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Characteristics of Hospitalized Children With a Diagnosis of Malnutrition: United States, 2010

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Abstract

Introduction: Malnutrition is common in hospitalized patients in the United States. In 2010, 80,710 of 6,280,710 hospitalized children <17 years old had a coded diagnosis of malnutrition (CDM). This report summarizes nationally representative, person-level characteristics of hospitalized children with a CDM. *Methods:* Data are from the 2010 Healthcare Cost and Utilization Project, which contains patient-level data on hospital inpatient stays. When weighted appropriately, estimates from the project represent all U.S. hospitalizations. The data set contains up to 25 *ICD-9-CM* diagnostic codes for each patient. Children with a CDM listed during hospitalization were identified. *Results:* In 2010, 1.3% of hospitalized patients <17 years had a CDM. Since the data include only those with a CDM, malnutrition's true prevalence may be underrepresented. Length of stay among children with a CDM was almost 2.5 times longer than those without a CDM. Hospital costs for children with a CDM were >3 times higher than those without a CDM. Hospitalized children with a CDM were less likely to have routine discharge and almost 3.5 times more likely to require postdischarge home care. Children with a CDM were more likely to have multiple comorbidities. *Conclusions:* Hospitalized children with a CDM are associated with more comorbidities, longer hospital stay, and higher healthcare costs than those without this diagnosis. These undernourished children may utilize more healthcare resources in the hospital and community. Clinicians and policymakers should factor this into healthcare resource utilization planning. Recognizing and accurately coding malnutrition in hospitalized children may reveal the true prevalence of malnutrition. (*JPEN J Parenter Enteral Nutr*. 2016;40:623-635)

Keywords

malnutrition prevalence; healthcare cost; hospitalized children; nutrition assessment; outcomes

Clinical Relevancy Statement

There is ample validation in the literature that malnutrition is common among hospitalized children in the United States and that malnutrition negatively affects outcomes. What is not known is the prevalence of malnutrition through a large population-based, stratified data set. At >80,000 patients, this paper represents the largest sample size of pediatric patients with a coded diagnosis of malnutrition that has been studied to date. The paper documents the underreporting of pediatric malnutrition in healthcare facilities, illustrating the need for better identification, documentation, and coding of malnutrition. It also describes the increased utilization of resources required by a malnourished pediatric patient. So while this paper does not reflect the true prevalence of malnutrition in hospitalized children, it does accurately describe the population, length of stay, cost of treatment, and resource utilization.

Introduction

There is mounting scientific evidence that demonstrates the role of optimal nutrition in preventing childhood disease, managing outcomes, and improving quality of life.[1] The timely identification of pediatric malnutrition and its proactive management are essential for providing quality healthcare.[2] On

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May 30, 2014, the World Health Organization's member states endorsed 5 major global targets for improving maternal, infant, and young child nutrition, thus advocating for nutrition to be at the forefront of public health policies.[3] Among these 5 major global targets for 2025 were (1) aiming for a 40% reduction in the number of children <5 years of age who are stunted (ie, height for age z score ≤–2) and (2) reducing and maintaining childhood wasting (ie, weight for height z score ≤–2) to <5%. The World Health Organization member states declared their commitment to monitoring these targets as priority areas for action and catalyzing global change.

Adequate nutrition has an undeniable positive impact on growth and cognitive development. Malnourished infants and young children are at high risk for cognitive and developmental delays because deficiencies in calories, protein, and micronutrients (eg, iron) impair brain development at a vulnerable stage.[4-6] Given the significant impact that optimal nutrition has on clinical outcomes and overall survival, diagnosing and treating malnutrition in clinic settings has the potential to improve outcomes and control costs. Malnutrition is common in hospitalized patients in the United States[7]; nevertheless, an in-depth examination of the demographic and clinical characteristics of hospitalized patients in the pediatric age group has not been conducted.

While the prevalence of pediatric malnutrition has been reported as 6%–51%,[1] exact numbers and characteristics have been difficult to obtain due to the lack of a uniform definition. "Failure to thrive" (FTT) is a general term that is often used to describe a child who is not growing as expected. Since growth and nutrition are intricately connected, children with FTT often lack adequate nutrition to support growth. Various definitions of FTT have been proposed,[8-13] but none captures a meaningful assessment of a child's nutrition status, including the degree, duration, severity, or mechanism of malnutrition. The definitions for FTT do not address its negative impact and deleterious sequelae on function. Admittedly, the FTT diagnosis does include a small number of children with constitutional delay, genetic short stature, and catch-down growth.

In 2013, a new definition of pediatric malnutrition proposed by Mehta and colleagues provided an etiology-related definition for children and infants >1 month old. This definition incorporates not only growth but also anthropometric parameters, chronicity of malnutrition, etiology, and mechanisms of nutrient imbalance, as well as developmental and functional outcomes.[1] Mehta et al defined pediatric malnutrition (undernutrition) as an imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein, or micronutrients that may negatively affect growth, development, and other relevant outcomes. This new definition was endorsed by the Academy of Nutrition and Dietetics, the American Society for Parenteral and Enteral Nutrition, and the American Academy of Pediatrics. The advent of this definition has launched a new era of uniformly diagnosing pediatric malnutrition.

Malnutrition is common in hospitalized children in the United States, and it is associated with unfavorable outcomes, including higher medical and surgical complications, higher rates of infection, poor wound healing, longer lengths of stay, and increased costs.[1,2] We examined data from the 2010 Healthcare Cost and Utilization Project (HCUP) databases[14] to compare hospitalized children in the United States with a coded diagnosis of malnutrition (CDM) with children without a CDM in 2010.

