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The Role of Serum Albumin Level during Hospitalization as a Predictor of Complications and Mortality in Children with Burns

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Abstract

Background: Serum albumin can function as a potential biomarker to determine the severity of the injury and clinical staging of children with burns. Therefore, in this study, we investigated the association between serum albumin level and complications and mortality rate in children with burns.

Methods: In this descriptive-analytic cross-sectional study, 85 patients younger than 18 years with burns who were admitted to Shahid Motahari hospital between 2021 and 2022 were studied. Demographic information, including patients' age, sex, weight, underlying diseases, medical information, albumin level, and C-reactive protein (CRP), was obtained from patient records. Patients were observed until discharge. The independent t-test, chi-square, Pearson correlation, and logistic regression were used for analysis and to examine the predictive role of albumin.

Results: Out of 85 patients, 47 and 38 were boys and girls, respectively. The mean age of the participants was 3.69 ± 3.09 years. The mean length of hospital stay was 2.3 days, with a median of 1.5 days. The mean percentage of burns was 23.44 ± 16.50, and burn grade 2 was the most common. A total of 25 patients (29.41%) were admitted to the intensive care unit (ICU), and 13 deaths (15.29%) were observed among the patients. The mean albumin level was significantly lower than in other patients with outcomes of pulmonary infection, sepsis, renal failure, ICU admission, and death ($P < 0.001$).

Conclusion: Serum Albumin has a significant predictive value in death, pulmonary infection, sepsis, admission to the ICU, and renal failure. Serum albumin may be a good prognostic marker associated with morbidity and mortality.

Keywords: Serum Albumin, Hospitalization, Mortality, Burns, Pediatrics

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Introduction

Burns are one of the most destructive and debilitating traumas that can cause functional, cosmetic, and psychological problems (1). It is estimated that approximately 260,000 people die from burns each year, with more than 90% of these deaths occurring in low-income countries (2). Burns are one of the injuries that have high morbidity and mortality. Therefore, evaluating the risk of death in patients with burns is vital to improve treatment and expedite clinical management (3).

Severe burns characterized by ≥20%-30% of the total body surface area result in extensive skin and soft tissue damage, leading to systemic inflammation, hypermetabolism, and multiorgan dysfunction (4). After the initial stage of injury, the second or hypermetabolic phase, severe burns are characterized by increased cardiac output, increased blood flow to major organs, and accelerated catabolism that may persist for months after injury (5).

In recent decades, many efforts have been made for the prognosis and early diagnosis of patients with different severity of burns. The abbreviated burn severity index

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↑What is "already known" in this topic:
Research has shown that biochemical markers such as serum albumin should be considered to predict the condition of children with burns.

→What this article adds:
This study showed that serum albumin is a good predictor of mortality, pulmonary infection, sepsis, admission to the ICU, and renal failure in children with burns.

(ABSI) is the most common prognostic index for predicting mortality. In this regard, quantitative and measurable biochemical variables to the ABSI index can be considered both as an alternative assessment tool and provide valuable information to further validate the usefulness of the ABSI (6, 7).

Hypoalbuminemia is common in critically ill patients, especially burn patients. Severe hypoalbuminemia, defined as an albumin level <2 g/dL, is associated with greater burn area, burn severity, and mortality (8). Even when the burn covers <10% of the body surface, significant metabolic changes occur. Burns cause metabolic and hypercatabolic responses related to the extent and depth of damage (9). Consistent with these findings, the diagnostic value of determining serum albumin levels in predicting mortality and risk of renal disease has been reported (10).

In burns involving >20% of the body surface, there is a large loss of extracellular fluid, which leads to shock by increasing vascular permeability and decreasing plasma albumin from wound exudate. Therefore, hypoalbuminemia can lead to complications associated with increased extravascular fluid, such as edema, delayed recovery, pulmonary lesions, increased susceptibility to sepsis, and death (11, 12). Accordingly, serum albumin level can also serve as a potential biomarker to determine the severity of the injury and help in the clinical grading of patients with severe burns (3, 8). Biomarkers that specify morbidity and mortality and can be assessed on admission to the emergency department are necessary to predict complications, provide therapeutic interventions, and reduce clinical outcomes. Serum albumin level on admission could provide an additional diagnostic and prognostic value or replace subjective indices such as the ABSI and be useful for improving patients with severe burns. Therefore, in this study, we investigated the association between serum albumin level and complications and mortality rate in children with burns.

