COMMENTARY

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

Erin E. Shaughnessy, MD, FAAP,[a] Lisa L. Kirkland, MD, FACP, MSHA, CNSP[b]

Poor nutrition is an underrecognized cause of significant morbidity in hospitalized children.[1,2] 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,[3,4] 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.[5] 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%.[1,3,5,6] 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.[7] For example, in children with bronchiolitis in PICUs, poor nutritional status is significantly related to increased length of stay and duration of mechanical ventilation.[2] Malnourished children experience more complications, such as infections after surgery, than well-nourished children, also leading to increased length of stay.[8]

Malnutrition also affects growth. Growth depends on a permanent increase in fat and lean body mass, which requires positive energy and nitrogen balance.[7] 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,

www.hospitalpediatrics.org
DOI:10.1542/hpeds.2015-0144

Address correspondence to Erin E. Shaughnessy, MD, FAAP, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC 3024, Cincinnati, OH 45229. E-mail: erin.shaughnessy@cchmc.org

[a]Division of Hospital Medicine, Cincinnati Children's Hospital Medical Center, Department of Pediatrics, University of Cincinnati, Cincinnati, Ohio; and [b]Division of Hospital Medicine, Mayo Clinic, Rochester, Minnesota

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

Dr Shaughnessy conceptualized and researched the topic, and drafted the initial manuscript; Dr Kirkland conceptualized and researched the topic, and revised the manuscript; and both authors approved the final manuscript as submitted.

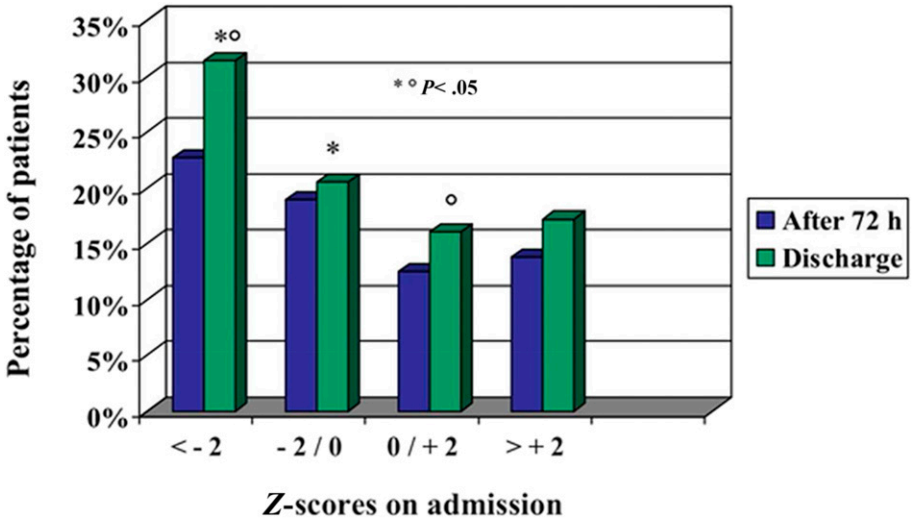

FIGURE 1 Percentage of BMI decrease ≥0.25 SD during hospitalization in 496 pediatric patients. Subjects were grouped by their *Z*-score at admission in the hospital. Although highly malnourished children lost the most in terms of BMI, even normally nourished children lost a statistically significant amount of weight during admission. Reprinted from Campanozzi A, Russo M, Catucci A, et al. Hospital-acquired malnutrition in children with mild clinical conditions. *Nutrition* 2009;25(5):540–547, with permission from Elsevier.[3] [medium]

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 al[9] associated early poor weight gain (diagnosed by 8 weeks of age) with later IQ deficits of ~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

children or adults at risk for nutritional deterioration.[5,17] The tool scores 4 categories: appetite, ability to eat, weight (measured as presence of recent weight loss and BMI for adults, and weight for length in children), and medical stress (classified as mild, moderate, or severe disease, based on underlying condition and/or surgery).

STRONGKids is a relatively simple screening tool that has been successfully validated in several pediatric hospitals.[4,18–22] The tool consists of 4 key items: subjective clinical assessment of nutritional status, presence of underlying disease with high risk for malnutrition, nutritional intake and losses, and presence of weight loss or absence of weight gain (see Table 1).[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.[23] 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.[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*[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.[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.[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.[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.[11] Studies have shown gross undernutrition in a large proportion of enterally fed children in the PICU setting.[26–28]

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).[29] Per ASPEN, many pediatric centers routinely initiate enteral nutrition for critically ill children within 48 to 72 hours after admission.[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.[30] More research is needed to better define

TABLE 1 STRONGKids Screen

STRONGKids screen: Answer the questions beside each category. Assign points based on a positive answer. Total points to assign a risk category.

