RESEARCH ARTICLE

The Effect of Malnutrition on the Risk of Unplanned 7-Day Readmission in Pediatrics

Louis Ehwerhemuepha, PhD,[a,b] Donald Bendig, MD,[a] Caroline Steele, MS, RD, CSP, IBCLC, FAND,[a] Cyril Rakovski, PhD,[b] William Feaster, MD, MBA, CHIO[a]

ABSTRACT

BACKGROUND: Malnutrition is known to be associated with higher morbidity and a risk factor of readmissions in the adult population. In this study, we explore the effect of malnutrition in pediatrics because it may differ from the adult population.

METHODS: Data for all inpatient encounters at a tertiary children's hospital within a 2-year period corresponding to 19 702 visits were obtained. The data included demographics, socioeconomic status, registered dietitian diagnosis of malnutrition, and variables of the LACE readmission model. We excluded all neonates and patients older than 21 years. A multivariable logistic model was obtained by implementing best subset regression on these variables, controlling for demographics and socioeconomic status, and considering all possible 2-way statistical interactions between malnutrition and the variables for demographics and socioeconomic status.

RESULTS: We discovered a statistical interaction effect between a patient's age and malnutrition status (*P* value = .002) with respect to odds of unplanned 7-day readmission. It is indicated in this interaction term that patients who were malnourished had higher odds of readmission than patients who were not malnourished. Furthermore, younger patients who were malnourished were at increased odds of readmission than their older peers, whereas among patients who were not malnourished, younger patients were at reduced odds of readmission.

CONCLUSIONS: The statistical interaction effect revealed that a patient's risk of readmission is jointly modified by the patient's age and malnutrition status. This finding advances our understanding of the complex picture of the simultaneous risk factor of unplanned 7-day readmissions in pediatrics.

www.hospitalpediatrics.org
DOI:https://doi.org/10.1542/hpeds.2017-0195

Address correspondence to Louis Ehwerhemuepha, PhD, Information Systems Department, Children's Hospital of Orange County, 1201 W La Veta Ave, Orange, CA 92868. E-mail: lehwerhemuepha@choc.org

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.

[a]*Children's Hospital of Orange County, Orange, California; and* [b]*School of Computational and Data Sciences, Schmid College of Science and Technology, Chapman University, Orange, California*

Dr Ehwerhemuepha retrieved relevant data, developed the statistical design, conducted statistical analysis and interpretation of results, and wrote and revised the initial draft of the manuscript; Dr Bendig reviewed and discussed the results from a clinical perspective and revised and rewrote portions of the manuscript; Mrs Steele provided expertise on malnutrition and how it is diagnosed, contributed to the interpretation of results, and reviewed and revised the manuscript; Dr Rakovski reviewed the statistical design, analysis, and interpretation and contributed to the exposition of the nature of the statistical interaction in the study and revision of the manuscript; Dr Feaster initiated the study, provided access to data and tools for its analysis, contributed to the statistical design and model building, provided clinical insights on results, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

Malnutrition has been shown to be common among adult patients who are hospitalized[1] and to be associated with increased complications, length of stay (LOS), cost, and increased risk for readmission.[2–4] There is a scarcity of recent studies in regards to the prevalence of malnourished pediatric patients who are hospitalized and potential complications in the United States.[5] The prevalence of illness-related malnutrition in hospitalized children has been estimated at 6% to 51%.[6] However, the lack of a uniform definition for the severity of pediatric malnutrition (before 2013) is likely responsible, in part, for the lack of prevalence and impact data in pediatrics.[6] Worldwide, the prevalence of pediatric malnutrition of hospitalized patients in developed countries has been estimated at 5% to 27%, depending on the criteria used.[7–10]

On the other hand, there has been an abundance of reports over the last several years in regard to pediatric readmissions, their prevalence, causes, metrics, and preventability.[11–15] Malnutrition has not been specifically addressed as a factor in any of the reports. In contrast to published adult studies on readmission,[16] pediatric rates of readmission are much lower and the contributing factors different. There has been an increased focus on malnutrition since the 2013 Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN)[17] consensus on malnutrition characteristics. The momentum for the pediatric studies on readmissions has been driven predominantly by the concern regarding the loss of reimbursement for "preventable" readmissions as is happening with adult hospitals and the use of readmission rates as a measure of quality of care in most pediatric organizations.[18]

The purpose of our study was to assess the relationship between malnutrition in the general pediatric inpatient population and unplanned 7-day readmissions in a retrospective study with a large sample at a children's hospital. Several medical conditions may covary with malnutrition. In this study, we aimed to find the aggregate effect of malnutrition averaged over all such scenarios. The Ohio Children's Hospitals' Solutions for Patient Safety recognizes a 7-day (instead of a 30-day) metric for quality reporting because the 7-day metric may be more indicative of preventable readmission than a 30-day metric in pediatrics.[19,20]

METHODS

This study was approved by the Internal Review Board of the Children's Hospital of Orange County (institutional review board #160992).

