Significance of levels of serum proteins and serum lipids as prognostic indicators in mortality of burn patients

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ABSTRACT

Background: Burn mortality is significant because of the higher metabolic and physiological abnormalities; it causes more so than because of the actual injury. Since these abnormalities persist throughout the clinical course of burns, it is believed that both the trend of change and absolute values of the serum proteins and serum lipids have an impact on the prognosis and outcome. **Aims and Objectives:** This study aimed to find whether serum albumin, globulin, total protein, cholesterol, and triglyceride levels are clinically relevant to determine the mortality of a burn patient and thereby the patient's outcome. **Materials and Methods**: The current prospective analytical study was carried out in patients who were admitted to the burn unit, Department of Surgery, Shyam Shah Medical College, and associated Sanjay Gandhi Memorial Hospital, Rewa (M.P.), during the period of April 1, 2021–June 30, 2022 (15 months), and the results were analyzed. **Results:** In the present study, a total of 112 patients were studied and followed up. Among them, 86% (96/112) of total patients were survivors who were discharged/DOR in stable condition and 14% (16/112) of total patients expired during the course of treatment. It could be statistically inferred that the increase in values of albumin, globulin, total protein, and cholesterol during the clinical course reduces mortality with serum albumin acting as the best predictor with the highest sensitivity of 100% and specificity of 100% and cholesterol the least. **Conclusion:** It could be statistically inferred that the increase in values of albumin, globulin, total protein, and cholesterol during the clinical course reduces mortality with serum albumin acting as the best predictor and cholesterol the least.

Key words: Burn; Mortality; Prognosis

INTRODUCTION

An injury to the skin and underlying tissues that are predominantly brought on by heat, electricity, friction, or chemical contact is referred to as a "burn."[1] However, systemic symptoms may occur if the burn surface area exceeds 15% of the total body surface area (TBSA).[2] Numerous models have been developed over time for predicting mortality of burn patients and have been successfully applied for assessment, treatment, planning, explaining prognosis and as research tools to compare the efficacy of various therapeutic modalities.[3-5]

Globally, improvements in burn care have drastically altered the clinical course of a patient's recovery and raised the likelihood of survival. The mortality rate is still high, though, and clinical indicators can be used to estimate the likelihood of death.[5-7] Burns display dynamic physiological and metabolic abnormalities during the injury's clinical course.[8-11]

The Acute Physiology and Chronic Health Evaluation and the Abbreviated Burn Severity Index are the two clinical scores that consider sex, age, full-thickness injuries, inhalational injuries, and the percentage of TBSA.[3] Numerous

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physiological and metabolic abnormalities that occur during the patients' clinical care determine mortality in burn patients. Because of increased capillary permeability and an increase in free radical oxidation of serum oxidatively modified proteins, hypoproteinemia occurs during the acute phase of burns. The primary causes for decline in serum protein levels in burn patients are attributed to wound exudation, oxidation of albumin resulting in increase aggregation of platelets and erythrocytes and decrease in protein levels.[2]

Nutritional support is particularly crucial and difficult for burn patients since severe burns result in major metabolic disturbances.

The present study will evaluate the predictive value of changes in the trends of serum proteins and serum lipids and effect to early supplementation in terms of burn patient mortality.

Aims and objectives

This study aimed to find whether serum albumin, serum globulin, serum total protein, serum cholesterol, and serum triglyceride (TG) levels are clinically relevant to determine the mortality of a burn patient and determine the patient's outcome presenting at SGMH, Rewa.

MATERIALS AND METHODS

The prospective cohort study entitled "Significance of levels of serum proteins and serum lipids and their trends as prognostic indicators in mortality of burn patients" was carried out on patients who were admitted to the burn unit, Department of Surgery, Shyam Shah Medical College, and associated Sanjay Gandhi Memorial Hospital, Rewa (M.P.), during the period of April 1, 2021–June 30, 2022 (15 months). After taking ethical clearance from the Institutional Ethical Committee, departmental records were checked, and all the details of the burn patients admitted were included in the study.

