VIA MEDICA

PRACE ORYGINALNE I KLINICZNE

Anestezjologia Intensywna Terapia
2016, tom 48, numer 3, 166–169
ISSN 0209–1712
www.ait.viamedica.pl

Hypoalbuminaemia at admission predicts the poor outcomes in critically ill children

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Abstract

Background: Hypoalbuminaemia at admission is a common finding in patients admitted to the Paediatric Intensive Care Unit (PICU) and it is thought that this may predict morbidity and mortality.

Methods: A retrospective study was conducted in the tertiary hospital. The medical records of critically ill children were reviewed. The data were analyzed for the prevalence of hypoalbuminaemia and outcomes.

Results: Two hundred and two patients were included in the analysis. The incidence of hypoalbuminaemia at admission was 57.9%. These patients had a mortality rate 4 times greater (adjusted odds ratio 3.8; 95% CI: 1.4–10.0), a longer length of PICU stay (8.6 vs. 6.7 days, $P = 0.04$) and a longer period on a ventilator (5.9 vs. 3.9 days, $P = 0.04$) than patients with normal albumin levels.

Conclusions: Hypoalbuminaemia at admission was a predictive factor of poor outcome in critically ill children. It is associated with a higher mortality, a longer length of stay in the PICU, as well as longer ventilator use.

Key words: hypoalbuminaemia; prediction factor; clinical outcomes; critically ill children

Anestezjologia Intensywna Terapia 2016, tom 48, nr 3, 166–169

Serum albumin plays an essential role by maintaining intravascular oncotic pressure and facilitating the transport of many hormones, drugs and bioactive elements in blood circulation. Furthermore, several previous studies showed other functions of albumin such as antioxidant effects, inhibition of platelet aggregation, anti-inflammatory and anti-apoptotic effects [1]. Hypoalbuminaemia is commonly found in patients with heart failure, liver cirrhosis, nephrotic syndrome, severe malnutrition, thermal injuries and protein-losing enteropathy. In critically ill patients, their blood albumin level might be low due to a decrease in synthesis by the liver, an increase in albumin degradation and/or a loss due to capillary leakage during a period of inflammation and infection [2–4]. In adults with critical illness, hypoalbuminaemia is clearly associated with poor clinical outcomes [5]. A meta-analytical study showed the presence of hypoalbuminaemia is connected with a higher mortality rate, length of intensive care unit stay, as well as overall hospital stay, along with duration of ventilator use. It has been estimated that each 10 g L^{-1} decrease in serum albumin will result in a mortality increase of about 137% [5]. However, there is a paucity of studies in the paediatric population, and which show conflicting results.

The aim of this study is to evaluate the prevalence of hypoalbuminaemia and investigate whether it is associated with poor clinical outcomes in the Paediatric Intensive Care Unit (PICU).

METHODS

The study was approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University Hospital, Chiang Mai University. It was a retrospective study conducted in a tertiary care hospital. The electronic medical records of all of the paediatric patients who had been admitted to the 12-bed PICU during the period June 2010 to May 2011 were reviewed. Patients were excluded if they had had underlying diseases or medical treatment which may have interfered with serum albumin levels including as

Należy cytować wersję: *Kittisakmontri K, Reungrongrat S, Lao-araya M:* Hypoalbuminaemia at admission predicts the poor outcomes in critically ill children. Anaesthesiol Intensive Ther 2016; 48: 158–161. doi 10.5603/AIT.a2016.0028.

Table 1. Demographic data of patients. Data given as mean ± SD or n (%)