Methods

Study Design

This was a descriptive-analytic cross-sectional study conducted on burn patients younger than 18 years who were admitted to Shahid Motahari hospital between January 2021 and January 2022. This study was conducted after approval by the Biomedical Studies Ethics Committee of Iran University of Medical Sciences (IR.IUMS.FMD.REC.1400.620). Participants and their parents were assured that participation in the study was voluntary. After receiving informed consent from their parents and a detailed explanation of study procedures, they participated in the study. All children aged 1 to 18 years with any grade of burn and any type of burn (inhalation, electrocution, chemical, and thermal) were included in the study. Patients with chronic renal failure, nephrotic syndrome, chronic liver disease, and trauma were excluded.

Data Collection and Sample Size

Demographic information, including patients' age, sex, weight, underlying diseases, medical information, albumin level, and C-reactive protein (CRP), was obtained from patient records. Patients were observed until discharge. The sample size was based on the study by Bandeira et al. (13). Considering the alpha error level of 5% and the statistical power of 95%, the sample size required to conduct this study was 70 patients. The required sample size was 85 patients if the chance of 20% of study participants withdrawing during the follow-up was also taken into account.

Statistical Analysis

The normality of the data was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests. There was no missing data. Data were expressed as mean ± standard deviation or frequency (percentage). The independent t test, chi-square, and Pearson correlation were used for analysis. Logistic regression was used to examine the predictive role of albumin. The SPSS software package (Version 22.0; SPSS Inc) was used for data analysis at a significance level of 0.05.

Results

A total of 85 patients were included in the study. The mean age of the participants was 3.69 ± 3.09 years (minimum and maximum ages were 1 and 13 years, respectively). The frequency of boys was higher than that of girls (55.29% vs 44.71%). The mean weight was 16.64 ± 8.76 kg. The mean length of hospital stay was 2.3 days, with a median of 1.5 days. The mean percentage of burns was 23.44 ± 16.50, and burn grade 2 was the most common. A total of 25 patients (29.41%) were admitted to the intensive care unit (ICU), and 13 deaths (15.29%) were observed among the patients (Table 1).

The mean albumin level was 3.44 ± 1.05 g/dL, with a minimum of 1.60 and a maximum of 5.50. The mean CRP level was 16.4 ± 34.93, with a minimum of 8 and a maximum of 77. The mean albumin level was significantly lower than in other patients with outcomes of pulmonary infection, sepsis, renal failure, ICU admission, and death ($P < 0.001$).

The Spearman correlation was used to examine the relationship between the length of hospital stay and the

Table 1. Demographic and clinical characteristics of patients

Variable		Frequency	Percentage
Sex	Male	47	55.29
	Female	38	44.71
Burn grade	Two	46	54.12
	Three	4	4.71
	Four	0	0
	Two and three	32	37.65
	Three and four	3	3.53
Type of burn	Inhalation	6	7.06
	Electrocution	5	5.88
	Chemical	1	1.18
	Thermal	73	85.88
Complications	Pulmonary infection	16	18.82
	Sepsis	29	34.12
	Renal failure	9	10.59

Table 2. The effect of serum albumin level on clinical outcomes of patients using univariate logistic regression

Outcomes	Beta	S.E.	P-value	Exp(B)	95% C.I.for EXP(B)	
					Lower	*P*-value
Death	-1.490	.479	.002	.225	.088	.576
ICU Amdission	-3.105	.733	.000	.045	.011	.188
Sepsis	-3.614	.863	.000	.027	.005	.146
Pulmonary Infection	-2.314	.631	.000	.099	.029	.341
Renal Failure	-3.402	1.186	.004	.033	.003	.340

Table 3. Multivariate analysis of covariates candidates affecting the chance of death and ICU admission using logistic regression

Death Covariates	Beta	S.E.	*P*-value	Exp(B)	95% C.I.for EXP(B)	
					Lower	Upper
Alb	1.389	.918	.130	4.012	.664	24.238
Age	-.108	.148	.466	.898	.672	1.200
Sex	.080	.835	.924	1.083	.211	5.566
Percentage of burning	.321	.115	.005	1.378	1.100	1.726
Type of burning	.138	.451	.760	1.148	.474	2.778
Percentage of burning and Serum albumin interaction	-.082	.036	.022	.921	.858	.988
Constant	-9.346	4.707	.047	.000		

amount of albumin and CRP. The results showed that albumin and CRP had a significant inverse and direct relationship with the length of hospital stay, respectively ($P < 0.05$).

To determine the predictive role of albumin in outcomes, the logistic regression test was performed. First, it was performed with the albumin variable only. In the first stage, albumin showed a significant effect on survival ($P < 0.05$). This means that patients with higher albumin levels had a lower hazard ratio for all endpoints (Table 2).

In the second phase, Logistic regression was used to control for age, sex, weight, burn type, and burn percentage variables. Since both albumin and the percentage of burning significantly affect the chance of death, the term interaction was used to adjust their effects. The percentage of burning did not change the chance of ICU admission (Table 3).

