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Serum Albumin as a Prognostic Biomarker for Disease Severity and Outcome in Sepsis: A Cross-Sectional Study from a Tertiary Care Centre in Bengaluru Rural, India

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Abstract: ***Sepsis is a life-threatening syndrome of dysregulated host response to infection and remains a leading cause of morbidity and mortality worldwide. Serum albumin, a negative acute-phase reactant, is frequently reduced in sepsis and has been proposed as a simple, low-cost biomarker of disease severity and prognosis. This cross-sectional study evaluated 70 patients diagnosed with sepsis according to Sepsis Guidelines 2022 at a tertiary care hospital in Bengaluru Rural, India, over an 18-month period. Clinical, laboratory and outcome data, including serum albumin, SOFA/qSOFA scores, organ dysfunction, inotropic requirement and mortality, were recorded and analysed using SPSS version 26, and receiver operating characteristic (ROC) curves were used to assess predictive value. The mean serum albumin level was 2.80 ± 0.54 g/dL, indicating hypoalbuminemia. Albumin was significantly lower in patients requiring inotropic support (2.49 vs 2.88 g/dL, p = 0.015), in those with organ dysfunction (2.43 vs 2.92 g/dL, p = 0.001) and in non-survivors (2.27 vs 2.87 g/dL, p = 0.003), and it declined progressively with increasing severity from sepsis to severe sepsis to septic shock (p = 0.003). ROC analysis showed good predictive value for mortality (AUC 0.784) and organ dysfunction (AUC 0.758) at cut-offs near 1.9 g/dL. Serum albumin shows a strong inverse relationship with severity, organ dysfunction and mortality in sepsis and represents a simple, inexpensive and reliable biomarker for risk stratification, particularly in resource-limited settings.***

Keywords: Sepsis, Serum albumin, Hypoalbuminemia, SOFA score, Prognostic biomarker

1. Introduction

Sepsis is a clinical syndrome of systemic inflammation in response to infection, ranging in severity from mild sepsis to life-threatening septic shock. The Third International Consensus Definitions (Sepsis-3) define sepsis as life-threatening organ dysfunction caused by a dysregulated host response to infection [1]. Despite advances in understanding its pathophysiology, sepsis remains a major cause of morbidity and mortality in intensive care units worldwide [2], with reported incidence rates ranging from 103 to 240 cases per 100,000 population [3, 4, 5].

The pathogenesis of sepsis involves recognition of pathogen-associated molecular patterns by host pattern-recognition receptors, triggering release of pro-inflammatory cytokines, endothelial dysfunction, coagulation activation and impaired tissue perfusion, which together drive multi-organ dysfunction [6, 7]. Scoring systems such as the Sequential Organ Failure Assessment (SOFA) and quick SOFA (qSOFA) have since been incorporated into the Sepsis-3 framework to aid prognostication [8].

Serum albumin, a 66.5-kDa hepatic protein accounting for roughly 60% of total plasma protein, maintains vascular oncotic pressure and glycocalyx integrity, and exhibits antioxidant, anti-inflammatory and immunomodulatory properties. In sepsis, hypoalbuminemia arises from capillary leak, reduced hepatic synthesis and increased catabolism, and low serum albumin has been identified as an independent predictor of mortality in critical illness. Several studies have reported significantly higher mortality among septic patients with low albumin [9, 10, 11], and serial rather than single-point albumin measurements have shown additional prognostic value [12, 13, 14], with proposed target thresholds for improved survival [15]. While randomised evidence on albumin supplementation itself remains inconclusive [16], the low cost and wide availability of serum albumin testing make it an attractive candidate biomarker for risk stratification, particularly in resource-constrained settings. This study aimed to determine serum albumin levels at presentation in patients with sepsis and to correlate these levels with clinical severity and outcome.

2. Materials and Methods

2.1 Study Design and Setting

This cross-sectional observational study was conducted in the Department of General Medicine at Akash Institute of Medical Sciences and Research Centre, Bengaluru, a tertiary care hospital, over an 18-month period (March 2024–September 2025).

