

Special Article - Malnutrition

Hospital Malnutrition in Pediatric Patients: A Review

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Malnutrition is common in pediatric inpatients, and nutritional status often deteriorates in the hospital. Although the prevalence of hospital malnutrition is high, this condition is ignored and consequently, not treated. The first step to fight malnutrition knows how to identify patients at greater risk of this condition. One way to identify them is by using risk screening tools, which should be used in all inpatients. Six screening tools have been created for pediatric patients, but none of these tools stood out. Nevertheless, the STRONGKids has been the most studied tool in many countries because of its ease and speed of use. In Brazil only STRONGKids has been translated and adapted, but just one study assessed its accuracy in our population, obtaining modest results. Hence, STRONGKids should be considered a preliminary tool, and its correlation with clinical data requires investigation.

Keywords: Malnutrition; Hospitalized child; Nutritional screening; Child nutrition disorders

Introduction

Child malnutrition is defined as an imbalance between nutrient requirements and intakes. The imbalance leads to cumulative energy, protein, and micronutrient deficits, which may impair growth and development, and to other important outcomes [1]. Malnutrition is caused by a deficiency or an excess of energy, protein, and/or other nutrients. This article will discuss nutrient deficiency, and more specifically, protein-energy malnutrition.

Based on its etiology, malnutrition is classified as primary, caused by environmental and behavioral factors associated with low nutrient intake, and secondary, caused by one or more diseases that promote nutritional imbalance [2]. Disease- or trauma-related malnutrition stems from different mechanisms: low nutrient intake, higher nutritional requirements, higher losses, and changes in food use [3].

In developed countries malnutrition results mainly from diseases, and it may be worsened by frequent hospital stays and the need to undergo diagnostic tests [4]. Primary malnutrition occurs mostly in developing countries. Although primary malnutrition decreased considerably in the last three decades, its prevalence remains high and disease-related malnutrition and hospital malnutrition also occur [5]. Malnutrition is common in pediatric inpatients as their nutritional status often deteriorates during hospital stay [2]. Even though the prevalence of hospital malnutrition is high [6], child healthcare professionals ignore this condition time and again, and consequently, leave it untreated [7].

Some factors related to this scenario are the lack of a universal definition for hospital malnutrition, the different practices used for diagnosing and screening patients at risk of nutritional status deterioration, and the non-prioritization of nutrition as part of inpatient care [2].

Nutritional status assessment on hospital admission identifies patients who are already malnourished, while nutritional risk screening identifies patients who are more likely to become malnourished

during hospital stay [8]. Therefore, in the last years, efforts have been made to create and implement nutritional risk screening tools to identify patients who would benefit from a nutritional intervention. The intervention would target patients malnourished on admission, or patients at risk of malnutrition or complications that may be prevented by proper nutritional support [9].

This literature review will discuss hospital malnutrition in children, the importance of its identification, and the quality of the existing nutritional risk screening tools for the pediatric population.

Hospital malnutrition: prevalence and diagnostic criteria

Hospital malnutrition is malnutrition diagnosed at any time during hospital stay – at admission, during hospitalization or even at hospital discharge. In this case, malnutrition is often associated with underlying chronic diseases, especially in developed countries.

According to the American Society of Parenteral and Enteral Nutrition (ASPEN), hospital-acquired malnutrition is a nutritional imbalance that occurs during hospital stay, regardless of whether the patients were malnourished or not on admission [2]. It happens, for example, when the children with severe acute illness often experience extreme metabolic stress. Although on admission these patients present without a prior history of malnutrition the presence of the massive inflammatory response in turn it limits the effectiveness of nutrition interventions and can contribute to the rapid development of malnutrition. Diagnosing hospital malnutrition (on admission or acquired) requires accurately measuring anthropometric parameters and indices, such as weight, height, and body mass index. However, accurately measuring the weight and height of pediatric inpatients is a challenge. Generally, obtaining these data serially is a low priority for health professionals [10].