Inclusion criteria

1. Patients aged 18 years and above who are admitted to the burn unit at Sanjay Gandhi Memorial Hospital and associated S.S Medical College, Rewa, were included in the study
2. Patients admitted within 24 h of the burn injury were included in the study
3. Percentage of TBSA involved should be 15–60%.

Exclusion criteria

1. Children <18 years of age
2. Patients who had comorbidities such as chronic liver disease, chronic renal disease, diabetes, hypertension, hypothyroidism, and septicemia were excluded
3. Electrical and chemical burns
4. Burns due to extreme cold
5. Thermal injury in pregnant and lactating women
6. 6. Percentage of TBSA <15% and >60%.

All the patients with burn injury who were admitted and fulfilled the inclusion and exclusion criteria were included in our study. After primary survey of the patient, a brief history was obtained from the patients (if conscious) or the accompanying attenders. Blood samples were collected and sent for hematological and biochemical investigations immediately while securing an IV access and simultaneously resuscitating them. Initial fluid resuscitation of burn victims was calculated using the Parkland formula. The rule of nine was used to assess the percentage of TBSA involved in burn injury. The pre-designed pro forma was filled using this information and informed consent was obtained. The patient's serum albumin, globulin, total protein, cholesterol, and TG levels on the day of admission followed by every 72 h were recorded. The patients were monitored during their course of critical illness and suitable IV antibiotics and adequate analgesics were administered.

Patients were grouped into survivors and non-survivors. From the 1st day of admission until discharge or death, the levels of serum albumin, globulin, total proteins, total cholesterol, and TGs were measured every 3rd day (every 72 h).

The cutoff threshold of the parameters (serum albumin, serum globulin, serum total protein, serum cholesterol, and serum TG) utilized in predicting mortality was determined using the receiver operating characteristic (ROC) curve. The lowest cutoff value corresponds to a sensitivity=1 and specificity=0. As the cutoff value increases, the test sensitivity decreases, and the test specificity increases until a cutoff value corresponding to a test sensitivity=0 and specificity=1. Over this interval, there is a cutoff value where the test sensitivity is equivalent to the test specificity. This point, where sensitivity=specificity was used for the determination of the test cutoff value as mentioned in Tables 7 and 8. The results were considered statistically significant with P<0.05.

RESULTS

The present study categorized the patient into survivors and non survivors (Table 1). The values of serum albumin, serum globulin, serum total protein, serum cholesterol and serum Triglycerides were recorded on the day of admission as well as followed by every 72 h (3rd day) and analyzed.

The observation and results were as follows:

In the present study, a total of 112 patients were included and followed up. Among them, 96 were survivors who

were discharged/DOR in stable condition and 16 patients expired during the course of treatment (Table 1).

In the present study, among the survivors, the highest number of patients belonged to the age group of 31–40 years with 44% of total survivor cases followed by 18–30 years with 38% of survivor cases. The least number of cases belonged to 51–60 years with 7% of survivor patients. The mean age among the survivors in our study was 32 years.

Among the non-survivors, the highest number of patients belonged to the age group of 51–60 years with 56% of total non-survivor cases followed by 41–50 years with 31% of non-survivor cases. The least number of cases belonged to 31–40 years with 13% of non-survivor patients. The mean age among the non-survivors in our study was 53 years (Table 2).

In the present study, among the survivors, the highest number of patients showed an involvement of 31–40% TBSA with 45% of survivor patients followed by 21–30% of TBSA in 29% of survivor cases, 41–50% of TBSA in 14%, and 51–60% TBSA in 10% of total survivor patients. The least number of 2% of survivor patients showed 15–20% of TBSA (Table 3).

Serum albumin levels of ≤2.1 g/dL at day 1 were considered a poor prognostic factor with P<0.0001 with a sensitivity of 98.9 and specificity of 100.0 and area under the ROC curve (AUC) of 0.99 (Table 3).

