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Original Research Article

Study to Evaluate Prevalence of Hypoalbuminemia in Critically Sick Children Admitted to Paediatric ICU (PICU): An Observational Study

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Abstract:

Background: Albumin has several important properties in both health and disease. Hypoalbuminemia is a frequent condition among patients admitted to paediatric intensive care unit. This study aimed to evaluate prevalence of hypoalbuminemia in critically sick children admitted to paediatric ICU (PICU).

Material & Methods: This cross-sectional study was conducted amongst children aged 2 months to 14 years admitted at PICU at Department of Pediatrics, BMIMS, Pawapuri, over a period of 12 months. All the patients aged 2 months to 14 years of age admitted to PICU during the period of 12 months were included in the study by convenience (non-random) sampling method. 200 patients were included in the study.

Results: In this research, a total of 200 cases were included. Among these instances, patients between the ages of 1 month and 5 years accounted for the highest proportion, including 55% (n=110) of the total patients. Patients between the ages of 6 and 10 years accounted for 25% (n=50), while patients between the ages of 11 and 14 years accounted for 20% (n=40) of the total patients. Out of a sample size of 200 cases, 120 were identified as male and 80 were identified as female. The predominant first symptom seen in patients brought to the Pediatric Intensive Care Unit (PICU) was fever, reported in 72% of cases, followed by vomiting, which was present in 52% of the paediatric population. Convulsions, dyspnea, and stomach pain were additional symptoms noted in 29%, 28%, and 24% of the paediatric population, respectively. Hepatomegaly was seen in 36% of the paediatric population. Hypotension and ascites were seen in 40% and 22% of the cases respectively. In the current investigation, it was shown that 55% of the patients exhibited low levels of albumin, while the remaining 45% had normal levels of albumin. Based on the major system impacted, it has been shown that post COVID MISC, acute infectious illnesses, systemic inflammatory disease, and sepsis are among the prevalent situations that exhibit a greater prevalence of hypoalbuminemia. A statistically significant difference was seen within this particular demographic group.

Conclusion: The occurrence of hypoalbuminemia is often seen among children who are hospitalized to the Pediatric Intensive Care Unit (PICU). The most prevalent disorders connected with it are post COVID Multisystem Inflammatory Syndrome in Children (MISC), acute infectious condition, sepsis, and systemic inflammatory diseases. Hypoalbuminemia is a significant prognostic factor for mortality in the pediatric intensive care unit (PICU), and blood albumin levels serve as a robust and dependable marker for identifying death.

Keywords: Hypoalbuminemia, Serum albumin level, Mortality, critically ill children, Post COVID MISC, Sepsis, Systemic inflammatory disease

Introduction

Albumin is the predominant protein found in plasma, constituting about two-thirds of its protein composition. As a result, it plays a significant role in maintaining the colloid osmotic pressure of plasma, contributing to around 75% or more of this pressure. [1] This protein is responsible for the transportation and binding of several molecules. Albumin is characterized by its high solubility in water and is mostly distributed inside the extracellular compartment. [2] Approximately one-third of albumin is found within the intravascular compartment, while the remaining two-thirds are located in the extravascular compartment. Hypoalbuminemia is a multifaceted condition that is often attributed to reduced synthesis, such as malnutrition, malabsorption, or hepatic dysfunction, or increased losses, such as urine losses associated with nephropathy or protein-

losing enteropathy. [3] The diversion of synthesis capacity towards other proteins, namely acute-phase reactants, represents an additional etiological factor contributing to the development of hypoalbuminemia. [3,4] Inflammatory illnesses have the potential to expedite the breakdown of albumin, a protein, while concurrently reducing its production.