In addition, acute diseases are frequently associated with water retention (edema), resulting in incorrect body weight. Weight may be affected by clothes, tubes, and other equipment used for inpatient care. Critical patients are considered to be too debilitated to be moved and weighed. Moreover, biochemical markers that can refine

the diagnosis of hospital malnutrition do not exist [10,11]. In the pediatric milieu, the problem of hospital malnutrition has been widely debated in the last years, but it is difficult to determine its prevalence because of the lack of standardized diagnostic criteria. Nevertheless, the prevalence remains high regardless of the diagnostic criteria [5,6]. The frequency of malnutrition will depend on the diagnostic method, reference growth curve used, study population, classification (acute or chronic), and time of diagnosis [1].

Yet, most studies in the literature regard malnutrition on hospital admission, ignoring the children who develop malnutrition during hospital stay, that is, children with hospital-acquired malnutrition [12].

In developed countries the prevalence of acute and chronic malnutrition on hospital admission varies from 6.1% to 19% and 8.7% to 12.8%, respectively [13]. Despite all the scientific knowledge, the prevalence of malnutrition in the last 10 years has not decreased [14]. In countries like Brazil and Turkey, for instance, the prevalence of acute hospital malnutrition on admission reach alarming figures, ranging from 33.8% to 52.4% [15-17]. Most of the studies use Body Mass Index (BMI) or weight for height greater than two Standard Deviations (SD) to define acute malnutrition and height for age greater than less DP to determine chronic malnutrition [2].

Some researchers use as the criterion hospital-acquired malnutrition the quantification of any weight loss [14], others define as a loss of weight greater than 2% [13] or a decrease in BMI greater than 0.25 SD [18]. Studies on the prevalence of hospital-acquired malnutrition or nutritional status deterioration during hospital stay are scarce. In France Sermet-Gaudelus et al. reported that 191 (65%) of the 296 children admitted to the pediatric or pediatric surgery units lost weight during hospital stay; 85 children (44.5%) had lost 2-5% of their body weight, and 49 children (25.6%) had lost more than 5% of their body weight on discharge [13]. An Italian study found that the BMI of 97 children (19.5%) on discharge had decreased by more than 0.25 standard deviations [18].

The latest studies show that the prevalence of hospital-acquired malnutrition has not changed [16]. In a study conducted in 2013 in a tertiary hospital in Belgium, 109 (31.8%) of the 343 children who completed the study had lost weight [19]. More recently [14], a multicentric study of 2,567 patients aged one month to 18 years from 14 centers in 12 European countries found that 217 (23%) of the 938 patients with hospital stays longer than four days lost weight.

In Fortaleza, Brazil, Rocha; Rocha; Martins found that 51.6% of children aged less than five years had lost weight on discharge. Ten years later in Recife, Gouveia; Tassitano; Silva (2016) found that the frequency of children who had lost weight during hospital stay remained high, with 129 (52.7%) of the 245 study children having lower weight on discharge.

Therefore, comparing the results of different studies is challenging because they often use different methods to measure the prevalence of hospital malnutrition. Some differences regard the criteria used for defining malnutrition, the study contexts, hospital type (secondary versus tertiary), country status (developed versus developing), age groups, and patient status.

Hospital malnutrition contributes to the morbidity and mortality

of children and adults because it weakens the immune system, increasing the risk of infections, delays wound healing, reduces gastrointestinal tract functions, increases dependence on mechanical ventilation, increases length of hospital stay, and increases hospital costs [20].

Hence, improving the nutritional status of pediatric inpatients promotes many benefits, such as fewer disease or treatment complications, lower disease severity and faster recovery from the disease, shorter convalescence period, and lower treatment costs [9].

Hospital malnutrition: associated factors

Children are more vulnerable to malnutrition due to the higher amount of energy required for growth and development, and their limited energy reserves. Given the protein catabolism and higher energy requirement associated with disease, energy intake will probably be inadequate, increasing the risk of malnutrition [6].

Many factors contribute to the high frequency of hospital malnutrition. Some factors are inherent to the patient, such as age, nutritional status at disease onset, medical and obstetric history, and social status [15]. Other factors are related to hospital stay, such as procedures that require fasting, diet acceptance, time to achieve full diet, diet efficacy, the disease itself, and disease severity [21].

