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Malnutrition among Hospitalized Children in the United States: Changing Prevalence, Clinical Correlates, and Practice Patterns between 2002 and 2011

Jennifer Carvalho-Salemi, MPH, RDN, LD; Jason L. Salemi, PhD, MPH; Molly R. Wong-Vega, MS, RDN, LD; Kiara K. Spooner, DrPH, MPH; Marisa D. Juarez, MPH, RDN, LD; Stacey S. Beer, MPH, RDN, LD; Nicki L. Canada, MS, RDN, LD, CNSC

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ABSTRACT

Background Pediatric malnutrition has been associated with adverse clinical outcomes, longer lengths of stay, and higher health care costs.

Objective To characterize prevalence, temporal trends, and short-term clinical outcomes of coded diagnoses of pediatric malnutrition (CDM) across sociodemographic, clinical, and hospital characteristics from 2002 to 2011.

Design This study is a retrospective cross-sectional analysis of nationally representative data from the Nationwide Inpatient Sample and the Kids' Inpatient Database.

Participants/setting The study sample included pediatric inpatient hospitalizations in the United States.

Main outcome measures International Classification of Diseases-9th Revision-Clinical Modification diagnosis codes were used to identify CDM and coded malnutrition subtypes based on an etiology-related definition of pediatric malnutrition.

Statistical analyses The national frequency and prevalence of CDM overall and across patient- and hospital-level characteristics were estimated for children aged 1 month to 17 years. Logistic regression was used to assess the association between CDM and each characteristic. Analyses evaluated conditions associated with the highest burden and risk of CDM, and compared clinical outcomes across malnutrition subtypes. Joinpoint regression was used to describe temporal trends in CDM.

Results Of the 2.1 million pediatric patients hospitalized annually, more than 54,600 had CDM, a national prevalence of 2.6%. Considerable variation was observed based on primary diagnosis, with fluid and electrolyte disorders contributing the most malnutrition cases. Highest CDM rates were among patients with stomach cancer, cystic fibrosis, and human immunodeficiency virus. Patients with CDM experienced worse clinical outcomes, longer lengths of stay, and increased costs of inpatient care. The overall prevalence of CDM increased from 1.9% in 2002 to 3.7% in 2011, an 8% annual increase, and temporal increases were observed in nearly all population subgroups.

Conclusions Despite improvements, pediatric malnutrition remains underdiagnosed in inpatient settings when relying exclusively on International Classification of Diseases-based codes, which underscores the need for a national benchmarking program to estimate the true prevalence, clinical significance, and cost of pediatric malnutrition.
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IT HAS BEEN WELL-DOCUMENTED THAT MALNUTRITION among hospitalized children is associated with longer lengths of stay (LOS), higher infection rates, and worsened clinical outcomes.[1-3] Because it is largely considered a so-called third-world phenomenon, little is known about the diagnosis and treatment of pediatric malnutrition in the United States, particularly among the most vulnerable and underserved populations. Considering the beneficial influence of optimal nutrition on morbidity and mortality, proper screening, diagnosis, and treatment measures should

not be underestimated. However, recent research suggests that barriers persist, including the lack of uniformly applied definitions and assessment protocols, inappropriate nutritional status measurement tools, and limited clinical nutrition education among health care providers.[4-8]

In an effort to address these barriers, an American Society of Parenteral and Enteral Nutrition (A.S.P.E.N.) expert workgroup convened and subsequently proposed a new etiology-based paradigm for defining malnutrition.[9] Based on this model, national benchmarking standards have been put forward. In 2014, the Academy of Nutrition and Dietetics and A.S.P.E.N. published a joint consensus statement recommending indicators for the identification and documentation of pediatric malnutrition.[6] This was an important first step toward improving the recognition, diagnosis, and treatment of malnutrition in a hospital setting.

