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Nutritional status of critically ill pediatric patients

Deepa Agarwal*, Hemamalini A.J

Department of Clinical Nutrition, Sri Ramachandra University, Chennai, Tamilnadu, India

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ABSTRACT

Background: Malnutrition is common at hospital admission and tends to worsen during hospitalization. As critical illness has a major impact on nutritional status of children it is imperative to be aware of the nutritional status of the children at admission in order to direct the health care strategies towards the overall improvement of these little lives. Despite its significant effect on clinical outcome, malnutrition is seldom recognized by health care professionals in hospitalized children. A prospective study was carried out to evaluate the incidence of malnutrition at pediatric tertiary intensive care unit. **Objectives:** To determine the incidence of malnutrition in critically ill pediatric patients and to evaluate the relation between nutritional status and diagnosis. **Patients and Method:** A total of 260 infants and children aged one month to six years admitted in the multispecialty pediatric intensive care unit of a university and teaching hospital from January'10- April'11 were enrolled in the study. All patients' height and weight was taken and interpreted accordingly. **Results:** Evaluation of height for age showed that in 51.9% of cases there was chronic malnutrition. Evaluation of weight for age and weight for height showed that in 49.2% and 39.6% of the cases, respectively, there was acute malnutrition. Higher percentage (93%) of undernutrition was observed among those with acute illness. **Conclusion:** The present observation reveals, that there is a co-existence of undernutrition in greater percentages among hospitalized critically ill children, posing a serious challenge to their care and clinical prognosis. For the prevention and treatment of malnutrition among children in the critical care set up, screening for malnutrition should be an integral part universally.

1. Introduction

Malnutrition is a continuum that starts with a nutrient intake inadequate to meet physiological requirements, followed by metabolic and functional alterations and in due course by impairment of body composition. According to a WHO report, the main victims are children under the age of fifteen. The prevalence of malnutrition among critically ill pediatrics, especially those with a protracted clinical course, has remained largely unchanged over the last two decades[1,2] and it is increasingly being recognized as an important factor in determining outcome of a disease. Malnutrition is common at hospital admission and tends to worsen during hospitalization. In Europe and North America, 40-50% of hospitalized pediatric patients are at risk of malnutrition. Several studies performed in Brazil and in other countries demonstrated that malnutrition can affect 50% of children and adolescents during hospitalization, [3]. Despite its high prevalence, malnutrition is seldom recognized by health care professionals of paediatric ICU. As a consequence, nutritional therapy is under prescribed and thus compounding the problem.

As malnutrition rates change in regard to the patient's age at the moment of their hospitalization, they also vary in terms of the underlying diagnosis [4,5]. For this reason, it is necessary to evaluate children's nutritional status at the moment of their hospitalization and to research how both influence each other, so that appropriate, early and effective nutritional support can be meticulously planned for critically ill children thereby avoiding hospital undernutrition [6].

* Corresponding Author : Dr. A.H Hemamalini
Associate Professor and Head
Department of Clinical Nutrition
Sri Ramachandra University
Chennai
E mail: deepagargphd@gmail.com, hemajanardh@rediffmail.com

To the best of our knowledge there are not many literatures reporting the incidence of malnutrition among critically ill hospitalized children in India. Therefore, a prospective study was carried out with an objective to evaluate and report the incidence of malnutrition among infants and children during the first 48 after admission in our tertiary intensive care unit and to further delineate the relation between nutritional status and diagnosis.

2. Materials and Method

The study was approved by the Institutional Research Ethics Committee. A total of 260 infants and children aged one month to six years admitted in the multispecialty pediatric intensive care unit in a tertiary care teaching hospital from January'10- April'11 were enrolled in the study. All patients' height and weight was measured. The obtained weight was compared with the expected weight using NCHS standards and it was interpreted with IAP Classification for weight for age and Waterlow's classification for weight for height. Weight for age (W/A) and Weight for height (W/H) indices were used to identify the incidence of acute malnutrition. Similarly, the obtained height was compared with the expected height using National Center for Health Statistics standards (NCHS) and it was interpreted with Waterlow's classification for height for age identifying the extent of prevalence of stunting. Body Mass Index (BMI) was also calculated among children aged 2-6 years to evaluate their nutritional status (both acute and chronic malnutrition) [7].