Hospital malnutrition present in the first 72 hours of hospital stay stems partially or totally from patient-inherent causes. If malnutrition occurs after the first 72 hours of hospital stay, it is more strongly related to low nutrient intake [22]. Age is an important risk factor for malnutrition as the risk of losing weight increases with decreasing age. Children of breastfeeding age require higher calorie intake per kilogram of body weight than older children and adolescents, so they are at greater risk of malnutrition during hospital stay. Campanozzi et al. found a decrease of more than 0.25 SD in the BMI of 60 (24.4%) of the 246 children aged less than 24 months, and a decrease of 0.25 SD in the BMI of 37 (14.4%) of the 250 children aged more than 24 months included in their study ($p < 0.001$) [18].

The data that related malnutrition on admission to the risk of weight loss during hospital stay are controversial. An Italian study found that minors with malnutrition on admission had lost more BMI on discharge than those with better nutritional status on admission [18]. On the other hand, a Turkish study found that hospital stay had a negative impact on the nutritional status of children with mild malnutrition on admission but not of children with moderate malnutrition on admission [17]. Normal weight and mildly malnourished patients do not draw the attention of the health care team to a possible need of nutritional support, while patients with moderate malnutrition receive special care.

The underlying disease or reason for admission is related to weight loss during stay, which is often increased by inflammation. Tissue disease or injury promotes an acute inflammatory response mediated by cytokines, especially interleukin 6 and tumor necrosis factor-alpha, which results in rapid lean body mass catabolism [23]. The inflammatory response during the acute disease phase is associated with high baseline energy expenditure and nitrogen excretion. Disease frequently induces anorexia and fever, in addition to vomiting and diarrhea, worsening the imbalance between nutrient requirements and intakes [2].

Diseases that promote grade 2 or grade 3 inflammations according to the American Academy of Pediatrics and American Dietetic Association have been associated with body weight loss higher than 2% [13]. Rocha et al. found that 59 (76.3%) of the 96 children who lost weight in their study had been admitted for pneumonia, and most of them were normal weight on admission.

A hospital stay longer than five days is considered a risk factor for malnutrition [15,18,21]. Length of hospital stay is multifactorial. Diet introduction is often postponed, and fewer than 50% of children receive food on the first day of hospital stay. In addition, the nutritional requirements in the first week of hospital stay may not be met, especially in critical patients [24]. Another problem is unnecessary diet interruption due to procedures that require fasting or food intolerances. Also, less than 50% of the patients finish their meals [25]. Length of hospital stay is negatively related to patient satisfaction with hospital meals [26].

Not recognizing patients' calorie and nutritional requirements is another factor related to malnutrition [27]. Roubenoff et al. reported that only 12.5% of the patients at nutritional risk had been identified on admission [28]. Appropriate nutritional therapies are infrequently prescribed for malnourished patients. A Brazilian study found that only 10.1% of malnourished patients received enteral therapy during their stay [21].

Therefore, assessment of hospital-acquired malnutrition risk must include many factors in addition to anthropometric parameters. Healthcare teams must also be attentive to special nutritional requirements and the hospital context.

Nutritional risk screening tools

To prevent hospital-acquired malnutrition, risk of nutritional status deterioration should be detected as soon as possible, if possible, on admission, to start an appropriate nutritional intervention right away. For this reason, in the last years, many efforts have been made to create a simple tool capable of screening nutritional risk in pediatric patients [29]. The tools available until then were based on tools developed for adults. Nonetheless, those tools should not be used on children for many reasons. For example, diseases impact the nutritional status of children differently as they can affect their growth and development, and nutritional requirements vary by age.

Assessment tools can be created for different purposes, such as the identification of malnourished patients, patients at risk of malnutrition, patients at risk of complications related to nutritional problems, or patients who require nutritional support. Such tools have been developed for hospital use and for children aged more than one month because in the neonatal period, weight and length are strongly related to gestational age [30].

After nutritional screening, health professionals need to establish a treatment plan, and for such, the entire healthcare team must become familiarized with the tool. High risk patients should undergo complete nutritional assessment to allow the planning of an appropriate diet therapy. On the other hand, patients at low risk of malnutrition should be reassessed periodically [12].

Nutritional screening tools for pediatric patients

For a better understanding of what nutritional screening tools

are and how they are constructed, first, one needs to understand some keywords, namely, nutritional assessment, nutritional risk, and nutritional screening.