Methods

Data in this report are from the HCUP, a family of databases sponsored by the Agency for Healthcare Research and Quality. HCUP databases include the National Inpatient Sample (NIS), which contains patient-level data on hospital inpatient stays. Several studies have been conducted with these data to examine the nutrition status in populations with gastrointestinal diseases.[15-17] The 2010 NIS contains deidentified discharge data from 1051 hospitals in 45 states, approximating a 20% stratified sample of U.S. hospitals. When weighted appropriately, estimates from HCUP represent all U.S. pediatric hospitalizations. The 2010 NIS contains up to 25 *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis codes for each patient. Using these codes, we identified pediatric patients who were diagnosed with malnutrition during their hospital stay. This current analysis aims to capture undernutrition and therefore excluded obesity as an indicator of malnutrition. Individual nutrient deficiency diagnostic codes were also excluded. However, obese individuals were coded as malnourished if their records contained another qualifying diagnosis of malnutrition. Table 1 shows the *ICD-9-CM* codes that were used to construct the dichotomous malnutrition variable in this report; with the conversion to *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*) in 2015, we also include the equivalent *ICD-10-CM* codes. Because we wanted to capture the characteristics of children who matched the new definition of pediatric malnutrition (>1 month old), we excluded *ICD-9-CM* codes that were associated with fetal malnutrition (764.12–764.99) and the *ICD-9-CM* code for FTT in newborn (779.34).

Patients with a CDM were contrasted to those without this diagnosis across a number of demographic and clinical factors, as well as factors associated with the hospitals where they were treated. In addition to basic demographic information such as age and race, additional variables were examined describing income (estimated from the median household income quartiles for the patient's zip code), the rural/urban status of patient's residence, as well as the expected source of payment. Rural/urban status is defined by rural urban commuting areas, which are assigned by zip codes based on population and commuting information from the U.S. Census.[18] Hospital

Table 1. *ICD-9-CM* and Equivalent *ICD-10-CM* Malnutrition Diagnosis Codes Used to Identify Malnutrition in Children 1 Month to 17 Years Old.

ICD-9-CM Code	Equivalent *ICD-10-CM*
260 Kwashiorkor	E40
261 Nutritional marasmus	E41 or E43
262 Other severe protein-calorie malnutrition	E43
263.0 Malnutrition of moderate degree	E44.0
263.1 Malnutrition of mild degree	E44.1
263.2 Arrested development following protein-calorie malnutrition	E45
263.8 Other protein-calorie malnutrition	E46
263.9 Unspecified protein-calorie malnutrition	E46
579.3 Other and unspecified postsurgical non-absorption	K91.2
995.52 Child neglect (nutritional)	T74.02XA or T76.02XA
783.41 Failure to thrive	R62.51
783.21–783.22 Abnormal weight loss or underweight	R63.4–R63.6

ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*; *ICD-10-CM*, *International Classification of Diseases, Tenth Revision, Clinical Modification.*

characteristics were also examined according to presence or absence of a CDM. These variables included the size of the hospital, ownership, rural/urban status, the region of the country in which the hospital was located, and whether it was a teaching hospital or part of a multihospital system. In addition, the most common principal diagnoses among children with and without a CDM were examined, as well as the prevalence of major operating room procedures that occurred during the hospital stay. Administrative variables, such as length of stay (LOS), cost, and the circumstances of both admission and discharge, were examined in relation to presence or absence of a CDM. Costs were calculated through the charges provided in the HCUP data and converted to costs via hospital-specific cost:charge ratios.

To understand the burden of comorbidity among people with and without a CDM, a series of 29 conditions was examined in relation to the dichotomous malnutrition variable. These 29 conditions were based on the presence of secondary diagnoses through HCUP's Comorbidity Software (version 3.7).[19] Finally, the frequency of receipt of enteral nutrition (EN) and parenteral nutrition (PN) and therapies was examined. Procedure codes 96.6 and 99.15 were used to identify patients who received EN and PN, respectively, and these variables were cross-tabulated with the CDM variable. Several variables were created for these analyses: 2 variables indicating patients who received either therapy and a variable indicating patients who had received both therapies during their hospital stay.

Comparisons were conducted through SAS survey statistical procedures (SAS Institute Inc, Cary, NC). These analyses accounted for the clustered design (multiple patients from the same hospital) that characterizes the NIS. Additional information on HCUP and the NIS are available.[14] For this report, reliability was assessed with guidelines from the National Center for Health Statistics and Centers for Disease Control and Prevention's Third National Health and Nutrition Examination Survey of 1996 (NHANES III).[20] Estimates that do not meet reliability criteria are denoted and should be interpreted with caution. An estimate and its standard error were deemed to be reliable if they met the following 2 criteria: for means and proportions based on commonly occurring events (where $.25 < P < .75$), the relative standard error (standard error/estimate) must be ≤30%; for proportions based on uncommon or very common events ($P \leq .25$ or $P \geq .75$), the denominator (n) must be sufficiently large such that the minimum of nP and $n(1 – P)$ is ≥8 times the design effect.

These data were de-identified and utilized in accordance with a data use agreement with the Agency for Healthcare Research and Quality. The project was given an exempt determination upon review by the Institution Review Board of the lead author's institution, as it does not involve human subjects.

Results

Time Trends in Malnutrition Diagnosis Codes

HCUP data for the 18-year period between 1993–2010 offer a context for the current analyses. The upward trend in the malnutrition diagnosis codes over these years includes both adult and pediatric patients (Figure 1).

Patient Demographics

In the United States in 2010, approximately 80,710 hospitalized patients ≤17 years of age had a malnutrition diagnosis. This corresponds to a prevalence of 1.3% among those ≤17 years of age (Table 2). The distribution of patients' ages differed significantly between those with a CDM and their counterparts without this diagnosis ($P < .0001$). The distribution of the expected primary payer differed between patients with and without a CDM ($P < .001$), with Medicaid being the primary payer among those with a CDM. The distribution of race/ethnicity was not significantly different between discharges with and without a CDM ($P = .231$). Non-Hispanic whites were predominant in both patient groups. Approximately half the patients in both groups were female ($P < .001$). The distribution of income quartile categories did not differ significantly between discharges with and without a CDM. The 2 groups also did not differ with regard to their residence in urban or rural areas.

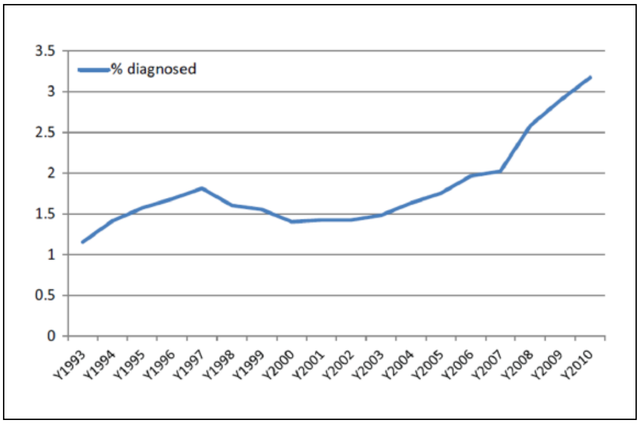

Figure 1. Percentage of U.S. hospital discharges with malnutrition diagnoses, by year. Reprinted with permission from Corkins MR, Guenter P, DiMaria-Ghalili R, et al. Malnutrition diagnoses in hospitalized patients: United States, 2010. *JPEN J Parenter Enteral Nutr.* 2014;38(2):186-195.