Serum globulin levels of ≤2.0 g/dL at day 1 were considered a poor prognostic factor with P<0.0001 with a sensitivity of 92.6 and specificity of 90.1 and AUC of 0.89 (Table 4).

Serum levels of total protein on day 1 ≤4.2 g/dL were considered a poor prognostic factor with P<0.0001 with a sensitivity of 97.8 and specificity of 99.4 and AUC of 0.98 (Table 5).

Serum cholesterol levels on day 1 ≤88 mg/dL were considered a poor prognostic factor with P<0.0001 with a sensitivity of 75.6 and specificity of 99.5 and AUC of 0.88 (Table 6).

Similarly, serum levels of TGs on day 1 ≥128 m g/dL were considered a poor prognostic factor with P<0.0001 with a sensitivity of 76.7 and specificity of 58.1 and AUC of 0.77 (Table 7).

The cutoff point of serum albumin levels during the course was found to be 1.6 g/dl at which area under the ROC curve was 0.9, signifying mortality chance of 100% with 100% sensitivity and specificity and P=0.0001.

A similar cutoff value of serum globulin levels during the course was 1.8 g/dL at which area under the ROC curve

Table 1: Categorization of patients

Total patients (n)	Survivors		Non-survivors	
	Frequency	Percentage	Frequency	Percentage
112	96	86	16	14

Table 2: Age distribution

S. No.	Age group (years)	Survivors		Non-survivors		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	18–30	36	38	-	-	36	32
2	31–40	42	44	2	13	44	40
3	41–50	11	11	5	31	16	14
4	51–60	7	7	9	56	16	14
	Total	96	100	16	100	112	100

Table 3: TBSA distribution (TBSA%) among patients

S. No.	% TBSA	Survivors		Non-survivors		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	15–20	2	02	-	-	2	2
2	21–30	28	29	-	-	28	25
3	31–40	43	45	-	-	43	38
4	41–50	13	14	6	38	19	17
5	51–60	10	10	10	62	20	18
	Total	96	100	16	100	112	100

TBSA: Total body surface area distribution

Table 4: Serum albumin and serum globulin values during the course of the study

Days	Survivors				Non-survivors				t-test (Serum albumin)	t-test (serum globulin)	P-value
	Serum albumin		Serum globulin		Serum albumin		Serum globulin				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
0	2.71	0.24	2.54	0.21	1.93	0.17	1.86	0.15	12.38	12.54	<0.0001
3	2.78	0.22	2.58	0.21	1.78	0.12	1.74	0.09	17.93	15.61	<0.0001
6	2.85	0.22	2.61	0.21	1.71	0.12	1.66	0.10	20.06	17.43	<0.0001
9	2.91	0.22	2.64	0.21	1.66	0.13	1.58	0.11	21.69	19.31	<0.0001
12	2.99	0.21	2.66	0.20	1.58	0.13	1.50	0.13	23.56	19.89	<0.0001
15	3.06	0.21	2.69	0.20	1.57	0.14	1.48	0.12	19.97	17.09	<0.0001
18	3.13	0.19	2.70	0.19	1.52	0.13	1.43	0.09	19.01	14.93	<0.0001
21	3.18	0.18	2.71	0.18							
24	3.21	0.17	2.73	0.19							
27	3.26	0.19	2.71	0.15							
30	3.32	0.26	2.71	0.27							

Table 5: Serum total protein and serum cholesterol values during the course of the study