Data	Hypoalbuminemic group (n = 117)	Non-hypoalbuminemic group (n = 85)	*P*-value
Age (months)	70.5 ± 61.3	46.1 ± 54.5	0.03
Male	61 (52.1)	39 (45.9)	0.38
Serum albumin (g dL^{-1})	2.78 ± 0.27	3.62 ± 0.27	< 0.01
Main causes of PICU admission			
Severe sepsis	34 (29)	12 (14.1)	0.06
Post-operative care	15 (12.8)	26 (30.6)	< 0.01
Respiratory failure	23 (19.6)	17 (20)	0.55
Neurological diseases	20 (17.1)	16 (18.8)	0.71
Cardiac diseases	7 (5.9)	9 (10.6)	0.82
Post-cardiopulmonary resuscitation	3 (2.5)	2 (2.3)	0.63
Multiple organ failure	9 (7.6)	2 (2.3)	0.12
Miscellaneous	6 (5.1)	1 (1.2)	0.31

follows: liver cirrhosis; severe protein energy malnutrition (PEM); second and third degree severe burns; nephrotic syndrome; as well as those patients who had received albumin or parenteral nutrition prior to admission to the PICU.

Hypoalbuminaemia was defined as a serum albumin level of less than 2.5 g dL^{-1} in infants aged less than 7 months and a level less than 3.4 g dL^{-1} in older children [6]. Serum albumin was measured using a photometry technique within 24-hours of admission. Severe sepsis was defined as sepsis complicated by organ dysfunction [7], while the definition of multiple organ failure was in accordance with the definition of the international paediatric sepsis consensus conference [8].

All data were analyzed using the SPSS program version 16 (IBM Corporation, Chicago, USA) and statistical significance was defined as a *P*-value < 0.05. A multiple logistic regression analysis was conducted to assess the relationship between hypoalbuminaemia and clinical outcomes. The results are shown as an odds ratio (OR) with 95% confidence intervals (CIs).

RESULTS

Three hundred and forty-six patients were admitted to the PICU during the study period. 144 patients who met the exclusion criteria were excluded. Data from 202 patients (58%) were analyzed. These patients were divided into two groups, those with hypoalbuminaemia and those without. There was no statistically significant difference in gender between the two groups. However, the mean age was higher in the hypoalbuminaemia group (70.5 vs. 46.1 months, $P = 0.03$). Sepsis was the most common reason for admission to the PICU in these patients. Although there was no difference in most of medical conditions admitted to the PICU, the percentage of post-operative care were dissimilar between hypoalbuminemic and non-hypoalbuminemic group. Most of surgical patients were well-prepared for elective surgery. For example, a complicated adenotosillectomy in high-risk obese children, pulmonary lobectomy and brain tumour removal, thus the surgical patients were significantly higher in the group with normal albumin levels (Table 1). The prevalence of hypoalbuminaemia and the overall mortality rate in the PICU were 57.6% and 18.8%, respectively. The hypoalbuminemic patients had a significantly higher mortality rate, and a longer length of PICU stay and more extended ventilator use than the non-hypoalbuminaemic group (Table 2). Furthermore, hypoalbuminaemia was only an independent variable in increasing mortality (adjusted OR 3.8, 95% CI: 1.4–10), length of PICU stay (8.6 vs. 6.7 days, $P = 0.04$) and ventilator use (5.9 vs. 3.9 days, $P = 0.04$) (Table 2). On the other hand, when the data was compared between patients who had survived and those who had not, there was no significant difference in gender, age or length of PICU stays. However, the survivors were admitted to hospital for a longer period (35.6 vs. 18.8 days, $P < 0.01$), and they needed a shorter duration of ventilation (4.2 vs. 8.7 days, $P = 0.01$). In the non-survival group, a higher incidence of hypoalbuminaemia was found (84.2% vs. 51.8%, $P < 0.01$) (Table 3).

DISCUSSION

This study has given weight to the theory that hypoalbuminaemia is commonly found in the PICU. The present study shows more than half of the patients had a low serum albumin level at the time of admission. More than half of the patients had a low serum albumin level at the time of admission. Moreover, the findings of a higher mortality rate and other adverse clinical outcome associated with hypoalbuminaemia on admission in critically ill children compared to those with normal serum albumin levels are similar to those when compared to findings from previous studies [9–11].