Data

Data from all inpatient encounters within a 2-year period at Children's Hospital of Orange County were obtained. This included demographic variables (sex, age, and race and ethnicity), type of health insurance as payer (taken to be an approximation of or proxy for socioeconomic status), acute and/or emergent admission, number of previous emergency department (ED) visits within the last 6 months, LOS, preregistration status, and registered dietitian (RD) diagnosis of malnutrition. We excluded all chemotherapy encounters as well as encounters that ended in patient death. Furthermore, we excluded all neonates (patients $<$4 weeks of age) and patients older than 21 years of age. For each qualifying encounter, we determined the readmission status using the preregistration status to differentiate between planned and unplanned readmissions. Therefore, our outcome variable of interest was an indicator for unplanned readmissions within 7 days of a previous discharge from the hospital. We followed the Ohio Children's Hospitals' Solutions for Patient Safety recommendations on exclusion criteria and provided a flowchart of how patient encounters were excluded in Fig 1.

LACE Readmission Model Variables

We considered the LACE readmission model variables, a priori, as putative factors for inclusion in the final model. The acronym, LACE, is derived from the variables included in the model: LOS, acute and/or emergent admission, the Charlson's Comorbidity Index Score, and number of ED visits in the previous 6 months (excluding visits that resulted in hospitalization).[21,22] It was developed and validated in the adult population, but since its validation, studies have revealed that the constituent variables are independent risk factors for readmission in pediatrics as well.

Diagnosing Malnutrition

All patients admitted to the hospital receive a nutritional screening by registered nurses in accordance with the Joint Commission standard. The result of this nutrition screening is used by the RD in determining

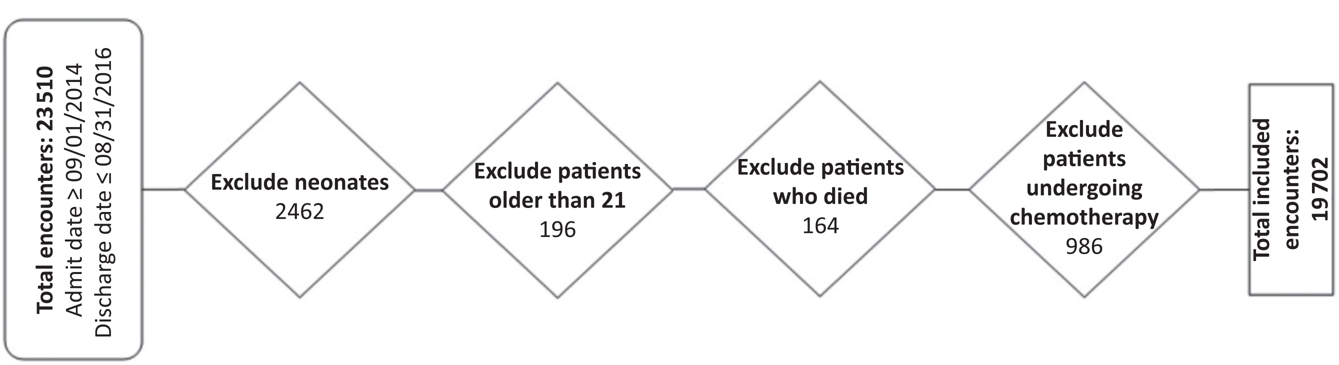

FIGURE 1 Selection of encounters.