During instances of critical illness, there is a notable increase in capillary permeability, mostly attributed to the presence of proinflammatory mediators such as histamine or bradykinin, or due to damage inflicted upon the structural integrity of capillary vessels. Consequently, this heightened permeability may result in increased leakage of fluids and substances from the capillaries. Furthermore, it modifies the interchange of albumin between the intravascular and extravascular compartments. [5] The accurate prediction of patient prognosis in the intensive care unit (ICU) has significant importance in assessing the overall quality of ICU treatment and informing subsequent management choices. The necessity for precise ways to forecast patient outcomes has prompted the development of several scoring systems and metrics aimed at prognosticating various aspects, such as patient mortality. [5]

The evaluations that have been recently created, which rely on physiological variables, possess some limitations due to the need of several variables that may not be feasible to gather for all patients admitted to the intensive care unit (ICU). Hence, it is essential to ascertain non-invasive, straightforward, expeditious, readily available, and uncomplicated methods or indicators for prognosticating the outcomes of patients in the intensive care unit (ICU), particularly in the context of paediatric patients. Nevertheless, there is a lack of available evidence that examines the relationship between serum albumin levels and the occurrence, importance, and prognosis of hypoalbuminemia in pediatric patients who are critically sick and hospitalized to the intensive care unit (ICU). [3,6]

Therefore, the purpose of this study was to assess the prevalence of hypoalbuminemia in critically ill children who were admitted to the paediatric intensive care unit (PICU). Additionally, the study aimed to investigate the relationship between hypoalbuminemia and disease severity, as well as its impact on clinical outcomes. Furthermore, the study sought to examine the classification of hypoalbuminemia in children admitted to the PICU.

Material & Methods

This cross-sectional study was conducted amongst children aged 2 months to 14 years admitted at PICU at Department of Pediatrics, BMIMS, Pawapuri, Nalanda, Bihar, India over a period of 12 months. All the patients aged 2 months to 14 years of age admitted to PICU during the period of 12 months (July 2022 to June 2023) were included in the study by convenience (non-random) sampling method. 200 patients were included in the study.

Inclusion Criteria

- All patients aged 2 months to 14 years of age admitted to PICU and admitted for at-least 24 hours were included in the study.
- Patients who had severe protein energy malnutrition (weight for height-3 standard deviations), chronic liver disease and liver cirrhosis, nephrotic syndrome and nephritis, presence of chronic gastrointestinal or kidney disease affecting the growth (malabsorption syndrome, celiac disease, inflammatory bowel disease, chronic renal failure), receipt of parenteral nutrition before admission, second or third degree burns and patients who received albumin or blood products before measuring the albumin level.

Exclusion Criteria

- Hypoalbuminemia was defined as a serum albumin level of less than 3.5 g/dl for patients and amongst them in mild category were categorised children with serum albumin level between 2.5-3.5 mg/dl and in marked category included children with serum albumin level below 2.5 mg/dl. Patients who were not expected to have a normal albumin level in their usual state of health were excluded

Methodology

All the paediatric intensive care unit admitted children and fulfilling the above-mentioned criteria were studied in detail. Detailed evaluation was done in relation to relevant history, general examination and systemic examination. Above data was documented on a prestructured proforma, following which a provisional diagnosis was made and the necessary investigations including basic and some special investigations was carried out and this data was also recorded in the proforma. Serum albumin level was done in all patients on the day of hospital admission. Depending upon the Serum Albumin level, it was categorised into mild and marked hypoalbuminemia. Then depending upon the frequency of hypoalbuminemia, according to primary system affected and grading of serum albumin level, the data was recorded and interpreted. Clinical course in the hospital in terms of length of hospital stay, use of inotropes and whether on mechanical ventilator was also entered in proforma. Outcome in term of death and discharge was also documented.

Statistical Analysis: The data was compiled and entered in SPSS version 23 for statistical analysis.

Data was studied in detailed in two group of population, amongst the normo-albuminemic group and hypoalbuminemia group. Amongst the Hypoalbuminemia group it was further classified into mild and marked category to study the further outcome. Then analysis was performed using chi square/Fisher's exact test, considering $p<0.05$ as statistically significant.

