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Original Research Article

Influence of nutritional status on clinical outcomes in critically ill children

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ABSTRACT

Background: Critically-ill children have a state of metabolic stress. The nutritional needs of these patients can be increased. Their nutritional status at admission and its possible deterioration during hospitalization can be a predictor of worse outcome. The objective of this study was to study the influence of nutritional status on outcomes like mortality, duration of mechanical ventilation and duration PICU stay and hospital stay, in critically ill children.
Methods: This was a prospective comparative study conducted on 60 critically ill children aged 1 month to 18 years admitted to PICU of tertiary care, teaching hospital, Bangalore, Karnataka over a study period of 12 months. Patients were divided into 4 categories based on Body mass index (BMI) as per WHO growth charts into: underweight, normal, overweight and obese and outcomes was analysed.
Results: In the present study 60 children were studied. Subjects were classified as underweight (23.33%), normal weight (45%), overweight/obese (31.67%) based on BMI Z-score at admission. The odds of prolonged hospital stay were higher in underweight and overweight/obese children (OR-2.85, p-0.12 and OR-3.92, p-0.03 respectively). Underweight and overweight/ obese children had higher odds for prolonged PICU stay. (OR-6, p-0.02 and OR-2.13, p-0.36 respectively). Underweight children required prolonged ventilator support (OR-2, p-0.03). There was no significant difference among the group.
Conclusions: There is a high prevalence of malnourishment in critically ill children compared to general population and they are prone for poor outcome. Malnourished children must be identified at admission and optimal therapies, nutritional strategies aimed at preventing further nutritional deterioration should be made.

Keywords: BMI, Critically ill children, Malnourishment

INTRODUCTION

Critical illness is a life-threatening multisystem process requiring support of failing vital organ systems without which survival would not be possible and also can result in significant morbidity or mortality[1]. This condition can be evoked by a variety of insults such as multiple trauma, complicated surgery, and severe medical illnesses. Paediatric intensive care unit (PICU) care aims at to achieve timely diagnosis and therapeutic interventions for controlling organ dysfunction and recover physiological stability. Without modern critical care medicine, critically ill patients would not survive. Critically-ill children have a number of organic alterations, metabolic responses which contribute to the maintenance of body homeostasis, switching nutritional compounds towards different functions and, at a further stage, may facilitate recovery.

The metabolic response to stress can also include catabolic processes that, in many circumstances, may increase physiological instability and resource wasting. Thus, causing an increase in nutritional requirements and leading to state of metabolic stress.[2]

Nutritional status can be assessed using clinical signs of malnutrition, biochemical indicators, and anthropometry. Anthropometry has an important advantage over other nutritional indicators, it is non-invasive, inexpensive, and relatively easy to obtain. Studies have documented that nutritional status of critically ill children at admission and its possible deterioration during hospitalization can be a predictor of worse outcomes.[3,4] But only a few studies have examined the relationships between a range of nutritional status categories i.e. underweight, normal weight, overweight and obesity and clinical outcomes in critically ill children.

This study was aimed to determine the influence nutritional status at admission, as assessed by BMI Z-score, on clinical outcomes in critically ill children. The objective of this study was to study the influence of nutritional status on outcomes like mortality, duration of mechanical ventilation and duration PICU stay and hospital stay, in critically ill children

METHODS

This was a prospective comparative study conducted on 60 critically ill children aged 1 month to 18 years admitted to PICU of tertiary care, teaching hospital, Bangalore, Karnataka over a study period of 12 months. Ethics approval for the study was obtained from the Institutional Review Board. All critically ill children admitted to PICU in the age group of 1 month to 18 years were included in the study excluding the children with chromosomal anomalies, musculoskeletal disorders or inborn error of metabolism

Detailed history and examination were done in all the patients including the relevant investigation and the data were collected at admission. Anthropometric parameters including weight and height/length were taken by trained personnel using the standardized technique within 24 hours of admission. Nutritional status on admission was defined by BMI Z-score using the most recent World Health Organization (WHO) growth charts. Subjects were categorized as 3 nutritional groups underweight (BMI Z-score <-2), normal weight (BMI Z-score ≥-2 and ≤1), overweight (BMI Z-score >1 and ≤2) and obese (BMI Z-score >2).[5,6]

Outcomes like mortality, duration of PICU stay, duration of hospital stay, and duration of mechanical ventilation were assessed in the groups.

Statistical Analysis

Statistical analysis was done using Stata student's edition version 12.