Hospital Characteristics

The prevalence of patients with a CDM differed significantly across categories of hospital ownership (P = .046), with malnourished patients being seen in clinical encounters more often at private, nonprofit hospitals. Patients with a CDM were also more likely to be discharged from teaching hospitals (75.8% vs 55.5%, P < .001). Malnutrition diagnoses also differed significantly by whether that location was categorized as rural, with fewer diagnoses occurring at rural hospitals (5.2% vs 10.2%, P < .001). However, the distribution of malnutrition diagnoses did not differ by the categories of bed size, region, or whether patients were discharged from a facility that was part of a multihospital system (Table 3).

Admission and Discharge Characteristics

Patients with a CDM had a significantly longer mean LOS (Figure 2) and higher total mean costs ($55,255 vs $17,309, P < .001; Table 4). The distribution of circumstances of admission also differed significantly by whether patients had a CDM or not (P < .001). For example, while nearly 65% of patients with a CDM were admitted to the hospital emergently or urgently, only 29.5% of those without a CDM were admitted under the same circumstances. Overall, patients with a CDM underwent fewer major operations during their hospitalizations (19.5% vs 25.7%, P < .0001). Not surprising, the distribution of discharge disposition categories differed significantly according to whether patients had a CDM. Eighty-three percent of patients with a CDM had a routine discharge, compared with 94.2% of routine discharges among patients without a CDM. Furthermore, discharge with home care was 3.5 times more common among malnourished patients (10.9% vs 3.1%, P < .001).

Comorbid Conditions and Principal Diagnosis at Discharge

Of the 29 comorbid conditions shown in Table 5, 27 occurred significantly more frequently among patients with a CDM. Chief among these were weight loss (24.4% vs 0.0%, P < .0001) and fluid and electrolyte disorders (18.9% vs 4.6%, P < .001). The top 3 most common diagnoses among hospitalized patients with a CDM were different from those patients without a CDM. The principal diagnoses among hospitalized patients with a CDM included FTT, live-born with cesarean, and live-born without cesarean (Table 6).

Parenteral and Enteral Therapy

Among patients with a CDM, 14.8% received either PN or EN during their hospital stay, and 1.2% received both (Table 7). Slightly >8% of these patients received PN, while a marginally smaller proportion received EN (7.6%). While PN and EN therapy was administered primarily to those patients with a CDM, it is notable that 2.6% of patients without this diagnosis also received either one of these therapies.

Discussion

In January 2014, Corkins et al[7] published the first nationally representative profile of hospitalized patients with malnutrition diagnoses. Their sample of 1,248,680 hospital discharges with a malnutrition diagnosis represented 3.2% of the total number of hospital discharges in 2010 and included both adults and children. This report presents details on a pediatric cohort using the HCUP NIS database.

The timing of our pediatric study follows the publication of the new etiology-related definition of pediatric malnutrition described by Mehta et al and endorsed by the Academy of Nutrition and Dietetics, the American Society for Parenteral and Enteral Nutrition, and the American Academy of Pediatrics.[1,2] Since the new definition does not address malnutrition in neonates, our study attempted to omit infants <1 month old from our data set by excluding the fetal malnutrition *ICD-9-CM* diagnostic codes (764.12–764.99) and the *ICD-9-CM* code for FTT in newborn (779.34). Based on these exclusions, it is reasonable to assume that our sample primarily includes children who were 1 month to 17 years of age, which matches the same age demographic used in other pediatric studies on malnutrition.[1,21,22] Indeed, on average the children in our study who had a discharge diagnosis of malnutrition were older than their counterparts without a CDM (3.8 vs 2.6 years, P < .0001). Moreover, the percentage of children who were <1 year old was significantly less in the group with a CDM than those without a CDM (48% vs 72%, P < .0001). Finally, the percentage of children with a CDM who were admitted as newborns was substantially less than the percentage of children without a CDM (13.7% vs 62.4%, P < .001). All of these

Table 2. Demographic Characteristics of Discharged Patients ≤17 Years of Age With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

	Malnutrition Diagnosis			No Malnutrition Diagnosis			
Characteristic	Estimate	95% CI		Estimate	95% CI		*P* Value
Total							
Weighted n	80,710			6,200,000			
Percent	1.3			98.7			
Mean age, y	3.8	3.3	4.2	2.6	2.3	2.8	<.0001
Age, %							<.0001[b]
<1 y	47.5	42.5	52.5	72.4	69.3	75.4	
1–17 y	52.5	47.5	57.5	27.6	24.6	30.7	
Race, %							.231
White	53.1	47.2	59.0	51	47.9	54.0	
Black	16.6	13.7	19.6	16.4	14.6	18.2	
Hispanic	19.3	15.0	23.5	22	19.4	24.6	
Asian/Pacific Islander	4	2.2	5.9	4.4	3.0	5.8	
Native American	0.7	0.4	1.2	0.9	0.6	1.3	
Other	6.2	4.2	8.2	5.3	4.2	6.4	
Female, %	48.1	47.1	49.1	48.7	48.4	49.0	<.001
Income quartile, %							.971
Quartile 1	28.6	24.8	32.5	29.1	26.4	31.9	
Quartile 2	24.9	22.2	27.6	24.6	23.0	26.3	
Quartile 3	24.2	21.9	26.5	24.5	22.9	26.0	
Quartile 4	22.2	16.8	27.8	21.8	18.5	25.0	
Location, %							.691
Central metropolitan, ≥1 million	32.7	24.7	4.7	30.3	25.7	35.0	
Fringe metropolitan	20.5	14.2	26.8	23.4	19.2	27.6	
Metropolitan, 250K–1 million	21.9	15.8	28.1	21.5	17.2	25.9	
Metropolitan, 50K–250K	8.8	6.3	11.3	8.8	6.6	11.0	
Micropolitan	10.4	8.3	12.6	9.9	8.8	11.0	
Rural	5.7	4.4	6.9	6	5.3	6.8	
Expected primary payer, %							<.001
Medicare	0.3	0.2	0.5	0.2	0.1	0.3	
Medicaid	55	52.2	57.8	48.5	46.3	50.6	
Private, including HMO	37.7	35.0	4.4	44.2	41.8	46.6	
Self-pay	2.3	1.6	3.0	3.7	3.0	4.4	
No charge	0.3	0.0	0.7	0.2	0.0	0.5	
Other	4.3	2.5	6.0	3.1	2.6	3.6	