Category	Question	Points
Subjective clinical assessment	Is the patient in a poor nutritional status judged by subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face)?	Yes = 1 point
High-risk disease	Is there an underlying illness with a risk of malnutrition or expected major surgery?	Yes = 2 points
Nutritional intake and losses	Is 1 of the following present: • ≥5 stools per day and/or vomiting >3 times per day the past few days? • Reduced food intake before admission (excluding fasting for a procedure) • Preexisting dietetically advised nutritional intervention? • Inability to consume adequate intake because of pain?	Yes = 1 point
Weight loss or poor weight gain	Is there weight loss, or no weight gain (for infants <1 y), during the past few weeks/months?	Yes = 1 point
Scoring of malnutrition risk:	Total the points from each category = _____	Points = Risk 0 = low 1–3 = moderate 4–5 = high

Reprinted from Joosten KF, Hulst JM. Malnutrition in pediatric hospital patients: current issues. *Nutrition.* 2011;27(2):133–137, with permission from Elsevier.[10]

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*.[31] Other resources include the *Harriet Lane Handbook*,[24] *Nelson's Textbook of Pediatrics*,[32] and *Pediatric Surgery*.[33]

SPECIAL CONSIDERATION FOR PEDIATRIC SURGICAL PATIENTS

Studies of infants after surgery have shown a markedly decreased resting energy requirement initially after surgery.[34] Thus, postoperatively, infants are at risk for overfeeding 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).[34] 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.[35] That said, early initiation of trophic feeds after gastrointestinal surgery in infants has been associated with improved return of gut function.[36]

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.[37] Multiple studies indicate such work can drastically improve patient outcomes and reduce health care costs.[25,38–40]

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."

REFERENCES

1. Pawellek I, Dokoupil K, Koletzko B. Prevalence of malnutrition in paediatric hospital patients. *Clin Nutr*. 2008;27(1):72–76
2. Mezoff A, Gamm L, Konek S, Beal KG, Hitch D. Validation of a nutritional screen in children with respiratory syncytial virus admitted to an intensive care complex. *Pediatrics*. 1996;97(4):543–546
3. Campanozzi A, Russo M, Catucci A, et al. Hospital-acquired malnutrition in children with mild clinical conditions. *Nutrition*. 2009;25(5):540–547
4. Moeeni V, Walls T, Day AS. Nutritional status and nutrition risk screening in hospitalized children in New Zealand. *Acta Paediatr*. 2013;102(9):e419–e423
5. Aurangzeb B, Whitten KE, Harrison B, et al. Prevalence of malnutrition and risk of under-nutrition in hospitalized children. *Clin Nutr*. 2012;31(1):35–40
6. Sissaoui S, DeLuca A, Piloquet H, et al. Large scale nutritional status assessment in pediatric hospitals. *e-SPEN Journal*. 2013;8(2):e68–e72
7. Agostoni C, Axelson I, Colomb V, et al; ESPGHAN Committee on Nutrition; European Society for Paediatric Gastroenterology. The need for nutrition support teams in pediatric units: a commentary by the ESPGHAN committee on nutrition. *J Pediatr Gastroenterol Nutr*. 2005;41(1):8–11
8. Secker DJ, Jeejeebhoy KN. How to perform Subjective Global Nutritional assessment in children. *J Acad Nutr Diet* 2012;112(3):424–431.e6
9. Emond AM, Blair PS, Emmett PM, Drewett RF. Weight faltering in infancy and IQ levels at 8 years in the Avon Longitudinal Study of Parents and Children. *Pediatrics*. 2007;120(4):e1051
10. Joosten KF, Hulst JM. Malnutrition in pediatric hospital patients: current issues. *Nutrition*. 2011;27(2):133–137
11. Mehta NM, Compher C; A.S.P.E.N. Board of Directors. A.S.P.E.N. Clinical Guidelines: nutrition support of the critically ill child. *JPEN J Parenter Enteral Nutr*. 2009;33(3):260–276
12. Ong C, Han WM, Wong JJ, Lee JH. Nutrition biomarkers and clinical outcomes in critically ill children: A critical appraisal of the literature. *Clin Nutr*. 2014;33(2):191–197
13. Ferrie S, Allman-Farinelli M. Commonly used "nutrition" indicators do not predict outcome in the critically ill: a systematic review. *Nutr Clin Pract*. 2013;28(4):463–484
14. Bauer J. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *JPEN J Parenter Enteral Nutr*. 2002;26:1–138
15. Silva C, Amaral TF, Silva D, Oliveira BM, Guerra A. Handgrip strength and nutrition status in hospitalized pediatric patients. *Nutr Clin Pract*. 2014;29(3):380–385
16. Pacheco-Acosta JC, Gomez-Correa AC, Florez ID, et al. Incidence of nutrition deterioration in nonseriously ill hospitalized children younger than 5 years. *Nutr Clin Pract*. 2014;29(5):692–697
17. Reilly HM, Martineau JK, Moran A, Kennedy H. Nutritional screening—evaluation and implementation of a simple Nutrition Risk Score. *Clin Nutr*. 1995;14(5):269–273
18. Moeeni V, Day AS. Nutritional risk screening tools in hospitalised children. *Int J Child Health Nutr*. 2012;1(1):39–43
19. Hulst JM, Zwart H, Hop WC, Joosten KF. Dutch national survey to test the STRONGkids nutritional risk screening