TABLE 1 Diagnosis of Malnutrition by the RD

Primary Indicators	Mild Malnutrition	Moderate Malnutrition	Severe Malnutrition
When child presents only a single data point			
Wt for height, *z* score	−1 to −1.9	−2 to −2.9	−3 or lower
BMI for age, *z* score	−1 to −1.9	−2 to −2.9	−3 or lower
Mid-upper arm circumference, *z* score	−1 to −1.9	−2 to −2.9	−3 or lower
Length or height for age, *z* score	No data	No data	−3 or lower
When child presents historical medication information and 2 or more data points			
Wt gain velocity[a]	<75% of the norm for expected wt gain	<50% of the norm for expected wt gain	<25% of the norm for expected wt gain
Wt loss in patients 2–20 y of age	5% of upper body wt	7.5% of upper body wt	10% of upper body wt
Deceleration in wt for length *z* score	By 1 *z* score	By 2 *z* scores	By 3 *z* scores
Inadequate nutrient intake	51%–75% of estimated energy and/or protein needs	26%–50% of estimated energy and/or protein needs	≤25% of estimated energy and/or protein needs

[a] <2 y on the basis of World Health Organization data.

who gets an assessment for malnutrition. The RD classifies patients that they diagnose with malnutrition into mild, moderate, or severe malnutrition using the 2013 definitions described by an interdisciplinary work group of ASPEN.[6] The process for diagnosing malnutrition (shown in Table 1) depends on whether the child has only a single data point for use as criterion (weight to height ratio, BMI, mid-upper arm circumference, and length to height ratio) or when a child has historical medication information and 2 or more data points available for use as criteria as determined by ASPEN.[6] We used the resulting diagnosis from the RD's note to determine patients diagnosed with malnutrition and dichotomized the corresponding variable for malnutrition as an indicator of the absence of a diagnosis for malnutrition or the presence of any degree of malnutrition.

Statistical Analysis

We had complete data for all variables except for payer in which there was 0.28% missing due to clerical (data entry) error. We proceeded with imputation[23] of the missing payer data via a logistic regression imputation model and under a missing completely at random assumption for the missing data mechanism. Missing completely at random implies that the probability of missing data on a variable is not related to some observed data in the analysis or the value of the missing data itself.[23,24]

Summary statistics were calculated and a bivariate analysis of the variables under consideration was conducted. In the development of a multivariable model, we implemented a best subset logistic regression selection algorithm to find the optimal model for the odds of unplanned 7-day readmission. Best subset regression is a method for selecting the best regression model through an exhaustive search over all possible models[25] that included main effects and 2-way interactions. The statistical tool for model comparison and selection that we used was the Bayesian Information Criteria, a tool that favors the most parsimonious model that explains the most variation in the data.[26,27] The inclusion of 2-way interaction terms determines if there are any significant complex joint effects between malnutrition and the sex, race and ethnicity, age, or payer of the patient. In other words, these interactions reflect the changing effect of a variable over a range of values of another variable. In our case, the interactions answer the following question: "Does the role (if any) that malnutrition plays in modifying one's risk for being readmitted differ by payer, age, race, or sex?" We used the δ method[28–30] in cases in which we had to estimate the SE of the transformation of the regression coefficients to appropriately calculate corresponding confidence intervals (CIs). All statistical analyses were conducted using the R statistical programming language, version 3.4.0.[31]

RESULTS

The sample consisted of 19 702 encounters with 759 unplanned readmissions corresponding to a readmission rate of 3.85%. The average age of the patients was 7.5 years with a SD of 6.0 years, 45.9% were

TABLE 2 Average Values of Putative Risk Factors of Readmission

Putative Risk Factors of Readmission	Mean and/or Proportion (SD)		
	All Encounters	Patients Who Were Malnourished	Patients Without Malnutrition
LOS, d	5 (8)	13 (20)	4 (7)
Acute and/or emergent admissions	0.58 (0.49)	0.58 (0.49)	0.58 (0.49)
Average comorbidity scores	0.70 (1.29)	1.09 (1.64)	0.68 (1.26)
ED visits within previous 6 mo	0.47 (0.99)	0.65 (1.23)	0.46 (0.97)