HMO, health maintenance organization.
[a]Data from 2010 Healthcare Cost and Utilization Project.[14,18,19,49]
[b]Logistic regression.

findings suggest that children with a CDM were older and less likely to have been newborns.

Our analysis found that 1.3% (n = 80,710) of the 6,274,857 pediatric patients who were discharged from U.S. hospitals in 2010 had a CDM. Previous studies that focused on malnutrition have reported a prevalence of 6%–51% in hospitalized children.[22-27] It is well known that a gap exists between diagnosing malnutrition in hospitalized patients and actually coding for it.[28] To our knowledge, there is little published data describing the extent of this gap, particularly in children. However, one pediatric hospital recently showed that only 3% of pediatric hospitalized patients who were diagnosed with a CDM by a registered dietitian in late 2013 actually had the medical diagnosis documented in the patient's chart.[29] With further education and with work by clinical documentation specialists to put communication protocols in place, this number increased to 39% one year later and 71% the following year.[30] Additional interdisciplinary strategies are needed to achieve the goal of documenting and coding the malnutrition diagnosis every time it is diagnosed. Because the data in our study were from 2010 and used coded malnutrition diagnoses to ascertain the prevalence of malnutrition, we suspect that 1.3% grossly underrepresents the true number of children with malnutrition.

Even though 1.3% is a modest number, it represents 80,710 children with a malnutrition-related diagnosis. Of these

Table 3. Hospital Characteristics of Discharged Patients ≤17 Years of Age With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

	Malnutrition Diagnosis			No Malnutrition Diagnosis			
Characteristic	Estimate	95% CI		Estimate	95% CI		*P* Value
Bed size, %							NS
Small	5.9	1.7	10.0	8.9	7.2	10.6	
Medium	29.3	28.7	40.0	26.9	23.6	30.1	
Large	64.8	53.7	76.9	64.2	60.8	67.8	
Ownership, %							.046
Government/nonfederal	14.7	6.6	22.9	13.4	9.7	17.2	
Private, nonprofit	79.7	70.4	89.0	74.6	70.1	79.2	
Private	5.5	0.8	10.3	11.9	9.1	14.7	
Rural location, %	5.2	3.1	7.2	10.2	9.0	11.4	<.001
Region, %							NS
Northeast	11.6	31.7	55.0	16	13.6	18.3	
Midwest	18.9	16.0	36.1	20.4	17.7	23.0	
South	43.3	33.0	51.3	38.8	35.1	42.5	
West	26.1	14.5	28.7	24.9	21.8	28.0	
Teaching, %	75.8	70.3	81.3	55.5	51.9	59.0	<.001
MHS member, %	53.5	38.3	68.8	63.3	56.7	69.8	NS

MHS, multihospital system; NS, nonsignificant.
[a]Data from 2010 Healthcare Cost and Utilization Project.[14]

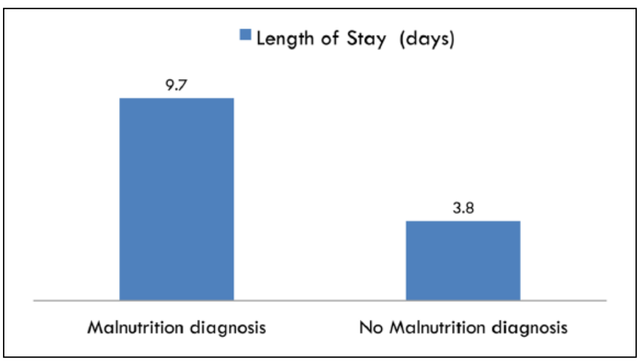

Figure 2. Hospital length of stay between those with a coded diagnosis of malnutrition vs those without.

children, 15,981 had one of the malnutrition-specific codes (*ICD-9-CM* 260–263.9). To our knowledge, this represents the largest sample size of pediatric patients with a CDM that has been studied.

Trends from 1993 through 2010 demonstrate that the percentage of hospital discharges with the diagnosis of malnutrition has tripled over 17 years, with the largest spike occurring from 2007–2010 (Figure 1). It is possible that improved awareness on the part of clinicians regarding the identification of malnutrition plays a role in this increase, as evidenced by a major revision in the *ICD-9-CM* codes effective on October 1, 2007, which upgraded mild and moderate malnutrition to the level of a "CC" (complication and comorbidity) from a "non-CC." It is noteworthy that *all* malnutrition-specific diagnostic codes, including arrested development following protein-calorie malnutrition (*ICD-9-CM* 263.2), are now designated as either an "MCC" (major complication and comorbidity; *ICD-9-CM* codes 260–262) or a "CC" (*ICD-9-CM* codes 263.0–263.9). When a MCC or CC condition is present, the level of reimbursement increases. MCC and CC conditions also increase the risk of mortality score and the severity of illness score, which can also affect reimbursement (Figure 3). To accurately reflect the patient population mix of any given hospital, it is imperative to use precise, appropriate clinical documentation.[28]

FTT is a term used to describe children who are not growing as expected.[31] Under the new etiology-related definition of pediatric malnutrition, faltering growth and growth failure are often the first signs of illness-related and nonillness-related malnutrition. Indeed, as compared with adults, growth failure is a unique feature of malnutrition in children. Consequently, under the new definition, it is difficult to conceive of a scenario where a child who has growth failure severe enough to be diagnosed with FTT does not have some form of illness or nonillness-related malnutrition. Historically, FTT had been defined as weight for age less than the 5th percentile or a weight deceleration that crosses 2 major percentiles on a growth chart.[11,31] According to the new criteria to define malnutrition, the anthropometrics that were often referenced with FTT would indicate some degree of malnutrition; therefore, patients with a diagnosis of FTT (*ICD-9-CM* code 783.41) were included in our analysis. Since our data were gathered from a large data set of discharge diagnoses, we cannot exclude the possibility that a small number of the FTT patients had short stature due to teratologic conditions, genetic syndromes, or endocrine conditions.[12] However, we suspect that,