3. Results and Discussion

The population studied comprised of 260 subjects aged one month to six years who were admitted to the multispecialty pediatric intensive care unit of Sri Ramachandra Hospital. Sixty two percent of the study subjects were less than one year of age and 38% were greater than one year of age. The mean age of the subjects was 1.61±1.64 years. 58% were boys and 42% were girls. One hundred and sixty eight (65%) of the cases were hospitalized with acute and 35% with chronic disease.

3.1.Overview of Malnutrition Incidence

The prevalence of undernutrition across all age groups in terms of stunting, wasting and underweight could be better understood from the following Venn diagram.

Figure 1: Incidence of Undernutrition

It could be observed from fig.1, that out of 260 subjects, 68 (26%) subjects were stunted, 22(8%) subjects were underweight and 39 (15%) subjects had wasting. Three (one percent) subjects had both stunting and wasting, 46 (18%) subjects were both stunted and underweight, 43 (17%) subjects were underweight and also had wasting. All the three forms of undernutrition such as stunting, wasting and underweight was observed among 17 (7%) subjects. Overall, it is understood that only 22 (8%) subjects among the study population were normal and 238 (92%) were malnourished, when all the three parameters were taken into consideration.

Malnutrition in hospitalized children varies between 21% and 80% in proportion with the level of development of the countries (Cortes RV, 1995; Leite HP, 1993) [8,9]. A research done in Mexico purports that in 72.2% of 450 hospitalized patients, a varying degree of malnutrition was found (Cortes RV, 1995)[8]. According to two studies done in different areas of Turkey, malnutrition rates varied between 55.1-56.6% (Ozer N, 2001; Genel F, 1997) [10,11]. In contrary, the overall prevalence of malnutrition was higher (92%) in our study population when compared to the studies cited above.

3.2. Nutritional Status According To Body Mass Index (Bmi)

Body Mass Index is a number calculated from a child's weight and height. It does not measure fat directly, but research has shown that BMI correlates to direct measures of body fat. Moreover it is a simple and inexpensive method of screening for weight categories that may lead to health problems. For children and teens, BMI is age and sex specific and is often referred to as BMI for age. It is calculated and interpreted for children aged 2-18 years [12].

The details of nutritional status of our study subjects between 2- 6 years of age, classified according to BMI are as presented in table 1.

Table 1. Nutritional Status according to BMI

Malnutrition degree	Number of cases (n-93)	Percentages
Mild malnutrition	16	17
Moderate malnutrition	42	45
Severe malnutrition	25	27
Normal	09	10
Overweight	01	01

Evaluation of both types of malnutrition according to BMI in our study subjects showed that 45% (42) of the subjects were moderately undernourished, but the incidence of overall undernutrition was alarming at 89% (83) and only one subject was overweight. In a prospective study done in Turkey by Yasar Dogan, 2005, among hospitalized children aged one month to 18 years with acute and chronic disease, malnutrition according to BMI was observed in 45.7% which is far lesser than the results of our study. In conclusion, a high prevalence of undernutrition among hospitalized critically ill children in our population is worth an attention.

3.3.Nutritional Status According To W/A, W/H, H/A Criteria

Evaluation of the nutritional status of the subjects using W/A, W/H and H/A criteria was done to determine the incidence of acute and chronic malnutrition and it is as presented in table 2.

Table 2: Nutritional Status according to W/A, W/H, H/A criteria

Nutritional Status	W/A (n-260) n (%)	W/H (n-260) n (%)	H/A (n-260) n (%)
Grade III	43 (16.5)	20 (17)	45 (09)
Grade II	41 (15.5)	40 (18)	47 (14)
Grade I	44 (17)	43 (17)	43 (17)
Normal	132 (51)	157 (48)	125 (60)

Wasting (W/H values) indicates recent or acute malnutrition. Evaluation of W/H values revealed a nutritional disturbance (wasting) in 103 (39.6%) cases, of which severe wasting was observed in 17% of the subjects. Similar research done in Turkey among hospitalized children revealed that 40.9% of their cases had wasting [3] which is comparable to findings of our study wherein overall 39.6% of our subjects had wasting when classified according to weight for height. In contrary, a study done in Brazil by Marcelle MM Maia, 2008, reported wasting in only 4.4% of their study population.