TABLE 3 Summary Statistics and Bivariate Analysis

Variable	Level	Not Readmitted	Readmitted	OR (95% CI)	P
Sex, n (%)	Female	8687 (45.86)	356 (46.90)	Reference	.57
	Male	10 256 (54.14)	403 (53.10)	0.96 (0.83–1.11)	
Race and ethnicity, n (%)	Hispanic	9227 (48.71)	394 (51.91)	Reference	.006
	White	5974 (31.54)	221 (29.12)	0.87 (0.73–1.02)	
	Asian	1499 (7.91)	51 (6.72)	0.80 (0.59–1.06)	
	Black or African American	508 (2.68)	35 (4.61)	1.61 (1.11–2.27)	
	Other	1735 (9.16)	58 (7.64)	0.78 (0.59–1.03)	
Age, y, mean (SD)	—	7.49 (6.02)	8.69 (6.54)	1.03 (1.02–1.04)	<.001
Payer, n (%)	Private and/or nongovernmental	7330 (38.70)	257 (33.86)	Reference	.007
	Medicaid and/or low-income	11 613 (61.30)	502 (66.14)	1.23 (1.06–1.44)	
Malnutrition, n (%)	No	18 082 (95.45)	698 (91.96)	Reference	<.001
	Yes	861 (4.55)	61 (8.04)	1.84 (1.39–2.39)	
LACE variables, mean (SD)	LOS	2.31 (1.76)	3.35 (2.02)	1.33 (1.28–1.37)	<.001
	Acute and/or emergent admission	1.74 (1.48)	1.94 (1.43)	1.10 (1.05–1.16)	<.001
	Comorbidity	0.66 (1.15)	1.16 (1.53)	1.31 (1.25–1.37)	<.001
	ED visits	0.44 (0.88)	0.64 (1.02)	1.23 (1.15–1.32)	<.001

—, not applicable.

female, 48.8% were Hispanic, and 61.5% were low-payer. We defined patients with private or nongovernmental insurance plans as high-payer, and patients on Medicaid or other low-income plans as low-payer. Average values of the putative risk factors of readmission (LOS, acute and/or emergent admissions, comorbidity scores, and ED visits) for all encounters, patients who were malnourished, and patients who were not malnourished are given in Table 2.

We conducted a summary and bivariate analysis to assess the unadjusted effect of each variable on the odds of readmission as shown in Table 3. We found that all variables except sex attained unadjusted statistical significance at an α level of .05.

We developed a multivariable model using best subset logistic regression selection approach. Our results reveal that the following variables were significant predictors of readmission (α level of .05): LOS (P value $<$ .001), acute and/or emergent admission (P value $=$ .002), comorbidities (P value $<$ .001), number of ED visits (P value $<$ .001), the main effect term for age (P value $<$ .001), the main effect term for malnutrition (P value $=$ .007), and an interaction between malnutrition and age (P value $=$ .002). Patients with a longer LOS were more likely to be readmitted than patients with a shorter LOS. A patient with acute and/or emergent admission had higher odds of readmission compared with patients with routine admission, and every unit increase in comorbidity score and ED visits were associated with increased odds of readmission, with an odds ratio (OR) of 1.17 and 1.16, respectively.

TABLE 4 Multivariable Logistic Model for Unplanned 7-Day Readmission With Statistical Interaction Between Malnutrition and Age

Variable	Level	Regression Coefficients of Statistical Interaction	OR (95% CI)	P
Sex	Female	—	Reference	.96
	Male	—	1.00 (0.86–1.15)	
Race and ethnicity	Hispanic	—	Reference	.13
	White	—	0.95 (0.79–1.14)	
	Asian	—	0.85 (0.62–1.15)	
	Black or African American	—	1.50 (1.03–2.14)	
	Other	—	0.87 (0.65–1.14)	
Age, y	—	0.026	—	<.001
Payer	Private and/or nongovernmental	—	Reference	.46
	Medicaid and/or low-income	—	1.07 (0.90–1.26)	
Malnutrition	No	—	Reference	.007
	Yes	0.570	—	
LACE variables	LOS	—	1.28 (1.23–1.33)	<.001
	Acute and/or emergent admission	—	1.08 (1.03–1.14)	.002
	Comorbidity	—	1.17 (1.11–1.23)	<.001
	ED visits	—	1.16 (1.08–1.25)	<.001
Malnutrition to age interaction term	—	−0.068	—	.002

—, not applicable.