Table 2. Comparison of clinical outcomes between patients with hypoalbuminaemia and those who are non-hypoalbuminemic. Data given as mean ± SD or n (%) otherwise indicated

Clinical outcomes	Hypoalbuminemic group (n = 117)	Non-hypoalbuminemic group (n = 85)	*P*-value
Mortality rate (%)	32 (27.4)	6 (7.1)	< 0.01
Length of PICU stay (days)	8.6 ± 8.9	6.7 ± 5.6	0.04
Length of hospital stay (days)	30.8 ± 30.4	34.8 ± 50.2	0.48
Length of ventilator use (days)	5.9 ± 8.3	3.9 ± 5.8	0.04
Clinical outcomes	**Odds ratio (95% CIs)**	**Adjusted odds ratio (95% CIs)**	
Hospital mortality	4.6 (1.9–12.5)	3.8 (1.4–10)	
Length of PICU stay ≥ 7 days	1.4 (0.8–2.5)	–	
Length of hospital stay ≥ 7 days	1.1 (0.8–2.3)	–	
Length of ventilator use ≥ 3 days	1.4 (0.8–2.5)	1.3 (0.7–2.4)	

Table 3. Comparison between survivors and non-survivors. Data given as mean ± SD or n (%)

Variables	Non-survivors (n = 38)	Survivors (n = 164)	*P*-value
Age (months)	68.6 ± 61.6	58.3 ± (59.2)	0.34
Males	15 (39.5)	85 (51.8)	0.17
Patients with hypoalbuminaemia	32 (84.2)	85 (51.8)	< 0.01
Length of PICU stay, mean (days)	8.5 ± 8.3	7.6 ± 7.7	0.54
Length of hospital stay, mean (days)	18.8 ± 19.7	35.6 ± 42.7	< 0.01
Length of ventilator Use mean (days)	8.7 ± 10.2	4.2 ± 6.3	0.01

The prevalence of hypoalbuminaemia on admission in critically ill children from previous studies is about 33–57% [9–11]. This might reflect the differences in the study population and the definition of hypoalbuminaemia. Tiwari *et al.* [11] defined hypoalbuminaemia as a serum albumin level lower than 2.5 g dL^{-1} while Durward *et al.* [9] defined it as lower than 3.3 g dL^{-1}. In this study, because of the wide age range of the study population, hypoalbuminaemia was defined according to age itself. In order, to give greater weight to all these studies, a clear definition of hypoalbuminaemia in paediatric patients should be made. Due to this limitation, the true prevalence of hypoalbuminaemia is difficult to compare directly.

According to the meta-analytical study there is a strong association between patients with hypoalbuminaemia and high mortality rates in adult intensive care units (ICUs) while the studies in PICUs show conflicting outcomes [5]. The mortality rate in hospitals showed no statistically significant difference between the hypoalbuminaemia and non-hypoalbuminaemia groups in the studies by Durward *et al.* and Tiwari *et al.* [9–11]. However, Horowitz *et al.* [10] reported that the survival rate of hypoalbuminemic patients is significantly less than patients with normal serum albumin. Similarly, this study found a significant association between hypoalbuminaemia and hospital death. The hypoalbuminaemia was the only independent variable of hospital mortality which was shown as an adjusted odds ratio of 3.8 (95% CI: 1.4–10). Nevertheless, the other clinical outcomes, especially the length of PICU stay and the length of ventilator use, were strongly associated with hypoalbuminaemia in critically ill children [9–11]. Moreover, we also found that the non-surviving patients had lower serum albumin levels independent of their age.

In conclusion, this study supports the hypothesis that there is an association of hypoalbuminaemia with adverse outcomes in critically ill children. Patients with hypoalbuminaemia tend to have higher hospital mortality and morbidity. The major limitation of the present study is the fact that as it is a retrospective study, it is very difficult to include the impact of some other variables. Moreover, due to the incomplete retrospective data, the severity of the children's condition at early admission which might have affected outcomes, were unable to be taken in account. Thus, prospective studies with larger sample sizes and clear parameters describing hypoalbuminaemia in children are required.

ACKNOWLEDGEMENTS

1. We are grateful to all patients and their parents who participated in the study.
2. Financial support — none.
3. Conflict of interest — none.

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Otrzymano: 27.08.2015 r.
Zaakceptowano: 9.03.2016 r.