Nutritional assessment is part of the basic care provided to an inpatient as it identifies the patient's nutritional status, and diagnoses the physical, functional, mental, and social consequences of nutritional deficiencies. It also includes the organization and assessment of collected data for the planning of an appropriate nutritional therapy [31]. Thus, nutritional assessment can detect malnutrition, classify its severity, and collect data that enable its correction. Nutritional assessment is a continuous activity that monitors the effects of nutritional interventions. It may consist of many elements, such as clinical history, clinical examination, anthropometry, laboratory tests, and bioelectric impedance analysis.

In clinical practice it is not easy to fully assess the nutritional status of all inpatients. Few professionals have been trained to conduct a complete nutritional assessment. Moreover, it would overload daily medical care. Nutritional assessments require much time, and only a fraction of the assessed patients would need specific nutritional support [11]. For this reason, nutritional screening aims to identify those patients who require thorough nutritional assessment.

Ergo, given the high prevalence of hospital malnutrition and the aim of improving the nutritional management of pediatric patients, in 2005 the Nutrition Committee of the European Society of Pediatric Gastroenterology, Hepatology, and Nutrology (ESPGHAN) recommended that all hospitals establish nutritional care teams. Their main tasks would include nutritional risk screening, identification of patients that require nutritional support, provision of proper nutritional management, and health professional education and training for delivering nutritional care [32]. In 2013 the American Society of Parenteral and Enteral Nutrition (ASPEN) recommended the formalization of policies and procedures to screen for hospital malnutrition. It added that all patients should be assessed for nutritional risk in the first 24 hours of hospital stay [10].

The Manual of Nutritional Assessment of Children and Adolescents of the Department of Nutrology of the Brazilian Society of Pediatrics (SBP) does not mention hospital malnutrition and does not recommend the nutritional screening of pediatric inpatients [33]. In October 2015 the Brazilian Association of Nutrology (ABRAN) warned about inpatients' need of nutritional support [34], but they did not outwardly recommend nutritional risk screening. Ordinance number 272 of the Ministry of Health, issued on April 8, 1998, established that every hospital that provides enteral and nutritional therapy must have a multi-professional nutritional therapy team (EMTN), and one of the team's attributions is to create mechanisms for the development of nutritional screening and surveillance stages [35].

The nutritional risk refers to the increased probability of morbimortality due to nutritional status. It is a complex evaluation and involves a combination of variables: current nutritional status, occurrence of underlying disease, severity of the disease and presence of risk situations (eg diarrhea, vomiting and loss of appetite). Patients at nutritional risk are more prone to nutritional status-related morbidity and have higher mortality [36].

Nutritional screening aims to identify patients at nutritional risk. It can identify protein-energy malnutrition early, preferably on admission, and/or predict the occurrence or worsening of malnutrition based on the patient's present and future statuses [9]. This prediction allows the healthcare team to implement nutritional interventions in order to prevent complications. Nutritional risk screening is complex because it considers multiple variables: current nutritional status, presence of an underlying disease, disease severity, and presence of debilitating symptoms, such as diarrhea, vomiting, and loss of appetite.

A good nutritional screening tool should: identify malnourished patients or patients at risk of malnutrition who require thorough nutritional assessment; be fast and easy to use; be reproducible; include objective (anthropometry) and subjective (dietary data, for example) data; have good sensitivity and specificity; relate to the clinical outcomes; and have good cost-benefit [29]. Still, until the present date, not one nutritional screening tool meets all these criteria. There is also no consensus on the most appropriate screening tool for pediatric inpatients. Furthermore, all tools were developed in European countries, that is, in different contexts, and used in Brazil without adaptation. Tools for each region or country are not available.

Six nutritional screening tools for pediatric patients have been developed in the last decades. Sermet-Gaudelus et al., 2000, described a simple tool after studying 296 children with different clinical diagnoses [13]. Although this tool seems easy to use, the developers did not detail its requirements or reproducibility. In 2007 Secker & Jeejeeboy created a tool called Subjective Global Nutritional Assessment (SGNA) and tested it in preoperative children. The classifications provided by the tool are related to outcomes, such as infectious complications and length of hospital stay, but the tool is difficult to use and requires much time [37].