Table 4. Admission and Discharge Characteristics of Discharged Patients Aged ≤17 Years With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

	Malnutrition Diagnosis			No Malnutrition Diagnosis			
Characteristic	Estimate	95% CI		Estimate	95% CI		*P* Value
Mean length of stay, d	9.7	8.4	10.9	3.8	3.7	4.0	<.001
Mean total costs, $	55,255	45,517	64,993	17,309	15,259	19,359	<.001
Admission type, %							<.001
Emergency	32.7	27.3	38.1	18.3	15.4	21.3	
Urgent	31.9	26.7	37.0	11.2	9.4	13.1	
Elective	21.3	17.3	25.4	7.6	6.5	8.7	
Newborn	13.7	6.7	20.6	62.4	57.9	66.9	
Trauma center	0.4	0.2	0.7	0.5	0.3	0.7	
Other	0[b]	0.0	0.0	0.0[b]	0.0	0.0	
Major operating room procedure, %	19.5	17.9	21.0	25.7	24.7	26.7	<.0001
Discharge disposition, %							<.001
Routine	83.2	78.8	87.6	94.2	93.4	95.0	
Transfer to short-term hospital	3.2	2.5	3.9	1.7	1.5	1.8	
Other transfers	1.9	1.3	2.5	0.5	0.4	0.6	
Home health care	10.9	6.4	15.4	3.1	2.4	3.9	
Against medical advice	0.09	0.0	0.1	0.08	0.1	0.1	
Died	0	0.0	0.02	0.4	0.4	0.4	
Discharged alive, destination unknown	0	0.0	0.02	0.01	0.0	0.0	

[a]Data from 2010 Healthcare Cost and Utilization Project.[14]
[b]Estimates failed reliability test.

if present, this would represent too small a number to affect the validity of the statistical analysis.

Of the malnutrition diagnostic codes selected in our study, FTT (48%) was the top *ICD-9-CM* code for children carrying a CDM, followed by "abnormal weight loss or underweight" (32%) and "unspecified protein-calorie malnutrition" (14%; Table 8). Of the malnutrition codes used in our study, 20% of the discharges had a malnutrition-specific code from the *ICD-9-CM* 260–263.9 categories. This is likely because in 2010, there was very little agreement as to how to define pediatric malnutrition. The 2013 publication of the new definition is changing the landscape of pediatric malnutrition diagnostics. Whereas in 2010, illness-related malnutrition was still sometimes being diagnosed with the terms "kwashiorkor" and "marasmus" (2.3% of our study's diagnostic codes), the shift toward an etiology-related definition of pediatric malnutrition is causing these terms to fall out of favor in developed countries.

Under the new definition, clinicians are able to define pediatric malnutrition by its level of severity (ie, severe, moderate, and mild malnutrition). In 2010, without a uniform definition, the majority of malnutrition-specific cases were coded with *ICD-9-CM* code 263.9, "unspecified protein-calorie malnutrition." Only 615 children (0.8%) were coded with "other severe protein-calorie malnutrition" (*ICD-9-CM* code 262), which is an MCC. Moderate and mild malnutrition (*ICD-9-CM* codes 263 and 263.1) were coded in 1633 children (2%), whereas only 31 children (0.04%) were diagnosed with arrested development following protein-calorie malnutrition (*ICD-9-CM* 263.9). Using the malnutrition-specific codes, classifying the degree of severity, and diagnosing arrested development following protein-calorie malnutrition present a major opportunity for the pediatric medical community.[29]

For many years, a definition for FTT remained as elusive as a definition of pediatric malnutrition.[9,13,31,32] With the publication and endorsement of the new etiology-related definition of pediatric malnutrition, which includes both illness and nonillness-related malnutrition, it is more accurate to code for severe, moderate, and mild malnutrition if the child meets malnutrition diagnostic criteria, even if the child is also coded for FTT. Since FTT is not designated as an MCC or CC, diagnosing the severity of pediatric malnutrition based on uniform cutoffs will allow for the appropriate allocation of resources resulting in the correct level of reimbursement.[3,28] When pediatric malnutrition is appropriately diagnosed, coding for malnutrition instead of FTT has a strong influence on the level of reimbursement, as illustrated in Figure 4. By using the malnutrition-specific codes instead of FTT or along with FTT, research studies and providers will be able to ascertain which interventions result in improvement in the severity of malnutrition. As new research outcomes become available, cutoffs for defining the degree of malnutrition will become even more clear.[3]

Our data show that the LOS was 2.5 times longer in children with a CDM than children without a CDM. The average LOS for hospitalized U.S. children is 3.8 days,[33] which is identical to our data in the children without malnutrition. Our finding of increased LOS in children with a CDM is consistent with other studies that have shown a correlation between malnutrition and LOS.[22,34,35] A recent large prospective multicenter

Table 5. Comorbid Conditions of Discharged Patients Aged ≤17 Years With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