Despite the importance of nutrition during childhood, there is a paucity of large, multiyear studies that comprehensively investigate risk factors, clinical outcomes, and practice patterns related to malnutrition in the US pediatric population. Abdelhadi and colleagues[8] recently reported on characteristics of hospitalized children with a coded diagnosis of pediatric malnutrition (CDM) in the United States in 2010. The authors suggested that there exists a substantial underestimation of the prevalence of pediatric malnutrition in hospital settings and they emphasized the importance of early recognition and appropriate clinical documentation. The purpose of this study was to address remaining gaps in knowledge by using multiple nationally representative databases to characterize the prevalence and temporal trends in CDM among pediatric hospitalizations between 2002 and 2011; identify pediatric subgroups who are at highest risk of CDM; determine the influence of CDM on morbidity, inpatient mortality, and hospital use; assess the degree to which diagnostic coding of malnutrition has changed over time; and highlight potential gaps in the coding of pediatric malnutrition in the hospital setting and their implications for future research.

MATERIALS AND METHODS

Study Design and Data Sources

A retrospective cross-sectional analysis of pediatric inpatient hospitalizations (ie, discharges) in the United States between January 1, 2002 and December 31, 2011 was conducted using data from two nationally representative databases created under the Healthcare Cost and Utilization Project (HCUP): the Nationwide Inpatient Sample (NIS) and the Kids' Inpatient Database (KID). The NIS constitutes the largest all-payer, publicly-available inpatient database in the United States.[10] To create the NIS, all nonfederal community hospitals from participating states (1,049 hospitals from 46 states in 2011) are first classified into strata based on five characteristics: geographic region of the United States, urban or rural location, number of beds, type of ownership, and teaching status. Then, within each stratum, 20% of hospitals are selected using systematic random sampling, and all inpatient hospitalization records from selected hospitals are included in the NIS. Sampling weights are provided with the NIS so that national frequency and prevalence estimates account for the two-stage cluster sampling design. The NIS was chosen for the primary analyses because it is produced annually, which was important for an assessment of temporal trends. Conversely, the KID is generated every 3 years, and uses a different sampling procedure.[11] The KID is composed of a sample of pediatric (aged $\leq$20 years at admission) discharges from all hospitals (ie, instead of all discharges from sampled hospitals), specifically including 10% of uncomplicated in-hospital births, 80% of complicated in-hospital births, and 80% of all other pediatric hospitalizations. Despite sampling differences, the KID, like the NIS, is weighted to generate national frequency and prevalence estimates. The determination of the study population (see next section) was the same regardless of the database. The KID was used to assess potential biases in prevalence estimates and measures of association using the NIS. The NIS and KID data are de-identified; therefore, the analyses performed for this study were deemed exempt by the Baylor College of Medicine Institutional Review Board. This study was deemed exempt under federal regulation 45 46.101(b)CFR.[12]

Case Definition

Inpatient CDM was defined using selected International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)[13] codes (Table 1, available at www.jandonline.org). Given the lack of a uniform and standard diagnosis for malnutrition, presence of one or more of these codes, as either the principal diagnosis or any of up to 24 secondary diagnoses, was operationalized as a positive indication of CDM. Similar to a recent A.S.P.E.N. Malnutrition Committee study,[8] this study's focus was on undernutrition among children aged 1 month and older. Therefore, the case definition did not include ICD-9-CM codes indicative of obesity (278.0 to 278.8), individual nutrient deficiencies (264.0 to 268.9), fetal malnutrition (764.10 to 764.99), or failure to thrive (FTT) in the newborn (779.34). In addition to an "any CDM" classification, patients were grouped into the following CDM subtypes: postneonatal FTT, protein-calorie malnutrition, abnormal loss of weight and underweight, anorexia (not including anorexia nervosa), other and unspecified postsurgical nonabsorption, cachexia; and nutritionally related child neglect. Children diagnosed with more than one CDM subtype were placed into a separate "$>$1 CDM subtype" category to make the groups mutually exclusive and prevent double-counting children in subtype comparisons.

Study Population

Because the new etiology-related definition of pediatric undernutrition proposed by Mehta and colleagues[9] was not designed to address neonates younger than age 1 month, the study population was restricted to children hospitalized between age 1 month and 17 years. Hospitalizations in which the date of admission occurred when the child was younger than age 1 month could continue into and beyond the second month of life, at which point malnutrition may be diagnosed. Because the data do not permit assessment of the precise timing of diagnoses, discharges in which any part of the hospitalization occurred between the ages of 1 month and 17 years were included. This was operationalized by first restricting to patients aged $\leq$17 years at admission and then excluding discharges in which the entire hospitalization, from admission to discharge, was completed before the end of the first month of life.