Continuous variables like PRISM score which followed normal distribution have been summarized as mean and standard deviation and compared between the nutrition categories using one-way ANOVA test. Continuous variables like age, duration of hospital stay and duration of PICU say which did not follow normal distribution have been summarized as median and inter quartile range and compared between the nutrition categories using Kruskal Wallis test. Overweight and obese children were assessed together because of less number. Categorical variables were summarized as proportions. Comparison of proportions between the nutrition status categories was done using fisher's exact test. To assess association of nutritional status with different morbidity and mortality related outcomes, odds ratio with 95% confidence interval was calculated. All statistical analysis was considered significant if p value <0.05.

RESULTS

In the present study 60 children who met with inclusion criteria were enrolled in to the study. Mean and median age of the study population was 4.8 and 2.5 years respectively with a standard deviation of 4.91. There were 27 (45%) children who had normal BMI for age, 14 (23.33%) children were underweight and 19 (31.67%) were overweight/ obese as per WHO charts.

Table 1: Characteristics of the study participants.

	Underweight (n=14)	Normal (n=27)	Overweight or obese (n=19)	P value
Median Age (IQR)	0.95 (0.25-3)	3.6 (1.3-5)	4.0 (1.7-10)	0.049
Age categories				
Less than 1 year (n=10)	7 (50.0)	1 (3.7)	2 (10.5)	0.006
1-4 years (n=29)	4 (28.6)	17 (63.0)	8 (42.1)	
5 years and above (n=21)	3 (21.4)	9 (33.3)	9 (47.4)	
Gender				
Male (n=39)	11 (78.6)	18 (66.7)	10 (52.6)	0.308
Female (n=21)	3 (21.4)	9 (33.3)	9 (47.4)	
PRISM score	17.7 (7.1)	18.8 (11.5)	18.5 (8.3)	0.945
Duration of hospital stay	6.5 (5-7)	5.0 (3-7)	7.0 (4-8)	0.17
Duration of PICU stay	2.5 (1-4)	2 (1-3)	3 (2-3)	0.33

Median age of the study population was comparable among the groups but when age is categorised there was a statistically significant (p-0.006) difference among the group. Gender distribution and PRISM score was comparable among the groups (Table 1). Duration of hospital stay was compared among the Study groups, it was seen that there was no statistically significant difference among the groups (p value = 0.17) however underweight and overweight/ obese children had higher odds for prolonged hospital stay compared normal children. (OR-2.85, p-0.12 and OR-3.92, p-0.03 respectively) (Table 2).

Table 2: Association between nutrition status and duration of hospital stay.

	7-14 days		<7 days		Odds ratio (95% CI)	P value
	N	%	N	%		
Normal	7	25.9	20	74.1	1 (Reference)	
Underweight	7	50.0	7	50.0	2.85 (0.73-11.08)	0.12
Overweight or obese	11	57.9	8	42.1	3.92 (1.12-13.75)	0.03
Total	25	41.7	35	58.3		

Table 3: Association between nutrition status and duration of PICU stay.

	4 or more days		<4 days		Odds ratio	P value
	N	%	N	%		
Normal	3	11.1	24	88.9	1 (Reference)	
Underweight	6	42.9	8	57.1	6 (1.21-29.72)	0.02
Overweight or obese	4	21.1	15	78.9	2.13 (0.41-10.88)	0.36
Total	13	21.7	47	78.3		

Table 4: Association between nutrition status and need for mechanical ventilation.

	Required		Not required		Odds ratio	P value
	N	%	N	%		
Normal	9	(33.3)	18	(66.7)	1 (Reference)	
Underweight	7	(50.0)	7	(50.0)	2 (0.53-7.47)	0.03
Overweight or obese	6	(31.6)	13	(68.4)	0.92 (0.26-3.23)	0.9
Total	22	(36.7)	38	(63.3)		

Table 5: Association between nutrition status and final outcome.

	Death		Recovered		Odds ratio	P value
	N	%	N	%		
Normal	9	(33.3)	18	(66.7)	1 (Reference)	
Underweight	4	(28.6)	10	(71.4)	0.8 (0.19-3.27)	0.75
Overweight or obese	5	(26.3)	14	(73.7)	0.71 (0.19-2.61)	0.61
Total	18	(30.0)	42	(70.0)		

Further when duration PICU stay was analysed among the group, no statistically significant difference was noted, however similar to Duration of hospital stay, underweight and overweight/ obese children had higher odds for prolonged hospital stay compared normal children. (OR-6, p-0.02 and OR-2.13, p-0.36 respectively) (Table 3).