The main finding in our study was the 2-way interaction term between malnutrition and age that was found to be a significant predictor of unplanned 7-day readmission (*P* value = .002). The presence of this interaction term modifies the main effect terms of age and malnutrition (hence the absence of ORs for age, malnutrition, and their interaction in Table 4). In Fig 2, we plot the predicted probability of readmission by malnutrition status, keeping sex, race, and socioeconomic status constant while considering the difference in average values of the LACE variables across both groups of patients. Because we have an interaction between a dichotomous and a continuous variable, separate regression lines with different slopes and different intercepts are required to model the effect of age within the 2 groups of patients. In other words, it is indicated in the interaction that age has effects with opposite signs on the 2 groups of patients. Within the group of patients who were malnourished, the odds of readmission are higher for younger children. On the other hand, within the group of patients who were not malnourished, the odds of readmission are highest in older patients. The odds decrease with increasing age in the first group but increases with age in the second. Furthermore, the odds of readmission among the patients who were malnourished tend to be higher than those who were not malnourished.

In addition to plotting the predicted probability of readmission, it is important to estimate OR and corresponding 95% CIs for different combinations of age and malnutrition status. In Table 5, we provide ORs to throw more light onto the varying effect of age on odds for readmission by malnutrition status. We can see that all scenarios selected had ORs implying significance at the .05 α level.

DISCUSSION

The main finding in our study was the identification of a statistically significant interaction between age and malnutrition status regarding unplanned 7-day readmissions in pediatric patients. The interaction is such that the odds of readmission among patients who were malnourished were higher than the odds for patients who were not malnourished. Among patients who were malnourished, the odds of readmission were higher in younger patients and decreased with age. And finally, the odds of readmission increased from younger to older patients among those who were not malnourished.

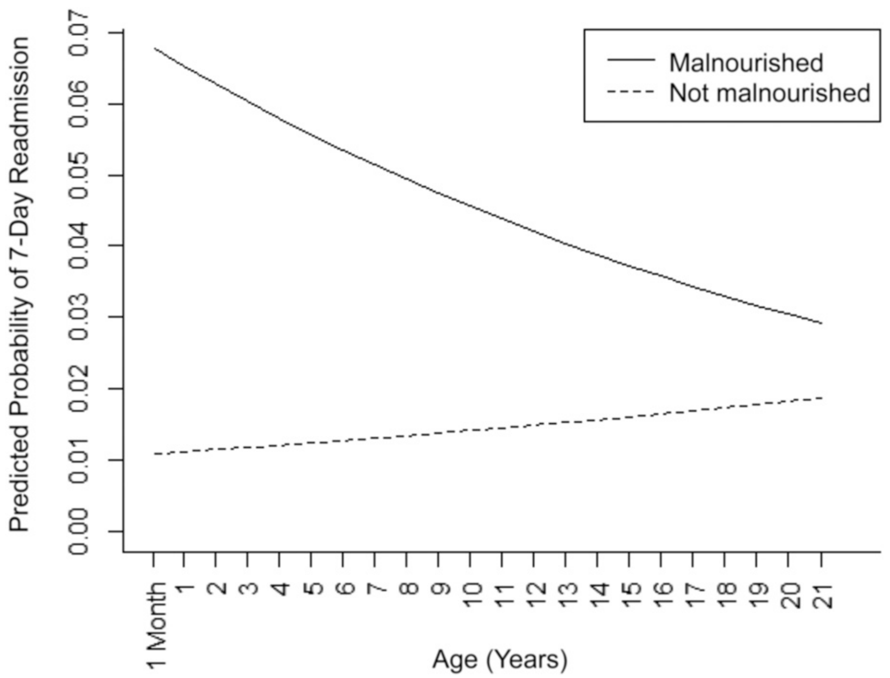

FIGURE 2 Predicted probability of readmission as a function of age by malnutrition status.

Why the odds of readmission among patients who were malnourished would be higher in younger patients was not part of our study and was somewhat unexpected. This may have to do with a period of rapid growth seen in patients <2 years old when malnutrition may be more detrimental.[5,7] The model also identified known risk factors

TABLE 5 Scenario-Specific OR and Corresponding 95% CI Exploring the Statistical Nature of the Interaction Between Malnutrition and Age on the Risk of Unplanned 7-Day Readmission