Discussion

The present results showed that the mean albumin level was significantly higher in the group in which there were fewer deaths, pulmonary infections, ICU admissions, renal failure, and sepsis than in the other patients. In addition, the results showed that there was an inverse and significant relationship between the amount of albumin and the length of hospital stay. In other words, the length of hospital stay increased with decreasing albumin levels. Albumin played a significant role in predicting death, pulmonary infection, sepsis, ICU admission, and renal failure. One possible explanation for this finding is that serum albumin is a good prognostic marker that correlates with morbidity and mortality. Hypoalbuminemia is caused by low liver synthesis in the post resuscitation period in burn patients and is an indicator of the severity of the underlying disease. Intravenous albumin infusion can correct serum albumin levels but may have little effect on the disease itself (14).

Bandeira et al showed that the rate of hypoalbuminemia was 41.8%, with 11.8% of patients reaching the cutoff of 2.2 g/dL or less. The mortality rate in patients with serum albumin ≤2.2 g/dL was 43.7%. There was a significant association between the decrease in serum albumin level and complications such as pulmonary infections, renal failure, and sepsis, as well as ICU admission and death, and it was found that the most significant risk measure was the predictor of mortality (OR, 18.7) (13), which was completely consistent with the results of the present study. This strong association confirms that albumin stability is a good predictor of death and other outcomes in burn patients.

Romero et al showed that 82.6% of patients had hypoalbuminemia and that there was a strong correlation between burn rate and low serum albumin level. However, their study showed no association between serum albumin level and length of hospital stay, ICU admission, complications, and mortality (15), which is not consistent with the results of the present study. In another retrospective study of 56 patients, hypoalbuminemia (defined as albumin level <3 g/dL) occurring in the first 24 hours after burn injury was associated with more severe organ dysfunction. However, no statistically significant difference in the number of deaths was found in this study between patients with normal albumin levels and patients with reduced albumin levels (16). In a study by Tymowski et al, patients with albumin <23 g/l had a higher mortality rate than patients with albumin ≥23 g/l (42% vs 11%; P = 0.003) (17). This difference in results may be due to the small sample size of the studies.

Yu et al investigated the role of CRP in relation to albumin as a prognostic factor in severe burns. They showed that the ratio of CRP to albumin at admission was an independent risk factor for sepsis and prognosis in severe burns. Total burn severity and CRP to albumin ratio on admission ($P = 0.009$) were 2 independent risk factors for sepsis in severe cases. A higher value (≥1.66) of CRP to albumin ratio during hospitalization was associated with a lower 30-day survival rate ($P = 0.005$) (18). In the present study, CRP levels were significantly higher in the death and sepsis groups. Several studies have shown a strong association between CRP and sepsis. CRP has been proposed as a screening biomarker for neonatal sepsis (19). A study by Ticinesi et al in elderly patients showed that CRP level on admission helps diagnose acute infec-

tion, especially sepsis (20).

Another study by Liu et al showed that CRP is useful for early diagnosis of pneumonia and sepsis and for measuring response to treatment and predicting prognosis in infants (21). A meta-analysis by Tan et al also demonstrated the diagnostic value of CRP for sepsis in adult patients. In addition, the correlation between albumin and sepsis has also attracted much attention (22). Decreased serum albumin levels are frequently observed in patients with inflammatory diseases, including sepsis. This is due to the altered distribution of albumin between the extravascular and intravascular compartments because of increased microvascular permeability (23).

Hypoalbuminemia is strongly associated with increased mortality during ICU admission (24). Albumin not only acts as a plasma volume enhancer but is also an important proinflammatory mediator (25).

Albumin is an important element in modulating the inflammatory response to bacterial infection through albumin complexes with pathogen-associated molecular patterns by binding peptidoglycan, lipoteichoic acid, and lipopolysaccharide (26, 27). Moreover, the increase in extravascular fluids caused by hypoalbuminemia leads to complications such as impaired recovery, edema, and increased susceptibility to sepsis (12). Moreover, excessive oxidative injury is common in sepsis and often leads to cellular dysfunction, death, and organ failure (28), whereas albumin acts as an important protective agent against this oxidative stress (29).

Limitations

Our study has limitations. The sample size was relatively small. This study was conducted in one center and cannot be generalized to the whole community. It is suggested to be done with larger and multicenter samples. It is also possible to examine the variables affecting burns.

Conclusion

Our study showed an inverse and significant relationship between albumin and hospitalization. Albumin played a significant role in predicting death, pulmonary infection, sepsis, ICU admission, and renal failure.

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Ethical Approval

The study protocol was approved by the ethics research committee at Iran University of Medical Sciences (IR.IUMS.FMD.REC.1400.620).

Conflict of Interests

The authors declare that they have no competing interests.

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