Further when ventilator days was analysed among the group, underweight children required prolonged ventilator support compared normal children and overweight/ obese children. (OR-2, p-0.03) (Table 4).

Final outcome, mortality in children was compared a shown in Table 5, and there was no significant difference among the group.

DISCUSSION

PICU is an important component of tertiary paediatric care service in care of critically ill children including timely diagnosis and treatment. The main purpose of the PICU is to prevent mortality and morbidity by intensively monitoring and treating critically ill children who are considered at high risk of mortality. The patient's

mortality not only depends on clinical characteristic of patient, ICU performance, infrastructure but also on nutritional status of the patient.[7]

A better understanding of the role of malnutrition in critical illness and its effects on ultimate outcome of the patient is of vital importance, in terms of the interpretation of anthropometric data, and subsequent prioritization of intervention and targeting strategies. Assessment of malnutrition is often used to determine the severity of morbidity and mortality.[8]

In our study, suboptimal nutritional status was documented in nearly half (55%) of the critically ill children on admission to the PICU. In that 23.33% children were underweight and 31.67% were overweight/ obese as per WHO charts, which is more compared to prevalence in general population signifying that malnourished children are more liable for ICU care than normal children.[9,10]

It was also seen that being underweight or overweight/obese patients was associated with significantly higher odds of prolonged PICU stay/hospital stay compared to normal children which was in accordance to Bechard et al, a two multicenter cohort studies in Boston[11], Nangula et al, a prospective study conducted on a cohort of 400 children admitted to tertiary care hospital, Ludhiana.[12]

Obesity/overweight was significantly associated prolonged PICU care. The nature of the impact of obesity on outcomes may depend on the individual patient and illness type. Excess fat stores may affect ventilatory status, potentially increasing dependence on respiratory support. Patients who are obese may also be at greater risk for complications.[13]

Underweight children had higher odds prolonged hospital stay. Underweight could be a symptom of an underlying disease or reason for admission that relates to mortality risk. Underweight children may also have impaired immune function that could limit their defence against infections.[14,15] Furthermore, critically ill children are at risk of further nutritional deterioration during their illness course due to disease or barriers to nutrient delivery in the intensive care unit.[11]

Being underweight was associated with significantly higher odds mechanical ventilation (OR-2, P value-0.03) compared normal. This in accordance to de Souza MF et al a prospective cohort study of children admitted to a Brazilian PICU.[16] In malnutrition, muscle function is affected, originating muscle fatigue and a reduction of up to 75% in work intensity and hence resulting in respiratory failure.[17-18]
There was no statistically significant difference in mortality among the 3 groups similar to a single center retrospective study conducted by Goh et al on mechanically ventilated children, overweight, obese or severely obese children did not have any significant difference in mortality, length of stay or duration of mechanical ventilation, when compared to patients with normal weight.[19]

Present results highlight the prevalence of malnutrition in PICUs and the importance of anthropometry to allow early interventions to be targeted in high-risk critically ill children. Previous studies have used only weight for age Z-scores to classify patients according to their nutritional status. But weight alone as a marker of nutrition may be misleading critical illness where fluid shifts are commonly present.

Considering this weight for height or BMI provide a better assessment of nutritional status in critical ill children. This also has recommended as primary indicators of nutritional status and growth in children.[20] However lean body mass may be a more accurate indicator.[21]

Other Anthropometric measurements such as mid-arm circumference, triceps skinfold thickness, mid-arm circumference can also be used to describe fat and nutritional status.[22] However, accurate measurements of theses require expertise and experience. Despite its limitations, BMI can be easily determined by weight and height measurement and may be a better indicator than body weight for evaluating the proportion of fat mass relative to lean mass in children.[23]

Despite the prospective nature of our study, this study has several limitations. Accurate measurement of weight and particularly height may not be feasible in all critically ill patients in addition alteration in the fluid balance during acute phase of illness may lead to erroneous measurement of weight and thereby BMI also.

CONCLUSION

Present study showed the high prevalence of malnourishment in critically ill children compared to general population. After stabilization of the initial critical phase, PICU outcome is influenced by then nutritional status of the children. Malnourished children are more prone for prolonged hospitalisation and ventilation. Malnourished children (both underweight and obese) must be identified at admission by means of simple anthropometric measures. And optimal Therapies aimed at alleviating the underlying conditions and nutritional strategies aimed at preventing further nutritional deterioration should be made. Future studies examining targeted strategies and their impact on outcomes in malnourished children in the PICU are desirable.

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