P1		P2		P1 Compared With P2
Age, y	Malnourished?	Age	Malnourished?	OR (95% C)
3	Yes	1 y	Yes	0.92 (0.85–0.99)
	Yes		No	5.62 (3.99–7.92)
	No		Yes	0.16 (0.10–0.23)
	No		No	1.05 (1.03–1.08)
12	Yes	1 y	Yes	0.63 (0.40–0.99)
	Yes		No	3.86 (2.68–5.58)
	No		Yes	0.12 (0.08–0.19)
	No		No	1.33 (1.16–1.53)
18	Yes	1 mo	Yes	0.47 (0.23–0.99)
	Yes		No	3.08 (1.78–5.33)
	No		Yes	0.10 (0.06–0.16)
	No		No	1.60 (1.28–2.00)
18	Yes	15 y	Yes	0.88 (0.78–0.99)
	Yes		No	2.09 (1.22–3.57)
	No		Yes	0.39 (0.25–0.60)
	No		No	1.08 (1.04–1.12)

P1, patient 1; P2, patient 2.

for readmission, such as LOS, acute and/or emergent admission, comorbidities, and ED visits, with effect sizes comparable to those found in other studies.[32]

The prevalence of malnutrition in 4.7% of the sample of patients in this study is lower than most reported estimates,[8–10] but such comparisons are difficult because of differences in how malnutrition may be assessed across different institutions. In our study, we used the recommendations of ASPEN, 2013 for the definition and diagnosis of malnutrition.[6] In earlier studies, Waterloo Criteria was used and obesity was included,[5] which we did not include in the present study.

Our findings of 3.9% of unexplained readmissions at <7 days and 10.5% at <30 days (in the sample of patients in this study) are comparable to other large studies in which multiple children's hospitals were involved.[13,15] Although malnutrition has rarely been studied previously in the context of pediatric readmissions, it has been researched in several adult studies.[3,4] In a 2011 retrospective study, Allaudeen et al[3] found that in a cohort of >6000 adult patients, weight loss was a statistically significant risk factor for readmission. Mudge et al,[4] also in 2011, in a prospective study of 142 patients who were hospitalized and >50 years of age with 2 or more hospitalizations in the past 6 months, found that being underweight was, again, a significant predictor of readmission. This association is not surprising in that malnutrition leads to abnormal immune function, increased infectious complications, delayed wound healing, muscle weakness, loss of lean body mass, and developmental delay, all of which are potential contributors to severity of illness.[6]

This study had several limitations, including the retrospective design involving a single children's hospital. This may limit the applicability to community hospitals that also care for children. Another limitation is the absence of data on possible readmissions of the patients in the study to other hospitals. Lastly, association, not causation, is indicated in our findings.

In our study, we clarify and indicate the presence of a complex joint effect of age and malnutrition status on the odds of readmission. One important clinical implication may be the identification of a subset of malnourished infants and children that can be targeted to reduce unplanned readmissions. Future researchers might incorporate multiple institutions and focus on a prospective observational or interventional study.

REFERENCES

1. Barker LA, Gout BS, Crowe TC. Hospital malnutrition: prevalence, identification and impact on patients and the healthcare system. *Int J Environ Res Public Health*. 2011;8(2):514–527
2. Tappenden KA, Quatrara B, Parkhurst ML, Malone AM, Fanjiang G, Ziegler TR. Critical role of nutrition in improving quality of care: an interdisciplinary call to action to address adult hospital malnutrition. *J Acad Nutr Diet*. 2013; 113(9):1219–1237
3. Allaudeen N, Vidyarthi A, Maselli J, Auerbach A. Redefining readmission risk factors for general medicine patients. *J Hosp Med*. 2011;6(2):54–60
4. Mudge AM, Ross LJ, Young AM, Isenring EA, Banks MD. Helping understand nutritional gaps in the elderly (HUNGER): a prospective study of patient factors associated with inadequate nutritional intake in older medical inpatients. *Clin Nutr*. 2011;30(3):320–325
5. Hendricks KM, Duggan C, Gallagher L, et al. Malnutrition in hospitalized pediatric patients. Current prevalence. *Arch Pediatr Adolesc Med*. 1995;149(10): 1118–1122
6. Mehta NM, Corkins MR, Lyman B, et al; American Society for Parenteral and Enteral Nutrition Board of Directors. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *JPEN J Parenter Enteral Nutr*. 2013;37(4):460–481
7. Shaughnessy EE, Kirkland LL. Malnutrition in hospitalized children: a responsibility and opportunity for pediatric hospitalists. *Hosp Pediatr*. 2016;6(1):37–41
8. Joosten KF, Hulst JM. Prevalence of malnutrition in pediatric hospital patients. *Curr Opin Pediatr*. 2008;20(5): 590–596
9. Joosten KF, Hulst JM. Malnutrition in pediatric hospital patients: current issues. *Nutrition*. 2011;27(2):133–137
10. Pileggi VN, Monteiro JP, Margutti AV, Camelo JS Jr. Prevalence of child malnutrition at a university hospital using the World Health Organization criteria and bioelectrical impedance data. *Braz J Med Biol Res*. 2016;49(3)
11. Hain PD, Gay JC, Berutti TW, Whitney GM, Wang W, Saville BR. Preventability of early readmissions at a children's hospital. *Pediatrics*. 2013;131(1). Available at: www.0070ediatrics.org/cgi/content/full/131/1/e171
12. Wallace SS, Keller SL, Falco CN, et al. An examination of physician-, caregiver-, and disease-related factors associated with readmission from a pediatric hospital medicine service. *Hosp Pediatr*. 2015;5(11):566–573
13. Auger KA, Teufel RJ II, Harris JM II, et al. Children's hospital characteristics and readmission metrics. *Pediatrics*. 2017; 139(2):e20161720
14. Toomey SL, Peltz A, Loren S, et al. Potentially preventable 30-day hospital readmissions at a children's hospital. *Pediatrics*. 2016;138(2):e20154182
15. Gay JC, Agrawal R, Auger KA, et al. Rates and impact of potentially preventable readmissions at children's hospitals. *J Pediatr*. 2015;166(3):613–619.e5
16. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360(14):1418–1428
17. Malone A, Hamilton C. The Academy of Nutrition and Dietetics/the American Society for Parenteral and Enteral Nutrition consensus malnutrition characteristics: application in practice. *Nutr Clin Pract*. 2013;28(6):639–650
18. House SA, Coon ER, Schroeder AR, Ralston SL. Categorization of national pediatric quality measures. *Pediatrics*. 2017;139(4):e20163269