Results

Table 1: Baseline characteristics of the patients included in the study

Variables	Numbers	Percentages (%)
Age group (Years)		
2 months-5	110	55
6-10	50	25
11-14	40	20
Gender		
Male	120	60
Female	80	40
Presenting symptoms		
Fever	144	72
Cough	40	20
Breathlessness	56	28
Vomiting	104	52
Abdominal pain	48	24
Loose stools	38	19
Oliguria/polyuria	6	3
Headache	24	12
Convulsion	58	29
Altered sensorium	20	10
Other significant complaints	120	60
Presenting signs		
Poor sensorium	32	16
Fever	96	48
Hypotension	80	40
Hypertension	6	3
Signs of shock	76	38
Pallor	58	29
Generalised edema	81	42
Ascites	44	22
Erythematous rash	56	28
Hepatomegaly	72	36

In the total of 200 cases in the present study, Patients aged between 1 month-5years of age comprised 55% (n=110) of total patients accounting for the maximum number amongst all, 6th-10th year of age were 25% (n=50) and 11th-14th year of age were 20% (n=40) respectively. In the total of 200 cases, 120 were males and 80 were females. The most common presenting symptom amongst patients admitted in PICU was fever (72%) followed by vomiting present in 52% of children. Convulsion, breathlessness and abdominal pain were some of the other symptoms observed in 29%, 28% and 24% of children respectively. Hepatomegaly was present in 36% of children. Hypotension and Ascites were present in 40% and 22% of the children.

Table 2: Frequency of hypoalbuminemia among study cases

Variables	Total no. of cases
Total no. of patients included in study	200
Total no. of patients with normal albumin levels	90 (45)
Total no. of patients with low albumin levels	110 (55)

In the present study, 55% patients had low albumin levels and 45% had normal albumin levels.

Table 3: Demonstrating conditions associated with hypoalbuminemia among study cases according to primary system affected

Primary system affected	Hypoalbuminemic group, (n=110)		Normoalbuminemic group,(n=90)		P value
	N	%	N	%	
Acute infectious disease	35	31.81	8	8.88	0.0032
Post COVID MISC	20	18.18	2	2.22	0.01
Cardiovascular system	6	5.45	6	6.66	1
Hematology	6	5.45	8	8.88	1
Central nervous system	8	7.27	36	40	<0.0001
Systemic inflammatory disease	12	10.90	00	-	0.02
Respiratory tract infections	00	0.00	8	8.88	0.0433
Sepsis	18	16.36	4	4.44	0.05
Metabolic	2	1.81	2	2.22	1
Others (Poisoning and envenomation, trauma and surgical conditions)	3	2.72	22	24.44	0.02

According to primary system affected, post COVID MISC, acute infectious diseases, systemic inflammatory disease and sepsis are some of the common conditions associated with higher incidence of hypoalbuminemia. Statistically significant difference was found in this group of population.

Table 4: Demonstrating grading of hypoalbuminemia among study cases

Grading of hypoalbuminemia	Total no. of cases,(n=200) (%)
Normal albumin levels(>3.5 mg/dl)	90 (45)
Mild hypoalbuminemia(2.5-3.5 mg/dl)	80 (40)
Marked hypoalbuminemia(<2.5 mg/dl)	30 (15)

In mild category there were 80 (40%) patients and in severe category there were 30 patients (15%).

Discussion

Albumin is produced in the liver and comprises about 50% of the total proteins found in plasma. It plays a crucial role in the transportation and binding of several molecules. [8] It plays a significant role in the regulation of blood volume, accounting for 80% of its overall control. Approximately 66% of albumin is mostly located in the extravascular compartment. The rate of synthesis and degradation of albumin, as well as its distribution between the intravascular and extravascular compartments, is modified by critical disease. [9] The occurrence of modified distributions in critical illness is associated with an elevation in capillary permeability. Inflammatory illnesses have the potential to expedite the breakdown of albumin, while concurrently reducing its synthesis. [10,11] The accurate prognostication of patients in the intensive care unit (ICU) has significant importance in assessing the overall quality of the ICU and facilitating informed choices pertaining to subsequent patient treatment. Accurate methodologies for forecasting patient outcomes have been deemed necessary, leading to the development of several scoring systems aimed at prognosticating various aspects such as patient mortality. Nevertheless, the task of forecasting the prognosis of critically sick patients, whose state exhibits frequent fluctuations, is a considerable challenge. [12]

