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Evaluation of Serum Albumin Levels as A Predictor Of Outcomes In Acute Ischemic Stroke

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Abstract

Background: Acute ischemic stroke (AIS) continues to be a primary cause of death and prolonged disability globally. Recognizing early prognostic indicators is essential for forecasting outcomes and informing treatment choices. Serum albumin, a versatile plasm a protein, has demonstrated potential as a predictive biomarker owing to its antioxidant, anti-inflammatory, and neuroprotective characteristics. ***Aim:*** This study aims to assess the prognostic significance of serum albumin levels in patients presenting with acute ischemic stroke.***Materials and Method:*** This was a prospective observational study carried out over 12 months at Government Sivagangai Medical College, Tamilnadu, India. Based on predetermined inclusion and exclusion criteria, 65 patients with a neuroimaging-confirmed acute ischemic stroke diagnosis were enrolled. Serum albumin concentrations were assessed within 24 hours of hospital admission. The National Institutes of Health Stroke Scale (NIHSS) was utilized to evaluate clinical severity upon admission, while functional outcomes were measured using the modified Rankin Scale (mRS) upon discharge and throughout a 3-month follow-up. Patients were classified into two groups according to their serum albumin levels: low albumin (<3.5 g/dL) and normal albumin (≥3.5 g/dL). A statistical analysis was conducted to ascertain the association between albumin levels along with stroke severity, length of hospital stay, and functional outcomes. ***Results:*** Among the 65 patients, 38 (58.5%) exhibited low serum albumin levels, whereas 27 (41.5%) presented with normal values. Patients with low albumin levels demonstrated markedly elevated NIHSS ratings (mean score: 14.2 ± 3.5) in contrast to those with normal albumin levels (mean score: 9.8 ± 2.7; $p < 0.01$), sig nifying more serious strokes. Functional outcomes evaluated by the mRS at three months indicated inferior recovery in the low albumin cohort, with 71% exhibiting an mRS ≥3, in contrast to 33% in the normal albumin cohort ($p < 0.01$). The length of hospital stay was markedly extended in the hypoalbuminemic cohort. Multivariate analysis indicated that low serum albumin independently predicted adverse functional outcomes. ***Conclusion:*** The serum albumin level upon admission is a significant, cost-effective, and readily obtainable prognostic indicator in individuals with acute ischemic stroke. Reduced blood albumin levels are significantly correlated with increased stroke severity, extended hospital stays, and poorer functional outcomes. Timely detection of hypoalbuminemia in AIS patients may facilitate risk assessment and enhance supportive treatment options.

Keywords: Acute ischemic stroke, hypoalbuminemia, prognostic marker, serum albumin, stroke severity.

INTRODUCTION

Stroke continues to be a predominant cause of mortality and chronic disability globally, presenting a significant public health challenge, particularly in low- and middle-income nations.1 Acute ischemic stroke (AIS) is the most common kind of stroke, representing around 85% of all cases.2 The occurrence transpires as a result of the abrupt blockage of a cerebral artery, resulting in diminished blood flow, deprivation of oxygen and glucose to brain tissue, and ultimately neuronal destruction or demise.3

Notwithstanding progress in acute stroke management, such as thrombolysis and mechanical thrombectomy, outcomes continue to be inconsistent and frequently uncertain. Age, stroke severity, comorbidities, and treatment timing are determinants of recovery . Nonetheless, despite analogous clinical presentations, patients frequently demonstrate divergent functional results.4 Consequently, the prompt identification of patients predisposed to adverse outcomes is :L |crucial. Therefore, the early identification of patients at elevated risk of adverse outcomes is essential for

enhancing care, informing treatment choices, and improving prognosis.