Acute malnutrition in terms of underweight can also be assessed by calculation of W/A values. In the studied population, W/A (according to IAP) analysis showed changes in nutritional status (underweight) in 128 (49.2%) cases, of which 16.5% of the subjects were severely underweight. Ferreira et al, 2002, when evaluating weight for age of the patients, reported that 71.2% suffered from malnutrition at the moment of their hospitalization. Overall in our study population, 49.2% according to IAP criteria were underweight. Though the incidence of wasting rates were lesser than the above reported observation, it does indicate that there is a need for understanding of the prevalent wasting among the critically ill children, which would impair the clinical prognosis. Malnutrition has shown to be associated with increased morbidity and mortality in children [13,14], including a higher risk of infections due to poor immune defense, wound healing problems, reduced gut function, longer dependency on mechanical ventilation, longer hospital stay and increases health care costs [15].

The calculation based on weight does not help to exclude other obvious syndromes with short stature. Moreover, it does not imply whether the PEM is of recent or past onset. Height indicates past or chronic PEM and is used to grade stunting. Using height measurements the severity of stunting can be identified as Grade I, II or III. The calculation of H/A analysis in our study showed lower height (stunting) in 135 (51.9%) cases of which over nine percent of them were severely stunted. Similarly, a study done by Yasar Dogan, 2005, when their study population was classified according to the height for age, chronic malnutrition was established in 27% of the cases. In our study, a total of 51.9% of the subjects were found to be stunted, which shows that these subjects were chronically undernourished.

As malnutrition rates change in regard to the patient's age at the moment of their hospitalization, they also vary in terms of the underlying diagnosis and its duration (Hankard R, 2001; Man WD, 1998) [4,5] For this reason, it is necessary to evaluate children's nutritional status at the moment of their hospitalization and to research how both influence each other, so that appropriate and effective nutritional support can be meticulously planned for critically ill children.

Table 3: Malnutrition rates in acute and chronic diseases

Malnutrition Categories	Acute disease (n-168) n (%)	Chronic disease (n-92)
Underweight	10 (06)	n (%)12 (13)
Wasted	29 (17)	10 (11)
Stunted	52 (31)	16 (10)
Underweight and Wasted	29 (17)	14 (15)
Underweight and Stunted	21 (12.5)	25 (27)
Stunted and Wasted	01 (0.5)	02 (02)
Underweight	14 (08)	03 (03)
Stunted and Wasted		

In evaluation of the patients in terms of disease duration, the analysis of various malnutrition categories clearly showed 156 subjects (93%) were undernourished of which wasting or underweight was recorded in around 17% of the subjects which is a clear indicator of recent onset of acute malnutrition. Majority (31%) of the subjects with acute illness had chronic malnutrition (stunting) which can be attributed to inadequate intake due to anorexia or increased metabolic demands. Though, environmental and social factors could be important risk factors in chronic malnutrition, deviations in growth, especially reduced growth, is associated with an increased risk of diseases both in short and long term [16].

Further analysis was also done to understand the nutritional status of subjects with chronic diseases. Out of 92 subjects with chronic illness, 25 (27%) subjects were underweight and stunted followed by 14 (15%) subjects who were underweight and wasted.

The overall prevalence of undernutrition was higher in subjects with acute illness (93%) than that with chronic illness (89%) nevertheless the difference in percentages in both the groups was

not very large. However, this implies that an undernourished state prevails both in acute and chronic disease conditions, which would impend the clinical course and outcome. Moreover, the presence of undernutrition in either of the cases also would be influenced by the underlying clinical conditions, compounding to more problems related to morbidity and mortality of the children. Studies have shown that when a malnourished child with any illness is admitted to a PICU, its nutritional status may further deteriorate if adequate nutritional support is not provided and this in turn is associated with increased mortality and morbidity, including a higher risk of infections due to poor immune defense, wound healing problems, reduced gut function, longer dependency on mechanical ventilation and longer hospital stay [13,17].

3.4.Influence of Diagnosis On Nutritional Status

The details of influence of the underlying clinical condition on the nutritional status of our study subjects are as displayed in table 4.

Table 4: Influence of Diagnosis on Nutritional Status

Pathologies	Well nourished n (%)	Malnourished n (%)
Medicine (n-103)	57(56)	46 (44)
Neurology (n-50)	30 (60)	20 (40)
Cardiology (n-27)	05 (19)	22 (81)
Surgery (n-18)	07 (39)	11 (61)
Respiratory (n-62)	31(50)	31 (50)

The types of disease conditions among well nourished and undernourished subjects were analysed to understand the effect of clinical condition on nutritional status.