Out of the 200 instances examined in this research, patients between the ages of 2 months and 5 years constituted 55% (n=110) of the overall patient population, representing the largest group. Patients aged between 6 and 10 years accounted for 25% (n=50), while those between 11 and 14 years formed 20% (n=40) of the total cases. Out of a sample size of 200 cases, 120 were identified as male while 80 were identified as female, a distribution that aligns with findings from previous research. [13,14] The predominant presenting symptom seen among patients admitted to the Pediatric Intensive Care Unit (PICU) was fever, with a prevalence of 72%. This was followed by vomiting, which was present in 52% of the pediatric population. Convulsions, dyspnea, and stomach pain were identified as additional symptoms seen in 29%, 28%, and 24% of the pediatric population, respectively. The prevalence of hepatomegaly in children was found to be 36%. Hypotension and ascites were seen in 40% and 22% of the pediatric population, respectively. In the current investigation, it was shown that 55% of the patients exhibited low levels of albumin, while the remaining 45% had normal levels of albumin. Based on the major system impacted, it has been shown that post COVID MISC, acute infectious illnesses, systemic inflammatory disease, and sepsis are among the prevalent situations that exhibit a greater prevalence of hypoalbuminemia.

A statistically significant difference was seen within this particular demographic group. In a previous investigation done by Yanni et al. [15], a total of 68 people in the Pediatric Intensive Care Unit (PICU) were examined. Among these individuals, 33 patients (48.5%) exhibited hypoalbuminemia, while the remaining 35 patients (51.4%) had normal levels of albumin. [12] In the present investigation, hypoalbuminemia was operationally defined as a serum albumin concentration below 3.5 mg/dl. This condition was further categorized into two subgroups: mild hypoalbuminemia, characterized by a serum albumin level below 3.5 mg/dl, and marked hypoalbuminemia, defined as a serum albumin level below 2.5 mg/dl. In previous research done by Tiwari et al, hypoalbuminemia was defined as a serum albumin level below 2.5 mg/dl, while Durward et al classified it as a level below 3.3 mg/dl. [9,11]

Research done by Deka et al. found a substantial correlation between a high number of sepsis patients and hypoalbuminemia, which aligns with the findings of our own investigation. [14] Research done by Kumar et al. [8] revealed that hypoalbuminemia was significantly connected with a substantial number of cases related to infectious illnesses. In the light group, a total of 80 people, accounting for 40% of the sample, were seen. Conversely, the severe category consisted of 30 patients, representing 15% of the total population.

Conclusion

The prevalence of hypoalbuminemia is often seen among children who are hospitalized to the Pediatric Intensive Care Unit (PICU). Over the course of the last ten years, the investigation into the use of albumin in the clinical management of critically sick individuals has undeniably generated significant insights that have facilitated the more judicious application of this therapeutic agent. In addition to its oncotic qualities, albumin has several secondary activities that may have a significant influence on various types of disorders. Following the COVID-19 pandemic, there has been an increased prevalence of many medical illnesses, like post COVID MISC, acute infectious diseases, sepsis, and systemic inflammatory diseases. These conditions have been often seen in association with the aforementioned pandemic. Hypoalbuminemia is a significant prognostic factor for mortality in the Pediatric Intensive Care Unit (PICU). Serum albumin, as a readily accessible and cost-effective test, serves as a valuable tool for early discrimination of prognosis and fate in critically sick children due to its simplicity, sensitivity, and specificity.

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