2.2 Participants

Inpatients aged above 18 years, of either sex, diagnosed with sepsis according to Sepsis Guidelines 2022 (≥ 2 of: temperature > 38°C or < 36°C, heart rate > 90/min, respiratory rate > 20/min or pCO_2 < 4.3 kPa, and neutrophilia > 12,000/mm³ or neutropenia < 4,000/mm³ with ≥ 10% immature forms), were enrolled after written informed consent. Patients with major surgery, chronic kidney disease, HIV infection, malignancy, nephrotic syndrome, or who were

pregnant/lactating were excluded. The required sample size, calculated using a 95% confidence interval, SD of 5.57 and allowable error of 1.35 ($n = Z^2 \times SD^2/d^2 = 65.39$), was rounded to 70 patients, recruited by systematic random sampling.

2.3 Data Collection

Socio-demographic, clinical and laboratory data were recorded, including complete blood count, liver and renal function tests (including serum albumin), procalcitonin (when indicated), and prothrombin time/INR. SOFA and qSOFA scores were computed, and patients were followed until discharge or death, with mortality, morbidity and duration of hospital stay recorded as outcomes.

2.4 Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables were expressed as mean ± SD and compared using Student's t-test or one-way ANOVA; categorical variables were expressed as frequencies/percentages and compared using the chi-square test. ROC curve analysis was used to assess the predictive value of serum albumin for mortality and organ dysfunction. A p-value < 0.05 was considered statistically significant.

3. Results

Seventy patients were included (mean age 52.71 ± 11.94 years; 60% male), with the largest proportion aged 51–60 years (38.6%). More than half (55.7%) had no documented comorbidity; diabetes mellitus (22.9%) and hypertension (18.6%) were the commonest comorbidities. Baseline vitals and laboratory parameters, summarised in Table 1, showed hypotension, elevated leucocyte count, mild renal and hepatic dysfunction, and reduced serum albumin (mean 2.80 ± 0.54 g/dL).

Table 1: Baseline demographic, clinical and laboratory profile (n = 70)

Parameter	Value
Age, years (mean ± SD)	52.71 ± 11.94
Male sex, n (%)	42 (60.0)
No comorbidity, n (%)	39 (55.7)
Diabetes mellitus, n (%)	16 (22.9)
Hypertension, n (%)	13 (18.6)
SBP / DBP, mmHg	96.14 ± 21.15 / 60.29 ± 13.07
SOFA score	5.90 ± 4.01
qSOFA score	1.10 ± 1.02
WBC, ×10⁹/L	16.43 ± 5.11
Hemoglobin, g/dL	12.14 ± 1.43
Platelets, ×10⁹/L	168.14 ± 61.16
Creatinine, mg/dL	1.33 ± 0.62
Serum albumin, g/dL	2.80 ± 0.54
Inotropic support, n (%)	14 (20.0)
Organ dysfunction, n (%)	17 (24.3)
Hospital stay, days	9.93 ± 3.47
Mortality, n (%)	8 (11.4)

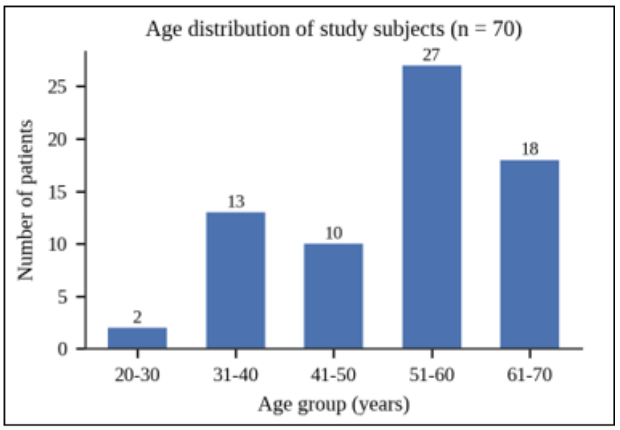

Figure 1: Age distribution of study subjects (n = 70)

