toddler, and young child for age 1–10, and older child to adult), allergy concerns, specific caloric and nutritional needs, and other dietary restrictions. The *Harriet Lane Handbook*\textsuperscript{24} provides several reference tables describing the indications of commonly available supplements. A recent retrospective case-control study of oral nutrition supplement use in hospitalized children age 2 to 8 found an association between oral nutrition supplement use and a decreased inpatient length of stay (6.4 vs 7.5 days), as well as a lower cost of hospitalization.\textsuperscript{25}

When oral supplementation is not sufficient, the American Society for Parenteral and Enteral Nutrition (ASPEN) recommends that children with a functioning gastrointestinal tract receive enteral nutrition as the preferred mode of feeding. Enteral nutrition has been shown to be more cost-effective and without the risk of nosocomial infection and possible liver injury inherent with parenteral nutrition.\textsuperscript{11}

Although enteral nutrition is preferred, there are insufficient data to support a particular route (gastric versus transpyloric) of feeding in critically ill children. Gastric feeding is less resource-intensive and may be more physiologic. However, transpyloric feeding may improve caloric intake when compared with gastric feeding, and may be a safer option for children at high risk of aspiration. Finally, some children who do not tolerate gastric feeding may tolerate transpyloric feeds.\textsuperscript{11}

It is important to note that a risk of enteral feeding is undernutrition. In addition to interruptions due to feeding intolerance or fluid restrictions, enteral feeds are routinely interrupted for procedures in critically ill children.\textsuperscript{11} Studies have shown gross undernutrition in a large proportion of enterally fed children in the PICU setting.\textsuperscript{20–26}

Although there is no extensive evidence on the optimal timing of initiation of nutritional support, it is clear that children who are malnourished at admission and/or who are critically ill require intervention sooner than normally nourished, non–critically ill children.

For critically ill children, one study suggests improved tolerance of enteral feeds in those in whom feeds were initiated early (<24 hours of PICU admission) rather than late (>24 hours after PICU admission).\textsuperscript{29} Per ASPEN, many pediatric centers routinely initiate enteral nutrition for critically ill children within 48 to 72 hours after admission.\textsuperscript{11}

For non–critically ill children or adults, ASPEN generally recommends initiating supplemental nutrition (enteral or parenteral) when a patient has inadequate intake for 7 to 14 days or is expected to have inadequate intake for 7 to 14 days.\textsuperscript{20}

More research is needed to better define
the optimal timeline for supplementation in non–critically ill pediatric patients.

Of course, in some patients, enteral nutrition is contraindicated and parenteral nutrition is the only option. Several excellent references exist to assist the provider in choosing an appropriate enteral or parenteral nutritional formula for pediatric patients at risk for malnutrition. The American Academy of Pediatrics publishes a comprehensive Pediatric Nutrition Handbook. Other resources include the Harriet Lane Handbook, Nelson’s Textbook of Pediatrics, and Pediatric Surgery.

SPECIAL CONSIDERATION FOR PEDIATRIC SURGICAL PATIENTS

Studies of infants after surgery have shown a markedly decreased resting energy requirement initially after surgery. Thus, postoperatively, infants are at risk for overwhelming if “normal” feeds (ie, feeds sufficient to support growth of a healthy infant) are resumed. The resumption of the normal anabolic state for these infants correlates to when serum CRP is normalized (<2 mg/dL). In general, infants and children who were in a good state of health before surgery or injury can typically sustain 5 to 7 days without significant nutrition, provided that adequate nutrition is supplied thereafter. That said, early initiation of trophic feeds after gastrointestinal surgery in infants has been associated with improved return of gut function.

ROLE FOR PEDIATRIC HOSPITALISTS

Pediatric hospitalists are uniquely positioned to team with dieticians, nurses, and other physicians to better recognize and treat poor nutrition in hospitalized children. By using quality improvement (QI) methods, hospitalists can lead efforts to standardize assessment of nutritional risk and implement timely nutritional support. Such efforts should focus on reliable implementation of nutritional risk assessment, followed by appropriate supplementation and follow-up. Specific QI methods to implement these care processes may vary based on the setting. An excellent review of QI methods may be found in the The Healthcare Quality Book by Joshi et al. Multiple studies indicate such work can drastically improve patient outcomes and reduce health care costs.

CONCLUSIONS

Malnutrition among hospitalized pediatric patients remains a common, treatable comorbidity that remains underrecognized. Pediatric hospitalists are uniquely positioned to solve this problem by applying QI methods, and such efforts can improve patient outcomes and reduce health care costs. Let this be our call to action: “Malnutrition in Hospitalized Children: Think of it. Assess it. Address it.”

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