Presently employed instruments for evaluating stroke severity and outcomes comprise clinical measures, including the National Institutes of Health Stroke Scale (NIHSS) and the modified Rankin Scale (mRS).5 These measures offer significant insights but are mostly founded on clinical assessment and functional performance. There is an increasing interest in discovering biochemical indicators that could enhance these therapeutic tools by providing early, objective, and easily quantifiable prognostic information. Serum albumin has garnered interest among the several biomarkers being studied because of its diverse physiological functions.6

Serum albumin, produced by the liver, is the predominant protein in human plasma and is essential for sustaining oncotic pressure, as well as for the transport of hormones, fatty acids, and pharmaceuticals.7 Furthermore, albumin demonstrates antioxidant capabilities by neutralizing free radicals and possesses anti-inflammatory actions that aid in the modulation of immunological responses. These multifunctional capabilities render it a possible biomarker in several important conditions, including acute ischemic stroke.8

In the realm of neurological disorders, albumin has demonstrated neuroprotective properties, including the mitigation of oxid ative stress, the attenuation of inflammation, and the enhancement of microcirculation. Reduced serum albumin levels, or hypoalbuminemia, frequently signify inadequate nutritional status, systemic inflammation, or chronic disease – all of which may lead to worse outcomes in stroke patients.9

Prior research has indicated that hypoalbuminemia correlates with elevated death rates, prolonged hospitalizations, and poorer functional outcomes in patients with acute medical conditions, such as stroke. Nonetheless, the evidence concerning the predictive significance of serum albumin in Acute Ischemic Stroke (AIS) is still restricted and inconsistent, especially in prospective trials employing standardized outcome criteria. The authors aim to ascertain if serum albumin can function as a dependable, cost-effective, and readily obtainable predictive biomarker in acute ischemic stroke (AIS) by examining its correlation with clinical outcomes, including stroke severity, length of hospital stay, and temporal functional recovery.

AIMS AND OBJECTIVES

• To assess the prognostic significance of serum albumin levels in patients presenting with acute ischemic stroke.

MATERIALS AND METHODS

This prospective observational study was conducted at Government Sivagangai Medical College in the Department of General Medi cine, over a period of 12 months, from March 2024 to February 2025. The study included patients admitted with acute ischemic stroke to the Medical Intensive Care Unit (MICU) and general medicine wards of the hospital. A total of 65 patients diagnosed with acute is chemic stroke, confirmed by neuroimaging (CT or MRI brain), were enrolled during the study period. Written informed consent was obtained from all participants or their legally authorized representatives.

Inclusion criteria:

• Patients aged 18 years and above.
• Patients admitted with a confirmed diagnosis of acute ischemic stroke (based on clinical presentation and radiological imaging).
• Patients who presented within 72 hours of symptom onset.
• Patients willing to give informed consent for participation (or through their guardian).

Exclusion criteria:

• Patients with hemorrhagic stroke, transient ischemic attacks (TIA), or stroke mimics.
• Patients with chronic liver disease, nephrotic syndrome, or malignancy, as these conditions may affect serum albumin levels.
• Patients with systemic infections, sepsis, or active inflammatory diseases at the time of admission.
• Patients with recent surgery or trauma within the past 4 weeks.
• Patients on long-term corticosteroid or immunosuppressive therapy.
• Pregnant or lactating women.

Upon acquiring informed consent, all qualifying patients admitted with acute ischemic stroke were included in the study. Upon admission, a comprehensive clinical assessment was conducted, encompassing the collection of demographic information, medical history, and stroke risk factors including hypertension, diabetes mellitus, tobacco use, and previous cardiovascular conditions. The National Institutes of Health Stroke Scale (NIHSS) was utilized to evaluate neurological state and quantify stroke severity.

Venous blood samples were obtained within the initial 24 hours of hospitalization to assess serum albumin concentrations. The samples underwent processing in the biochemistry laboratory for albumin quantification. All patients had neuroimaging (CT or MRI of the brain) to validate the diagnosis of acute ischemic stroke and exclude hemorrhagic stroke or other differential diagnoses. Comprehensive laboratory assessments, encompassing complete blood count, renal and hepatic function tests, blood glucose levels, lipid profile, and

electrocardiogram (ECG), were conducted to evaluate overall health and detect any problems.

Patients received management according to established stroke care procedures in the Medical Intensive Care Unit or medical wards, encompassing supportive care, monitoring for neurological decline, and secondary preventive strategies.