Gram-negative organisms were the commonest isolates (42.8%; Escherichia coli 25.7%), followed by gram-positive organisms (22.8%; Staphylococcus aureus 10.0%), while no organism was identified in 31.4% of cases. The respiratory tract was the leading source of infection (27.1%), followed by urinary tract (21.4%) and bloodstream (15.7%). By severity, 62.9% had sepsis, 21.4% severe sepsis and 15.7% septic shock. Mortality rose sharply with severity, from 2.3% in sepsis to 13.3% in severe sepsis and 45.5% in septic shock ($p < 0.001$), as did the requirement for inotropic support (4.5% to 26.7% to 72.7%, $p < 0.001$).

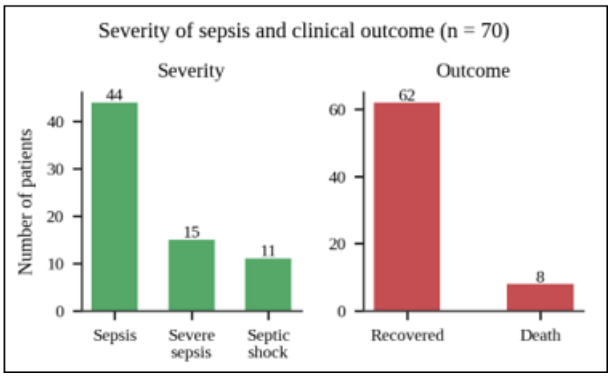

Figure 2: Severity of sepsis and clinical outcome (n = 70)

Table 2: Serum albumin (g/dL) according to clinical severity and outcome parameters

Parameter	Albumin (mean ± SD)	p-value
Inotropic support – Yes	2.49 ± 0.53	0.015
Inotropic support – No	2.88 ± 0.52	
Sepsis	2.93 ± 0.53	0.003
Severe sepsis	2.76 ± 0.44	
Septic shock	2.32 ± 0.49	
Recovered	2.87 ± 0.50	0.003
Death	2.27 ± 0.57	
Organ dysfunction – Yes	2.43 ± 0.45	0.001
Organ dysfunction – No	2.92 ± 0.52	
Source of infection (overall)	—	0.795

Serum albumin thus declined progressively with worsening severity, organ dysfunction, inotropic requirement and mortality, while showing no significant variation across anatomical sources of infection ($p = 0.795$).

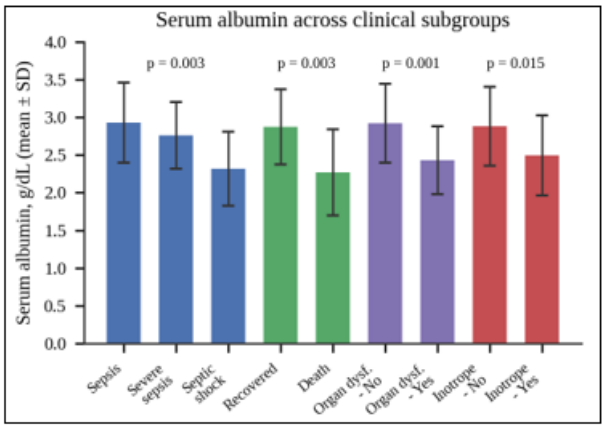

Figure 3: Serum albumin (mean ± SD) across clinical subgroups

Table 3: ROC analysis of serum albumin for predicting mortality and organ dysfunction

Metric	Mortality	Organ dysfunction
AUC	0.784	0.758
p-value	0.009	0.002
95% CI	0.588–0.981	0.130–0.375
Cut-off, g/dL	1.89	1.95
Sensitivity	98.40%	70.60%
Specificity	72.90%	96.20%

Serum albumin showed good discriminative ability for both mortality (AUC 0.784) and organ dysfunction (AUC 0.758), with a cut-off of approximately 1.9 g/dL yielding high sensitivity for mortality and high specificity for organ dysfunction.