Days	Survivors				Non-survivors				t-test (Serum protein)	t-test (serum cholesterol)	P-value
	Total serum protein		Serum cholesterol		Total serum protein		Serum cholesterol				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
0	4.93	0.23	116.99	8.01	3.86	0.20	104.38	17.64	17.71	4.72	<0.0001
3	4.93	0.15	137.05	13.45	3.74	0.20	91.44	8.32	28.70	13.13	<0.0001
6	4.89	0.14	165.08	26.22	3.64	0.39	78.44	12.16	23.59	12.95	<0.0001
9	4.85	0.15	189.27	16.06	3.69	0.09	72.20	9.49	30.00	27.43	<0.0001
12	4.82	0.15	212.70	20.63	3.66	0.08	61.36	13.45	27.49	26.58	<0.0001
15	4.77	0.16	234.95	22.14	3.64	0.05	54.88	8.37	20.00	22.78	<0.0001
18	4.73	0.17	252.36	20.83	3.64	0.05	44.00	5.48	13.93	22.22	<0.0001
21	4.70	0.17	269.78	17.43							
24	4.67	0.18	281.29	15.46							
27	4.69	0.13	291.58	8.43							
30	4.47	0.13	306.00	0.00							

Table 6: Serum triglyceride values during the course of the study

Days	Survivors		Non-survivors		t-test	P-value
	Serum triglyceride		Serum triglyceride			
	Mean	SD	Mean	SD		
0	110.43	28.23	133.63	12.91	3.22	0.002
3	93.41	30.48	140.63	24.13	5.89	<0.0001
6	86.66	23.01	183.13	59.28	11.67	<0.0001
9	80.41	15.75	207.73	62.74	17.07	<0.0001
12	73.41	10.01	244.07	57.18	27.18	<0.0001
15	68.61	8.53	245.13	49.67	30.92	<0.0001
18	63.60	11.59	286.40	45.11	32.59	<0.0001
21	60.67	15.27				
24	58.88	18.61				
27	62.58	20.59				
30	38.00	3.46				

was 0.92 signifying mortality with 83.1% sensitivity and 90% specificity and P=0.0001.

The cutoff point of serum total protein levels during the course was 3.9 g/dL with area under the ROC curve was 0.98 signifying mortality with 95.5% sensitivity and 92.6% specificity and P<0.0001.

The cutoff point of serum cholesterol was 78 g/dL with area under the ROC curve of 0.74 pointing mortality below this point with 48.9% sensitivity and 82.3% specificity and P=0.003.

The cutoff point of serum TG was 206.4 with area under the ROC curve of 0.87 pointing mortality below this point with 96.7% sensitivity and 76.4% specificity and P=0.001 (Table 8).

DISCUSSION

Burns involving >15% of TBSA have a profound systemic response that persists till the wounds heal. Since these physiological and metabolic derangements are dynamic over the clinical course of burns, it is expected that both trend of change and absolute values of the protein and lipid levels, to have a bearing on the prognosis and the ultimate outcome.

In the present study, a total of 112 patients were studied and followed up. Among them, 86% (96/112) of total patients were survivors who were discharged/DOR in

Table 7: Receiver operating characteristic curve for initial prognostication

Parameters	AUC	SE	95% CI		P	Cutoff point (Day 1)	Sensitivity	Specificity
			Lower	Upper				
Serum albumin	0.99	0.006	0.98	1.00	<0.0001	≤2.1	98.9	100.0
Serum globulin	0.89	0.004	0.92	0.90	<0.0001	≤2.0	92.6	90.1
Total protein	0.98	0.008	0.97	1.00	<0.0001	≤4.2	97.8	99.4
Serum total cholesterol	0.88	0.0228	0.83	0.92	<0.0001	≤88	75.6	89.5
Serum triglyceride	0.77	0.0129	0.75	0.80	<0.0001	≥98	76.7	58.1

Table 8: Receiver operating characteristic curve for prognostication during the course

Parameters	AUC	SE	95% CI		P	Cutoff point (during the course)	Sensitivity	Specificity
			Lower	Upper				
Serum albumin	0.90	0.10	0.70	1.00	0.001	≤1.6	100.0	100.0
Serum globulin	0.92	0.02	0.88	0.95	0.001	≤1.8	83.1	90.0
Total protein	0.98	0.011	0.96	1.00	<0.0001	≤3.9	95.5	92.6
Serum total cholesterol	0.74	0.026	0.69	0.80	0.003	≤78	48.9	82.3
Serum triglyceride	0.87	0.012	0.84	0.89	0.001	≥206.4	96.7	76.4