tool in hospitalized children. *Clin Nutr*. 2010;29(1):106–111

20. Cao J, Peng L, Li R, et al. Nutritional risk screening and its clinical significance in hospitalized children. *Clin Nutr*. 2014; 33(3):432–436
21. Moeeni V, Walls T, Day AS. Re: nutritional risk screening and its clinical significance in hospitalized children. *Clin Nutr*. 2014;33(2):368
22. Ling RE, Hedges V, Sullivan PB. Nutritional risk in hospitalised children: an assessment of two instruments. *e-SPEN Journal*. 2011;6(3):e153–e157
23. Jesuit C, Dillon C, Compher C, Lenders CM; American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Board of Directors. A.S.P.E.N. clinical guidelines: nutrition support of hospitalized pediatric patients with obesity. *JPEN J Parenter Enteral Nutr*. 2010;34(1):13–20
24. Engorn B, Flerlage J. *The Harriet Lane Handbook: Mobile Medicine Series, Expert Consult*. Philadelphia, PA: Elsevier Health Sciences; 2014
25. Lakdawalla DN, Mascarenhas M, Jena AB, et al. Impact of oral nutrition supplements on hospital outcomes in pediatric patients. *JPEN J Parenter Enteral Nutr*. 2014;38(suppl 2):42S–49S
26. Taylor RM, Preedy VR, Baker AJ, Grimble G. Nutritional support in critically ill children. *Clin Nutr*. 2003;22(4):365–369
27. Rogers EJ, Gilbertson HR, Heine RG, Henning R. Barriers to adequate nutrition in critically ill children. *Nutrition*. 2003;19(10):865–868
28. de Groof F, Joosten KF, Janssen JA, et al. Acute stress response in children with meningococcal sepsis: important differences in the growth hormone/ insulin-like growth factor I axis between nonsurvivors and survivors. *J Clin Endocrinol Metab*. 2002;87(7):3118–3124
29. Sánchez C, López-Herce J, Carrillo A, Mencía S, Vigil D. Early transpyloric enteral nutrition in critically ill children. *Nutrition*. 2007;23(1):16–22
30. ASPEN Board of Directors. Guidelines for enteral and parenteral nutrition in adult and pediatric patients. *JPEN J Parenter Enteral Nutr*. 2002;26(suppl 1):SA1–SA138
31. Kleinman RE *Pediatric Nutrition Handbook*. Elk Grove Village, IL: American Academy of Pediatrics; 2009:225–247
32. Maqbool A. Nutritional requirements. In: Kliegman R, Nelson WE, eds. *Nelson Textbook of Pediatrics*. Philadelphia, PA: Elsevier/Saunders; 2011:160
33. Teitelbaum DH, Btaiche IF, Coran AG. Nutritional support in the pediatric patient. In: *Pediatric Surgery*. Philadelphia, PA: Elsevier; 2012: 179–199.
34. Letton RW, Chwals WJ, Jamie A, Charles B. Early postoperative alterations in infant energy use increase the risk of overfeeding. *J Pediatr Surg*. 1995;30(7): 988–992, discussion 992–993
35. Herman R, Btaiche I, Teitelbaum DH. Nutrition support in the pediatric surgical patient. *Surg Clin North Am*. 2011;91(3):511–541
36. Ekingen G, Ceran C, Guvenc BH, Tuzlaci A, Kahraman H. Early enteral feeding in newborn surgical patients. *Nutrition*. 2005;21(2):142–146
37. Joshi M, Ransom E, Nash D, Ransom S. *The Healthcare Quality Book,* Chicago, IL: Health Administration Press; 2014
38. Chima CS, Barco K, Dewitt ML, Maeda M, Teran JC, Mullen KD. Relationship of nutritional status to length of stay, hospital costs, and discharge status of patients hospitalized in the medicine service. *J Am Diet Assoc*. 1997;97(9): 975–978, quiz 979–980
39. Neumayer LA, Smout RJ, Horn HG, Horn SD. Early and sufficient feeding reduces length of stay and charges in surgical patients. *J Surg Res*. 2001; 95(1):73–77
40. Correia MIT, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr*. 2003;22(3): 235–239

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

Erin E. Shaughnessy and Lisa L. Kirkland

Hospital Pediatrics 2016;6;37
DOI: 10.1542/hpeds.2015-0144 originally published online January 1, 2015;

Hospital Pediatrics®

AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

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

Erin E. Shaughnessy and Lisa L. Kirkland

Hospital Pediatrics 2016;6;37
DOI: 10.1542/hpeds.2015-0144 originally published online January 1, 2015;