The correlation between burn size and serum albumin level in the first 48 hours after burn injury

Ioana Cucereanu-Bădică¹, Irina Luca-Vasiliu¹, Ioana Grinţescu¹, I. Lascăr²

¹ “Floreasca” Emergency Hospital, Department of Anaesthesia and Intensive Care, Bucharest
² “Floreasca” Emergency Hospital, Department of Plastic and Reconstructive Surgery, Bucharest

Abstract

Goal: To determine whether burn size in severely burned patients (more than 25% of body surface area covered with second and third degree burns) influences the level of serum albumin during the first 48 hours after burn injury.

Material and method: This was a retrospective study of forty-seven patients with severe burns ranging from 25% to 90% of total body surface area consecutively admitted to intensive care unit of the Emergency Hospital of Bucharest from January 2006 to December 2012. We studied the relationship between burned surface area and the lowest serum albumin level during the first 48 hours after injury.

Results: There was a negative linear correlation between the burned surface area and serum albumin level during the first 48 hours post injury. We find a mathematic relationship to express this correlation and to calculate the expected level of serum albumin for a specific burned body surface area.

Conclusions: There is a negative correlation between burned surface area and serum albumin level; we proposed a linear polynomial fit in order to describe this correlation. Based on this relationship between those two parameters we suggest administration of intravenous albumin in the first 24 hours post injury, during the initial phase of fluid resuscitation when we would expect low levels of plasma albumin.

Keywords: serum albumin, severe burns, hypoalbuminemia, burn resuscitation

Introduction

Burn size in severely burned patients (more than 25% of body surface area covered with second and third degree burns) influences the level of serum albumin during the first 48 hours after burn injury. There are still lots of debates in the resuscitations guidelines for severely burned patients regarding the use of albumin [1-5]. The general rule now is not to administer albumin during the first 24 hours; however some practitioners advocate the role of albumin therapy during the initial phase of resuscitation [6-10]. The guidelines are the same for severely burned patients and do not take into consideration the magnitude of burn surface area. Since the expected decrease in serum albumin level varies with the percentage of burned body surface area and most of practitioners agree with administration of intravenous albumin when serum albumin level decreases below 2 g/dL we propose to develop a method of calculating the expected serum albumin related to the extent of burn areas. This study tries to seek to find whether there is a relationship between body burned surface area and the lowest serum albumin level during the first 48 hours after injury. When serum albumin level is expected to be lower than 1.5-2 g/dL we feel there are significant benefits to administration of albumin during the initial phase of fluid resuscitation.
Materials and methods

Forty-seven patients with severe burns ranging from 25% to 90% of total body surface area consecutively admitted to intensive care unit of the Emergency Hospital of Bucharest from January 2006 to December 2012 were included in this retrospective study. Inclusion criteria were: age over 14 and under 75 years, burned body surface area greater than 25% and admission in ICU within 48 hours of burn injury. Exclusion criteria were previous chronic illness such as significant cardiovascular, renal or hepatic diseases.

The magnitude of burn surface area expressed as total body surface area (ranging from 25% to 90%) was estimated using the Lund and Browder chart [11].

Serum albumin was determined twice daily and the lowest level of serum albumin during the first 48 hours after admittance was recorded. All patients received a similar resuscitation protocol based on Parkland formula [12], using Ringer’s lactate in the first 24 hours post burn. Surgical procedures at admission included decompression incisions, excision of devitalized tissues and skin grafts. The surgical team was the same throughout the study period. Nutrition was started as soon as feasible and included the enteral route supplemented as necessary by parenteral nutrition to achieve a predetermined nutritional goal.

Results

Baseline characteristics of the 47 subjects enrolled are summarized in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Baseline characteristic of the patients from study group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender M/F</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>range 15 to 61</td>
</tr>
<tr>
<td>BMI*</td>
</tr>
<tr>
<td>range 18.3 to 33.9</td>
</tr>
<tr>
<td>Burned surface (%)</td>
</tr>
<tr>
<td>range 30 to 90</td>
</tr>
</tbody>
</table>

* BMI – Body Mass Index

We found a negative linear correlation between the burned surface area and serum albumin level during the first 48 hours post injury (Fig. 1-3). Additionally, we sought a mathematic relationship to express this correlation. We propose the following linear polynomial fit:

\[
\text{albumin} = p_1 \times \text{burned surface area} + p_2
\]

where:

\* = multiplication

\[p_1 = -0.01925 \text{ (range, -0.02398, -0.01452)}\]

\[p_2 = 2.573 \text{ (range, 2.323, 2.823)}\]
The coefficients p1 and p2 have purely numerical values (there is no correlation between them or with any clinical or physiological parameter); p1 has just negative values – that demonstrates the negative correlation – low albumin levels are correlated with high burned body surface areas.

The values in parentheses represent the minimal and maximal (-0.02398 and -0.01452, respectively) for p1.

For example, for a patient with 60% burned surface area, we calculate an albumin level = 60 * (-0.01925 + 2.573) = 1.418 g/dL.

The minimum albumin level expected for that same burned surface area will be: 60 * (-0.02398 [minimum for p1]) + 2.323 [minimum for p2] = 0.8842 g/dL.

The maximum albumin level expected for that same burned surface area will be: 60 * (-0.01452 [maximum for p1]) + 2.823 [maximum for p2] = 1.95 g/dL.

There was one outlier in our series, a patient with 40% body surface area burns, whose lowest actual serum albumin (1.2 g/dL) was lower than the calculated serum albumin level (1.36-2.24 g/dL). This patient had suffered high-voltage electrocution, followed by a 5-meter fall. He was admitted to the operating room for femoral osteosynthesis and he received more than 12 L of colloids and crystalloids during the first 24 postoperative hours. It is likely that the serum albumin level was falsely low due to significant hemodilution.