	Malnutrition Diagnosis, %			No Malnutrition Diagnosis, %			
Comorbid Condition	Estimate	95% CI		Estimate	95% CI		*P* Value
Weight loss	24.4	19.2	29.6	0	0.0	0.0	<.0001[b]
Fluid and electrolyte disorder	18.9	16.9	20.9	4.6	4.1	5.1	<.001
Deficiency anemia	9.8	8.4	11.3	1.3	1.1	1.5	<.001
Peripheral vascular disease	8.2	7.7	8.6	5	4.8	5.2	<.001
Other neurologic disorders	7.3	6.3	8.4	1.3	1.0	1.5	<.001
Chronic pulmonary disease	6.6	5.7	7.6	3.1	2.8	3.4	<.001
Paralysis	5.2	4.4	5.9	0.8	0.6	0.9	<.001
Coagulopathy	3.9	3.0	4.8	0.6	0.5	0.7	<.001
Hypertension	2.7	2.1	3.2	0.6	0.5	0.8	<.001
Depression	2	1.5	2.4	0.5	0.5	0.6	<.0001
Liver disease	1.6	1.1	2.1	0.1	0.1	0.2	<.001
Hypothyroidism	1.6	1.4	1.9	0.3	0.0	0.4	<.001
Diabetes without chronic complications	1	0.6	1.4	0.2	0.2	0.3	<.001
Pulmonary circulation disease	1	0.7	1.2	0.1	0.1	0.2	<.0001
Renal failure	1	0.7	1.4	0.2	0.1	0.2	<.0001
Psychosis	0.8	0.6	1.0	0.5	0.4	0.6	.005
Solid tumor without metastasis	0.8	0.5	1.1	0.2	0.1	0.3	<.0001
Congestive heart failure	0.8	0.6	1.0	0.1	0.1	0.1	<.001
Valvular disease	0.7	0.6	0.9	0.2	0.2	0.2	<.0001
Drug abuse	0.7	0.5	1.0	0.7	0.5	0.8	NA
Chronic blood loss anemia	0.6	0.4	0.7	0.3	0.3	0.4	.022
Metastatic cancer	0.5	0.2	0.8	0.1	0.1	0.2	.004
Acquired immune deficiency syndrome	0.5[c]	0.4	0.6	0.3	0.2	0.3	<.001
Obesity	0.3	0.2	0.4	0.7	0.6	0.8	<.0001
Lymphoma	0.2	0.1	0.3	0.1	0.0	0.1	.009
Rheumatoid arthritis	0.2	0.1	0.3	0.1	0.1	0.1	.001
Alcohol abuse	0.1[c]	0.0	0.2	0.2	0.2	0.3	<.001
Diabetes with chronic complications	0.1[c]	0.0	0.2	0	0.0	0.0	.049
Peptic ulcer disease	0[c]	0.0	0.0	0.0	0.0	0.0	NA

NA, *P* value cannot be calculated.
[a]Data from 2010 Healthcare Cost and Utilization Project.[14]
[b]Logistic regression with ridging = absolute.
[c]Estimates failed reliability test.

study (n = 2567) obtained anthropometric measures within 24 hours of hospital admission and found that pediatric patients between the ages of 1 month and 18 years with moderate malnutrition (body mass index [BMI] <–2 SD) had an LOS 1.3 days longer than patients without a CDM ($P = .04$) and patients with severe malnutrition (BMI <–3 SD) had an LOS 1.6 days longer than those without a CDM ($P < .001$).[35] Other studies have demonstrated that children at high nutrition risk have increased lengths of stay as compared with children who are better nourished. A prospective study from the Netherlands that tested the STRONGkids nutrition screening tool showed that children with a moderate or high malnutrition risk score had a significantly greater LOS than those with a lower risk score ($P < .001$).[34]

Hospital costs account for the largest share of healthcare spending in the United States.[36] Patients with malnutrition are at higher risk for postsurgical complications, increased morbidity, and increased LOS.[22,35,37,38] In 2010, the average cost of a hospitalization was $4500 for those <1 year of age and $8200 for those 1–17 year olds.[39] Our data show that hospital costs for children with a CDM were 3.2 times higher than those without a CDM. Hospital costs are closely linked to LOS, partially explaining the increased cost in our study. Previous studies demonstrated increased complications, LOS, and costs in children with malnutrition. Secker and Jeejeebhoy found that 51% of pediatric patients undergoing major surgery were malnourished and had significantly higher rates of postsurgical infectious complications ($P \le .04$) and longer LOS ($P \le .002$) when compared with well-nourished children. They noted that the average cost of 1 day in a postsurgical ward was $587 and the increased LOS in the malnourished children led to an increase of costs to $1702, or 2.8 times higher than those without malnutrition.[22] Many adult studies have also demonstrated increased costs in patients with malnutrition.[7,40-43]

Table 6. Principal Diagnoses Among Discharged Patients Aged ≤17 Years With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

Rank Order	Malnutrition Diagnosis	No Malnutrition Diagnosis
1	783.41 Failure to thrive	V30.01 Single live born, born in hospital, delivered by cesarean section
2	V30.01 Single live born, born in hospital, delivered by cesarean section	V30.00 Single live birth
3	V30.00 Single live birth	486 Pneumonia
4	530.81 GERD	V31.01 Twin birth, mate live born, born in hospital, delivered by cesarean section
5	999.31 Other and unspecified infection due to central venous catheter	466.11 Acute bronchiolitis due to respiratory syncytial virus (RSV)
6	276.51 Dehydration	493.92 Asthma, unspecified type, with (acute) exacerbation
7	486 Pneumonia	540.9 Acute appendicitis with mention of peritonitis
8	277.02 Cystic fibrosis with pulmonary manifestations	466.19 Acute bronchiolitis due to other infectious organisms
9	V58.11 Encounter for antineoplastic chemotherapy	276.51 Dehydration
10	774.6 Unspecified fetal and neonatal jaundice	V58.11 Encounter for anti-neoplastic chemotherapy

GERD, gastroesophageal reflux disease.
[a]Data from 2010 Healthcare Cost and Utilization Project.[14]

Table 7. Receipt of Parenteral and Enteral Nutrition Among Discharged Patients Age ≤17 Years With and Without a Coded Diagnosis of Malnutrition: United States, 2010.[a]

	Malnutrition Diagnosis, %			No Malnutrition Diagnosis, %			
Characteristic	Estimate	95% CI		Estimate	95% CI		*P* Value
Received enteral nutrition	7.6	2.4	12.8	0.7	0.4	1.1	.009
Received parenteral nutrition	8.4	6.1	10.6	2.1	1.8	2.4	<.0001[b]
Received either enteral or parenteral	14.8	9.2	20.4	2.6	2.1	3.0	<.0001[b]
Received both enteral or parenteral	1.2	0.01	2.4	0.2	0.1	0.3	.1

[a]Data from 2010 Healthcare Cost and Utilization Project.[14]
[b]Statistically significant.