The tool STAMP (Screening Tool for the Assessment of Malnutrition in Pediatrics), tested in a surgery unit, consists of three elements: clinical diagnosis, diet intake, and anthropometric measurement (weight). Each element receives a score, and the score determines whether the patient should undergo complete nutritional assessment, but the authors did not assess whether score is related to clinical outcomes [38]. In 2010 Gerasimidis et al. developed the Pediatric Yorkhill Malnutrition Score (PYMS), which consists of a four-stage assessment based on BMI, recent weight loss and low food intake in the last week, and clinical status. Each stage receives a score, and the sum of the scores reflects the degree of nutritional risk. Notwithstanding, more than half the children were incorrectly referred to complete nutritional assessment [39].

In 2010 a group of Dutch researchers created the Screening Tool for Risk on Nutritional Status and Growth (STRONGKids) to identify malnourished patients and specially, those at risk of hospital-acquired malnutrition [40]. High risk of malnutrition and low weight-for-height z-score on admission were significantly related to longer hospital stays. Applicability is one of the strengths of STRONGKids as it can be used on admission and is easy and fast to use [19].

Recently, a nutritional risk screening tool called Pediatric Digital Scaled Malnutrition Risk Screening Tool (PeDiSMART) was developed. This tool has high sensitivity and specificity for predicting

weight loss and the need of nutritional support during hospital stay, but it has moderate inter-interviewer agreement ($\kappa = 0.474$) [41].

STRONGKids has been the most studied instrument in many countries due to its practicality and speed of use [12], and it can be administered by physicians, dietitians, and nurses [42]. Many recent studies investigated the quality of STRONGkids in various contexts. Some studies have found that the tool correlates strongly with anthropometric measurements on admission [43-45]. Other studies tested the association between its score and clinical outcomes [43]. For example, some studies found that higher scores were associated with longer hospital stays and the need of nutritional therapy [19,42].

STRONGKids is the only nutritional risk screening tool that has been translated into Brazilian Portuguese and adapted for the Brazilian population. The tool was easily understood by health professionals, parents, and/or guardians [46]. Even so, a Brazilian study found that the tool presented moderate sensitivity (60.3%) and low specificity (42.4%) for predicting a body weight loss greater than 2% on hospital discharge [16].

It is very difficult to rank nutritional screening tools because there is no universally accepted definition of malnutrition, tools are often developed to assess different populations, and tools may have different objectives, namely, to predict clinical outcomes, assess nutritional status on admission, and assess different populations.

A meta-analysis of seven studies, totaling 1,629 children, concluded that insufficient evidence prevents the selection of a nutritional screening tool. Whence, other criteria, such as the available human and financial resources, will determine the best tool for clinical practice [47].

A systematic review of eight studies assessed the clinical and diagnostic performance of nutritional risk screening tools for the pediatric population [48]. The authors concluded that the instruments have good performance, especially STAMP and STRONGkids, but they emphasized the need of more studies to validate screening tools and stated that only one tool had been translated into Brazilian Portuguese and adapted for the Brazilian population.

A recent multicentric study with 2,567 patients in twelve European countries compared three nutritional screening tools, PYMS, STAMP, and STRONGkids, and found that the identification of patients at nutritional risk and the classification of nutritional risk varied between tools, resulting in moderate tool agreement ($\kappa = 0.35 - 0.47$). Also, the tools failed to identify some malnourished patients, but the authors found a significant association between risk of malnutrition and longer hospital stays. For these reasons, the authors concluded that no nutritional risk screening tool available today can be indicated for routine use in pediatric hospitals [49].

Conclusion

Hospital-acquired malnutrition, defined as a nutritional imbalance that occurs during hospital stay, is very frequent but little studied. Its genesis is multifactorial, some factors are inherent to the patient, and others, to the stay, and its management requires the healthcare team to consider nutrition a part of inpatient care.

One of the strategies to fight malnutrition is nutritional risk

screening. In the last two decades, six nutritional risk screening tools have been developed for pediatric patients, but none stood out. Even so, STRONG Kids has been the most widely studied tool in many countries due to its practicality and speed of use, but more studies that validate nutritional risk screening tools are necessary before any tool can be implemented in the hospital routine.

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