Table 9: Categorization of survivors and non-survivors in various studies

Study ⟶	Gupta et al.[12] (%)	Bandeiraet al.[13] (%)	Present study (%)
Sample size ⟶	100	141	112
Survivors	83 (83)	129 (91)	96 (86)
Non-survivors	17 (17)	12 (9)	16 (14)

stable condition and 14% (16/112) of total patients expired during the course of treatment, signifying that our study had a higher percentage of survivors. The results were similar to a study conducted by Gupta et al.[12] and Bandeira et al.[13] (Table 9).

In the present study, among the survivors, the highest number of patients showed involvement of 31–40% TBSA with 45% of survivor patients, and among the non-survivors, maximum number of patients showed TBSA between 51% and 60% in 62% of non-survivor patients. The results significantly showed that an increase in burn size and higher %TBSA are associated with higher risk of death. Similar results were seen in a study conducted by Kim etal.,[14] suggesting that the burn size >or=65% was associated with a risk of ARF that was 9.9 times and with a risk of death that was 14.2 times as high as that for the burn size.

According to Vanek,[15] serum albumin is a poor nutritional marker, but it is a good prognostic marker correlating with morbidity and mortality in hospitalized patients. For that reason, it is hardly surprising that hypoalbuminemia is associated with increased mortality and prolonged length of stay in ICU. We agree with these statements since our results show an association between higher morbidity, represented in our study by a higher LHS, and lower serum albumin level.

Aguayo-Becerra et al.[4] studied the relation of albumin level at day 1 of burn with the mortality of burn patients and concluded that patients with levels <2 g/dL had a higher risk of mortality which was comparable to our study with

cutoff 2.1 at day 1. In our study, serum albumin on the 1st day of burn was significantly lower in the non-survivor group (1.5 vs. 2.3 g/dL) with a cutoff value was 2.1g/dL below which prognosis was poor. Similar to albumin levels, the globulin level at the 1st day of burn was also lower in the non-survivor group (1.7g/dL vs. 2.5g/dL), and the cutoff value was 2.0 g/dL below which prognosis was considered poor but the sensitivity of 92.6% and specificity of 90.11% which was lower than albumin (Table 7). Similarly, serum levels of TGs on day 1 ≥128 mg/dL were considered a poor prognostic factor and a negative prognostic factor.

Most of the studies from literature cited above correlated only the day 1 levels of serum protein with mortality and not the trend of serial values during the subsequent clinical course. It was observed in our study that there were a significant positive trend of serial serum albumin, globulin, total protein, and cholesterol levels in patients who survived and a gradual negative trend in patients who expired. This trend was reversed in TG levels, which were positive in non-survivors and negative in survivors. These trends can easily be explained by the hypercatabolic impact of burn injury in which there are hypoproteinemia and stimulated lipolysis due to increased glucagon and cortisol levels, suppression of insulin secretion, and peripheral insulin resistance. It could be statistically inferred that the increase in values of albumin, globulin, total protein, and cholesterol during the clinical course reduces mortality with serum albumin acting as the best predictor with the highest sensitivity of 100% and specificity of 100% and cholesterol the least.

Limitations of the study

The only limitation to present study was that it excludes the pre existing co morbid conditions which may change the trend if taken into consideration.

CONCLUSION

The study showed a significant relationship of serum albumin, serum globulin, serum total protein, serum cholesterol, and TGs in prognosis of burn patients. The most important prognostic parameter was found to be serum albumin, whose values on day 1 and during subsequent trend in the course were significantly different among the survivor and non-survivor groups, with maximum sensitivity and specificity. It could be statistically inferred that the increase in values of albumin, globulin, total protein, and cholesterol during the clinical course reduces mortality with serum albumin acting as the best predictor and cholesterol the least.

ACKNOWLEDGMENT

The authors would like to thank the department of surgery and department of pathology with all the nursing and technical staff for their co-operation and co-ordination throughout the period of study.

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