Children with malnutrition require more resources. In fact, when the principal diagnoses were ranked in our data set, FTT was the most common reason for admission in the malnutrition diagnosis group, reaffirming the burden of malnutrition on healthcare costs. Even though the *ICD-9-CM* codes for fetal malnutrition and FTT in a newborn were excluded, cesarean newborn births and live newborn births were the second-highest and third-highest principal diagnoses in those with a CDM. This finding reflects that a large number of children are born in the hospital and may also suggest that malnutrition can be found in neonates for whom we currently lack uniform malnutrition criteria. These findings support the need to develop a standardized definition for infants <1 month old, similar to the recent pediatric malnutrition definition for 1-month-olds to 17-year-olds.[1] Infection related to central venous catheter was among the top 5 reasons for hospital admissions in patients with a CDM, illustrating the necessity to continue research related to the prevention of catheter-related bloodstream infections in pediatric patients.

There is a growing trend to provide healthcare services for children at home in an effort to decrease the cost of hospitalizations. It is projected that $134.3 billion will be spent on home healthcare by 2020.[44] Our data show that hospitalized children with a CDM were less likely to have a routine discharge and 3.5 times more likely to require home care. Chima et al found that adult patients who were not at risk for malnutrition were more likely to be discharged home without additional health services when compared with patients at risk for malnutrition (66% vs 41%, $P \leq .05$). Malnourished patients were more likely to use home health services than patients without malnutrition (31% vs 12%, $P < .001$).[45] Since malnutrition is often associated with comorbidities, preventing and treating malnutrition may reduce healthcare costs by decreasing the number of malnourished children requiring home health services. Further research can also determine if the complexity and cost of home health services are less for children who are well nourished.

In 2010 there were >25.5 million emergency department (ED) visits for children <18 years old, with 96% of those children being treated and released from the ED. In our data set, almost 33% of the malnourished children were admitted through the emergency room. The children with a CDM were

Principal Diagnosis: Idiopathic Spinal Stenosis 2nd Diagnosis: None	Principal Diagnosis (Procedure): Idiopathic Spinal Stenosis with Fusion 2nd Diagnosis: None	Principal Diagnosis (Procedure): Idiopathic Spinal Stenosis with Fusion 2nd Diagnosis: Mild Protein-Calorie Malnutrition (E44.1)	Principal Diagnosis (Procedure): Idiopathic Spinal Stenosis with Fusion 2nd Diagnosis: Severe Protein-Calorie Malnutrition (E43)
DRG 347 Back & Neck Dis, Fracture & Injury GLOS 2.28	DRG 303 Dorsal / Lumbar Fusion for Curved Back GLOS 4.08	DRG 303 Dorsal / Lumbar Fusion for Curved Back GLOS 5.02	DRG 303 Dorsal / Lumbar Fusion for Curved Back GLOS 7.25
Relative Weight 0.5427 Reimbursement $5427	Relative Weight 4.4766 Reimbursement $44,766	Relative Weight 5.3576 Reimbursement $53,576	Relative Weight 7.6399 Reimbursement $76,399
SOI 1 ROM 1	SOI 1 ROM 1	SOI 2 ROM 1	SOI 3 ROM 2

Figure 3. Impact of malnutrition diagnosis on risk of mortality (ROM) and severity of illness (SOI) scores and reimbursement. Sample base rate = $10,000. Higher SOI and ROM scores reflect greater severity and higher risk. For more information on malnutrition coding, see Giannopoulos et al.[28] Source: University Hospitals Case Medical Center, Erica Remer, MD. DRG, diagnosis-related group; GLOS, geometric mean length of stay.

Table 8. Pediatric Malnutrition Cases and Discharge Diagnosis *ICD-9-CM* Codes.

ICD-9-CM Code at Discharge	Weighted Cases n	Weighted Cases %[a]
260.0 Kwashiorkor	161	0.2
261.0 Nutritional marasmus	1673	2.1
262.0 Other severe protein-calorie malnutrition	615	0.8
263.0 Malnutrition of moderate degree	1018	1.3
263.1 Malnutrition of mild degree	536	0.7
263.2 Arrested development following protein-calorie malnutrition	31	0.04
263.8 Other protein-calorie malnutrition	499	0.6
263.9 Unspecified protein-calorie malnutrition	11,448	14.2
579.3 Other and unspecified postsurgical nonabsorption	7134	8.8
995.52 Child neglect (nutritional)	1038	1.3
783.41 Failure to thrive	38,581	47.8
783.21–783.22 Abnormal weight loss or underweight[b]	26,176	32.4

ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification.*
[a]Percentages will not add up to 100 since patients with a malnutrition diagnosis code could have >1 code.
[b]This does not include "light for date of growth-restricted infants."

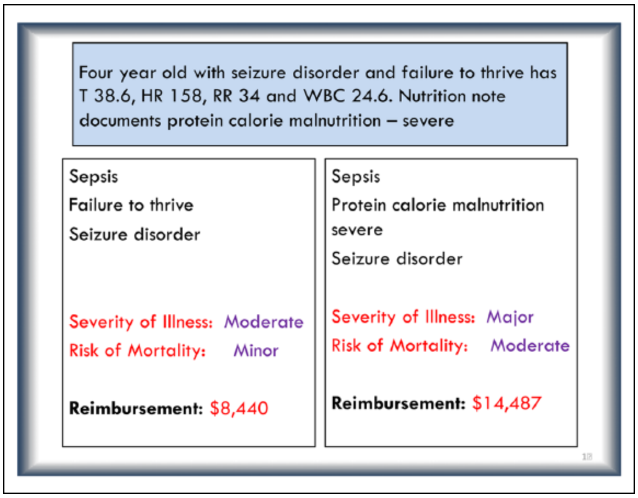

Figure 4. Case comparison utilizing failure to thrive versus malnutrition diagnosis and its impact on reimbursement. Source: University of Michigan C.S. Mott Children's Hospital, Clinical Documentation Specialists, Health Information Management.