In the present study, majority of the subjects were admitted with medical related conditions followed by respiratory disorders, neurological impairment and cardiovascular diseases. The assessment of nutritional status revealed that incidence of undernutrition (81%) in both forms such as moderate and severe malnutrition was predominant among those with cardiovascular disorders when compared to other disease condition. As in the present study, previous reports showed that cardiovascular disease related malnutrition is especially common in developing countries, but prevalence varies widely from 27% upto 90.4% [18]. In South India, Vaidyanathan and colleagues, 2009, reported prevalence of malnutrition in 59.0% of children with cardiovascular disease in their study population.

Inadequate caloric intake because of anorexia and increased metabolic demands due to reduced myocardial functioning are the predominant causes of growth failure and malnutrition in patients with cardiovascular disease condition[19]. Treatment plan should include managing any underlying causes of anorexia and implementation a medical nutrition regimen of frequent small meals. Appropriate techniques of nutrition support will range from oral food supplementation to enteric tube feedings. Studies have determined that continuous rather than bolus feeding is preferable, as it minimizes myocardial oxygen consumption [20].

The next diagnosis seemed to affect nutritional status was surgery wherein 61% of the subjects had malnutrition. Often the treatment for these conditions necessitates dietary restrictions or limitations that further compromise their nutritional status. Treatments may also be associated with inability to ingest or absorb nutrients. For, some patients, increased energy demands without a compensatory increase in foods energy may result in undernutrition [21]. Therefore, appropriate and early nutritional support is essential to optimize growth and minimize growth disturbances in such patients.

It could be further observed from the table that around 40% of the study subjects with neurological disorders were undernourished. Nutritional status in neurological disorders has been reported rarely. Malnutrition directly or indirectly affects a variety of organ systems including the central nervous system (CNS) and it is associated with increased stress reaction during the first week, higher frequency of respiratory and urinary infections and bedsores, greater mortality, worse outcome, and a longer duration of hospitalization [22]. Early nutrition support within 48 to 72 hours, through the enteral route has been shown to blunt catabolism, reduce complications and reduce length of stay in a number of neuropatients [23].

Similarly among subjects with respiratory disorders around 50% of them were malnourished. Evidence of malnutrition in critically ill paediatric patient with respiratory diseases ranges from 19% to 74% [24]. Malnutrition is a common finding in critically ill paediatric patients with respiratory illness because of decreased strength, greater fatigability, reduced endurance of the respiratory muscle mass and decreased ventilatory drive. Chronic weight loss, low body weight and alterations in biochemical parameters have been reported in acute respiratory diseases [25].

Nutrition support is an important aspect of patient care in any patient with respiratory disease, either to treat existing malnutrition or to prevent development of nutritional deficiencies. A number of clinical trials indicated the benefits of providing early nutrition support to critically ill paediatric patients with respiratory illness. Important outcomes such as improvement in nutrient intake, rates of infection, lengths of stay, ventilation support days and costs can be decreased by the early initiation of enteral feedings [26-30].

It could be observed that on an average, greater than 30 % of subjects under different clinical conditions were undernourished the higher incidence being among those with medical conditions, neurological impairments and respiratory disorders.

These observations reiterate the fact that while undernutrition per se is alarming in critically ill pediatric patients, the underlying clinical condition may also further increase the risk of

undernutrition. Thus, the consensus is that nutrition assessment at admission should be an integral part of clinical care in PICU children, guided by a multidisciplinary team and nutrition support protocols is very important for the treatment and prevention of malnutrition in this cohort.

4.Conclusion

Malnutrition is a major problem in pediatric intensive care and it is particularly a serious clinical health problem in children than their older counterparts because the ability to support and compensate for insufficient or unbalanced supplies is very limited due to small endogenous stores of a number of relevant substrates such as glycogen, fat and especially protein while baseline requirements are higher. Immature metabolic pathways and physiological functions also play a role. It is also likely that malnourished patients might present with a variety of atypical symptoms that might remain undetected, preventing the diagnosis of malnutrition.

A high prevalence of undernutrition (underweight 49.2%, stunting 51.9% and wasting 39.6%) among hospitalized critically ill children in our population with both acute and chronic disease is worth an attention. Therefore, assessment of nutritional status of all newly admitted patients in the pediatric intensive care unit is imperative and it should be performed as early as in the acute phase of critical illness. Evaluation of the nutritional status should be an element of the routine diagnostic and treatment process. Moreover, during critical illness and recovery thereafter, provision of adequate nutritional support is an essential aspect of the clinical management of PICU patients. Adequate feeding is essential for complete recovery and normal functioning of the growing child. In particular, closer observation and optimal nutritional support are required in patients who are admitted with chronic malnutrition.

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