Thus, in analyzing our results, we can conclude that the formula can be used to predict the expected serum albumin level in patients with burned body surface areas ranging from 25% to 90% (Fig. 4).

![Fig. 4. Plot of serum albumin level vs burned body surface area (%) with best-line fit and predicted range interval](image)

The residuals represent the difference between the value of serum albumin predicted by the formula and the actual value for the patients included in the study. For example, for a patient with burned surface area of 60%, the predicted serum albumin value is 1.418 g/dL. In our study patients with such burn areas, we found the following values: 1.4, 1.9, 1.8, 1.3, 1.7, 1.6, 1.4, 0.9. The residuals are 0.5, 0.4, -0.1, 0.3, 0.2, 0, -0.5, which represent a relatively uniform distribution around zero (Figure 5).

![Fig. 5. There is no significant difference in the residuals distribution about zero, and the average of residues is approximately zero](image)

**Discussion**

Burn is a very specific type of injury from many points of view. Burn injury induces a particular type of shock, a significant metabolic and stress response, impaired immunity and massive redistribution of intra- and extra-cellular fluids. The understanding of this type of shock and the implementation of burn-specific resuscitation protocols led to a great improvement in the survival rate of victims of burn injury. Debates still exist regarding the fluid of choice in this resuscitation protocol, and regarding the use of intravenous albumin during the initial phase of shock. Despite the recommendations made in December 1995 at the Consensus Conference in Paris [13], many practitioners hesitate to use albumin during the initial resuscitation phase.

A meta-analysis published in 1998 in the British Medical Journal, which reviewed 32 randomized, controlled trials, stipulated that the use of albumin in critical care patients increases the mortality rate by 6% [14]. This meta-analysis, subject to many debates and controversy, nevertheless significantly reduced the use of intravenous albumin in intensive care units. Burn patients are different from other ICU patients from the following point of view: the low levels of serum albumin are not just a consequence of reduced albumin synthesis in response to trauma, but mainly a consequence of great losses of proteins in tissue edema and
exudates. The magnitude of initial hypoalbuminemia is related to the magnitude of burn injury, and this is the reason why, when we expect a very low level of serum albumin, we should administer albumin starting with the initial phase of resuscitation.

We have found that the formula we fitted to the patients’ data can predict the expected serum albumin level for burned surface areas ranging from 25% to 90%. The limitations of this study are the relative paucity of included cases. Some errors could also have been the result of over- or under-estimation of the burned surface area. Excessive resuscitation with intravenous fluids can also lead to false low levels of serum albumin due to hemodilution. Our proposed best-line fit equation is just a prototype. We believe that this formula can be further improved by studying larger groups of burn patients and their serum albumin level in the first 48 hours after injury. The purpose of this correlation between burned surface area and serum albumin level is to establish a maximum acceptable burn body surface area beyond which we should prophylactically administer intravenous albumin for the initial resuscitation phase. In our clinic, this value is 60% of total body surface area. Further studies that include larger numbers of patients are required to determine a more reliable formula of the correlation between burned surface area and albumin plasma level.

Another potential limitation is the fact that for patients with similar burn body surface areas, the relative distributions of second- versus third-degree burns may have been different. At extremes, this may impact on the total intravenous fluid requirement and thus on the potential hemodilution effects, resulting in variability of serum albumin.

Based on this relationship between those two parameters, we suggest administration of intravenous albumin in the first 24 hours post injury, during the initial phase of fluid resuscitation.

**Conclusions**

1. There is a negative association between the total burned body surface area and serum albumin level (i.e., a high percentage of burn surface area is correlated with low levels of serum albumin)
2. There is a correlation between burned body surface area and serum albumin level
3. The correlation between burned body surface area and serum albumin level is not a simple one (there are other factors involved)
4. We propose a linear polynomial fit in order to describe this correlation

**Conflict of interest**

Nothing to declare

**References**


**Corelația dintre întinderea arsurii și nivelul albuminei plasmatice din primele 48 de ore postarsură**

**Rezumat**

**Scopul lucrării:** Magnitudinea arsurii la pacienții cu arsuri severe (mai mult de 25% suprafața corporală arsă de gradul II și III) influențează nivelul albuminei plasmatice din primele 48 de ore postarsură.

**Material și metodă:** Acest studiu retrospectiv a fost efectuat asupra a 47 de pacienți cu arsuri între 25% și 90% admisii în Secția de Terapie Intensivă a Spitalului Clinic de Urgență Floreasca în perioada ianuarie 2006 – decembrie 2012. Am studiat relația dintre suprafața corporală arsă și cel mai scăzut nivel al albuminei plasmatice înregistrat în primele 48 de ore postarsură.
Rezultate: Am găsit o corelație negativă între suprafața arsă și nivelul albuminei plasmatice din primele 48 de ore postarsură. Am elaborat o formulă matematică care exprimă această corelație și permite calcularea nivelului de albumină așteptat în funcție de întinderea arsurii.

Concluzii: Există o asociere negativă între suprafața arsă și nivelul albuminei plasmatice și am propus un fit linear polinomial pentru a descrie această corelație. Pe baza acestei relații matematice propunem administrarea albuminei în primele 24 de ore, încă din faza inițială a resuscitării pacientului ars sever, atunci când ne vom aștepta la scăderea marcată a albuminei serice.

Cuvinte cheie: albumina plasmatică, arsuri severe, hipoalbuminemie, resuscitarea pacientului ars