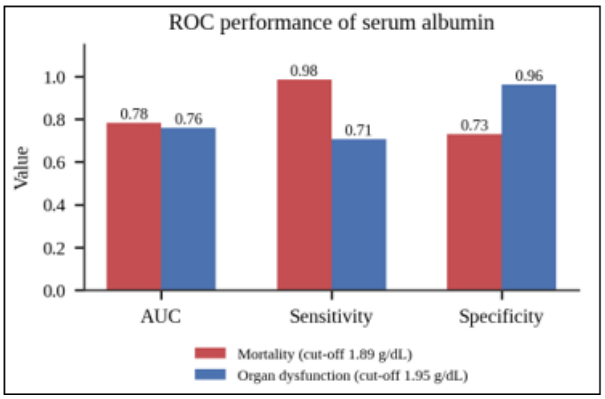

Figure 4: ROC performance of serum albumin for mortality and organ dysfunction

4. Discussion

In this study, a significant inverse relationship was observed between serum albumin and both the severity and outcome of sepsis, consistent with a growing body of literature identifying hypoalbuminemia as a clinically meaningful marker of disease progression rather than a mere laboratory abnormality. The demographic profile – mean age 52.71 years with male predominance (60%) – closely mirrored that reported by Kumar et al. (mean age 52.06 years, 60.8% male) [20] and was broadly consistent with Cao et al. [17], Tie et al. [13] and Rabi et al. [11], although Erdogan et al. reported an older, predominantly female cohort [10], and Farooque et al. a younger population with even stronger male predominance [12], suggesting some regional variation in age distribution despite consistent gender trends.

Baseline hypotension, elevated leucocyte count and moderate SOFA/qSOFA scores in our cohort paralleled findings from Cao et al. [17] and Tie et al. [13], while our mean albumin of 2.80 g/dL was lower than the 3.29 g/dL reported by Kumar et al. [20], possibly reflecting differences in disease severity or case-mix between cohorts. Severity distribution, hospital stay and organ-support requirements in our study were broadly comparable with these series, though ICU-based cohorts such as Tie et al. reported longer stays and higher rates of organ support [13], again likely reflecting a more critically ill population.

Our observed mortality of 11.4% was lower than the 21–56% reported in several ICU-based studies [13, 17, 20] and the 34.1% reported by Erdogan et al. [10], likely reflecting a case-mix weighted toward less severe sepsis (62.9% of our cohort) rather than septic shock. Nonetheless, the gradient of rising mortality with worsening severity in our data mirrors the consistent pattern reported across these studies.

The inverse association between albumin and inotropic requirement, severity, organ dysfunction and mortality observed here is concordant with Cao et al., who reported a graded mortality risk with declining albumin across multiple time points [17]; with Kumar et al., who linked hypoalbuminemia to vasopressor need and mortality [20]; and with Ali et al., who demonstrated a strong negative correlation between albumin and SOFA-defined severity ($r = –0.78$) [19]. The predictive performance observed in our ROC analysis (AUC 0.784 for mortality) is comparable to, or better than, that reported by Erdogan et al. (AUC 0.727) [10] and Rabi et al. (AUC 0.62) [11], and is supported by evidence that serial or dynamic albumin trends may further enhance prognostic accuracy [12, 13, 18].

This study has limitations: the sample size ($n = 70$) was modest, it was conducted at a single centre, and albumin was measured only at a single time point, precluding assessment of dynamic trends that other studies suggest may add further prognostic value.

5. Conclusion

Serum albumin demonstrated a significant inverse relationship with disease severity, organ dysfunction, inotropic requirement and mortality in patients with sepsis, and showed good predictive value for mortality and organ dysfunction on ROC analysis. As a simple, inexpensive and widely available test, serum albumin merits consideration as a routine tool for early risk stratification in sepsis, particularly in resource-limited settings, although larger multicentre and interventional studies are needed to establish its role in guiding management.

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