1.7 times more likely to be admitted through the ED than children without a CDM. Our results are similar to a recent prospective observational review of 1747 charts from a children's hospital ED evaluating the relationship between BMI and hospital admission. The study concluded that children with a BMI percentile <5% were admitted more frequently (P = .026) than normal weight, overweight, or obese patients. Underweight children were almost 1.5 times as likely to be admitted from the ED department as normal weight patients. Underweight patients admitted through the ED were admitted more often with respiratory infections (P = .0279) and fractures (P = .0278).[46]

The data from our study illustrate that some hospital characteristics are associated with greater incidence of malnutrition diagnosis. Urban, teaching, and private nonprofit hospitals had more patients with a CDM, whereas bed size and region did not seem to affect the presence of a malnutrition diagnosis. These findings highlight the practice variability for identifying and diagnosing malnutrition. Presently, implementation of the pediatric malnutrition definition varies among institutions.[21] Additionally, there is very little standardization for the identification, diagnosis, and intervention of malnutrition within institutions, let alone among institutions.[46] With the assumption that malnutrition prevalence is independent of facility-level characteristics, this report identifies the need for a uniform approach and practice to identify, code, and treat these children.

Our data show that 14.8% of patients with a CDM received nutrition support therapy, as compared with 2.6% of patients without a CDM. This prevalence of nutrition support further elucidates the reason for significantly greater hospital costs among children who were diagnosed with malnutrition. The relationship between the nutrition support therapies and improved nutrition status remains an important area of future research; our data do not evaluate outcomes from the interventions provided. Appropriate use of nutrition support also remains to be clarified. There were 161,007 patients without a CDM who received EN or PN support interventions. This is a substantial number of children who received targeted nutrition interventions. It raises many questions surrounding underdiagnosis and/or underdocumentation of malnutrition and appropriateness of aggressive nutrition support therapies. Furthermore, these data reveal that 45,746 patients with a CDM had no nutrition support therapy. Future research should explore timely interventions for malnourished patients to identify how nutrition support can improve nutrition status in an acute care setting and to ensure that patients diagnosed with malnutrition are receiving consistent and appropriate treatments.

Children diagnosed with malnutrition had significantly higher incidence of comorbidities when compared with children not diagnosed with malnutrition. This finding is consistent with current literature and confirms our understanding that malnourished patients have more complex hospitalizations due to insufficient lean body mass reserves, decreased respiratory function, immune compromise, and/or altered nutrient utilization.[2,7,47] The most prevalent comorbidity in our sample was weight loss, followed by fluid and electrolyte disorders. It is reasonable to assume that children with comorbid conditions are at increased nutrition risk. Future research should explore this assumption to identify how to improve screening and identification of these at-risk patients based on common comorbidities. Additionally, children with chronic diseases have many metabolic and pathologic abnormalities inherent with their disease process associated with comorbidities that further contribute to malnutrition risk and growth failure.[48] Awareness of these associations among nutrition alterations, chronic conditions, and comorbidities can contribute to earlier identification of malnutrition, facilitate timely interventions, and result in more successful patient outcomes.

Limitations

Our data are based on *ICD-9-CM* codes from hospital discharge records. Given the method by which our data were obtained, there was no way to control for the possibility of coding errors. However, HCUP does perform edit checks on coding validity. The ability to identify a case of malnutrition is only as good as the malnutrition coding practices in the sampled hospitals. Information technology systems should be developed in electronic medical records to communicate the identification of malnutrition to the physicians so that the diagnosis can be documented and coded appropriately.

Given the prevalence of malnutrition in studies when patients are carefully assessed, it is very likely that malnourished patients were not identified or coded as such, illustrating the need for standardized screening and assessment using validated tools. It is also possible, given the lack of a standardized definition, that some patients coded as malnourished were not. While our cross-sectional study represents the largest sample size of pediatric patients with a CDM that has been studied to date, the data highlighted in this report should be interpreted as associations rather than causal relationships.

Future Research

Additional research is needed to determine the actual prevalence of malnutrition using the standardized criteria from the new pediatric malnutrition definition and HCUP KIDS—a database within HCUP that contains pediatric inpatient data for 7 million hospitalizations.[49] Using a pediatric database would provide information regarding prevalence, age distribution, severity of malnutrition, LOS, costs, and comorbidities that could be then analyzed for the general pediatric population as well as for specific pediatric diseases.

There is also a gap in the literature discussing the prevalence of malnutrition in pediatric patients in the community setting. A recent study in adults by Snider et al analyzed the cost of community-based, disease-associated malnutrition in 8 conditions: breast cancer, chronic obstructive pulmonary disease, colorectal cancer, coronary heart disease, dementia, depression, musculoskeletal disorders, and stroke. The authors found that disease-associated malnutrition accounts for $156.7 billion per year, or $508 dollars per U.S. resident.[50] This study could be replicated using common pediatric conditions to determine the cost of illness-related malnutrition within the community.

The cost of malnutrition is evident, but there is a paucity of data looking at the cost savings of nutrition interventions in both the prevention and treatment of malnutrition. Interventions—such as the initiation of oral nutrition supplements at time of admission, if patients are identified as malnourished—could improve outcomes. Studies are needed to determine whether oral nutrition supplements should be considered early in the admission or even prior to admission for patients with medical conditions associated with malnutrition. The use of nutrition support algorithms and home monitoring programs has been shown to improve nutrition status and survival,[51-54] and more studies are needed demonstrating improved outcomes and decreased costs. Additional studies looking at the prevalence and treatment of malnutrition in the home setting would also contribute to our understanding of the best way to address malnutrition outside the hospital.

Our study focused on undernutrition in keeping with the scope of the new pediatric definition and, as such, included obese patients only if they had another indicator of malnutrition. It may be interesting to conduct a similar study comparing hospitalized children in the United States who have a coded diagnosis of obesity (another form of malnutrition) with those without a coded diagnosis of obesity.

Conclusions

Our study represents the largest sample of pediatric patients with the CDM that has been studied to date. A CDM is associated with longer LOS, increased comorbidities, higher hospital costs, and a greater likelihood of requiring continued medical care after discharge. The newly endorsed definition will increase the ability to accurately and uniformly diagnose pediatric malnutrition. Going forward, malnutrition-specific *ICD-10-CM* codes, which include the severity and chronicity of the malnutrition (E43, E44.0, E44.1, and E45), should be used whenever children meet the malnutrition diagnostic criteria even if they are also considered “failure to thrive” (*ICD-10-CM* R62.51). Screening and/or assessment tools used to identify children with malnutrition could incorporate the most common comorbidities. Appropriate clinical documentation of pediatric malnutrition should result in accurate coding, which can affect reimbursement, resource utilization, and resource allocation. Early identification of pediatric malnutrition can lead to prompt and targeted interventions, which should improve clinical outcomes.

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