19. Lyren A, Brilli R, Bird M, Lashutka N, Muething S. Ohio Children's Hospitals' solutions for patient safety: a framework for pediatric patient safety improvement. *J Healthc Qual*. 2016;38(4): 213–222

20. Children's Hospitals' Solutions for Patient Safety. Our goals. 2017. Available at: www.solutionsforpatientsafety.org/about-us/our-goals/. Accessed January 1, 2017

21. van Walraven C, Dhalla IA, Bell C, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *CMAJ*. 2010; 182(6):551–557

22. Au AG, McAlister FA, Bakal JA, Ezekowitz J, Kaul P, van Walraven C. Predicting the risk of unplanned readmission or death within 30 days of discharge after a heart failure hospitalization. *Am Heart J*. 2012; 164(3):365–372

23. Enders C. *Applied Missing Data Analysis*. New York, NY: Guilford Press; 2010

24. Azur MJ, Stuart EA, Frangakis C, Leaf PJ. Multiple imputation by chained equations: what is it and how does it work? *Int J Methods Psychiatr Res*. 2011; 20(1):40–49

25. James G, Witten D, Hastie T, Tibshirani R *An Introduction to Statistical Learning: with Applications in R*. 1st ed. New York, NY: Springer; 2013

26. Burnham KP, Anderson DR. Multimodel inference: understanding AIC and BIC in model selection. *Sociol Methods Res*. 2004;33(2):261–304

27. Neath AA, Cavanaugh JE. The Bayesian information criterion: background, derivation, and applications. *WIREs Comp Stat*. 2012;4(2):199–203

28. Cox C. Delta method. In: Armitage P, Colton T, eds. *Encyclopedia of Biostatistics*. Chichester, England: John Wiley & Sons; 1998:1125–1127

29. Oehlert GW. A note on the delta method. *Am Stat*. 1992;46(1):27–29

30. Jackson CH. Multi-state models for panel data: the {msm} package for {R}. *J Stat Softw*. 2011;38(8):1–28

31. *R: A Language and Environment for Statistical Computing* [computer program]. Version 3.4.0. Vienna, Austria: R Development Core Team; 2017

32. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review. *JAMA*. 2011;306(15):1688–1698

Hospital Pediatrics®
AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

The Effect of Malnutrition on the Risk of Unplanned 7-Day Readmission in Pediatrics

Louis Ehwerhemuepha, Donald Bendig, Caroline Steele, Cyril Rakovski and William Feaster

Hospital Pediatrics 2018;8;207
DOI: 10.1542/hpeds.2017-0195 originally published online March 6, 2018;