Functional outcomes were assessed at discharge and two months post-stroke utilizing the modified Rankin Scale (mRS) to evaluate the level of disability or reliance. Patients were categorized according to serum albumin levels at admission (low albumin <3.5 g/dL and normal albumin ≥3.5 g/dL), and clinical outcomes, such as stroke severity, length of hospital stay, and functional recovery, were compared between the groups.

Data was evaluated with SPSS software, version 20.0. Continuous variables were represented as mean ± standard deviation, whereas categorical variables were denoted as frequencies and percentages. Group comparisons employed t-tests for continuous data and Chi- square or Fisher's exact tests for categorical data. Correlations were assessed using Pearson or Spearman coefficients. A p-value of less than 0.05 was deemed significant.

RESULTS

A total of 65 patients diagnosed with acute ischemic stroke and admitted to the Medical ICU and medicine wards at Govt. Sivagangai Medical College were included in the study. Patients were grouped based on their serum albumin levels into two categories:

- **Low albumin**: <3.5 g/dL
- **Normal albumin**: ≥3.5 g/dL

The majority of patients (87.7%) were over 40 years of age, with the highest proportion (>60 years). Males were more commonly affected than females. (Table 1)

Table 1: Age and Gender Distribution

Demographic Variable	Category	Frequency (n = 65)	Percentage (%)
Age group (years)	18–40	8	12.3%
	41–60	26	40.0%
	>60	31	47.7%
Gender	Male	38	58.5%
	Female	27	41.5%

Hypertension and diabetes were the most prev alent risk factors. Smoking was also seen in over one-third of patients. (Table 2) **Table 2: Common Risk Factors Among Patients**

Risk Factor	Present (n)	Percentage (%)
Hypertension	47	72.3%
Diabetes Mellitus	39	60.0%
Smoking	24	36.9%
Dyslipidemia	17	26.2%
Atrial Fibrillation	6	9.2%
Previous Stroke/TIA	8	12.3%

Hypoalbuminemia was observed in more than half of the patients, indicating a high burden of low serum albumin in acute ischemic stroke.

Table 3: Distribution of Serum Albumin Levels

Serum Albumin	Number	Percentage (%)
<3.5 g/dL	38	58.5%
≥3.5 g/dL	27	41.5%

Patients with low serum albumin had significantly higher NIHSS scores, suggesting more severe strokes at presentation.

(Table 4) **Ta ble 4: Comparison of Mean NIHSS Scores by Albumin Level**

Albumin Group	NIHSS Mean ± SD	Correlation Coefficient (r)	p-value
<3.5 g/dL (Low)	14.2 ± 3.5	-0.56	<0.01
≥3.5 g/dL (Normal)	9.8 ± 2.7		

A significantly higher proportion of patients with normal albumin had favorable outcomes at 3 months, as indicated by mRS scores.

Functional Outcome (mRS)	Total	Low Albumin (<3.5)	Normal Albumin (≥3.5)	Correlation Coefficient (r)	p-value
Good (mRS 0–2)	29	11 (28.9%)	18 (66.7%)	-0.49	<0.01
Poor (mRS 3–6)	36	27 (71.1%)	9 (33.3%)		

(Table 5) **Table 5: Functional Outcome at 3 Months (Modified Rankin Scale)**

Patients with low serum albumin had significantly longer hospital stays, possibly reflecting greater disease severity or complications. (Table 6) In- hospital mortality was higher among patients with low albumin levels, and the difference was statistically significant. (Table 7)

Table 6: Comparison of duration of Hospital Stay among the Groups

Albumin Group	Hospital Stay (days) Mean ± SD	Correlation Coefficient (r)	p-value
Low Albumin (<3.5)	10.4 ± 3.2	-0.41	<0.05
Normal Albumin (≥3.5)	7.6 ± 2.5		

Table 7: Comparison of In-hospital Mortality

Albumin Group	Mortality Rate (%)	p-value
Low Albumin (<3.5)	13.2%	<0.05
Normal Albumin (≥3.5)	3.7%	

DISCUSSION

The demographic distribution in this study matched global stroke trends, with 87.7% of patients over 40 years of age and a greater prevalence of males (58.5%) compared to females (41.5%). This aligns with other research indicating that advancing age and male sex are non-modifiable risk factors for stroke. The heightened risk of stroke in the elderly may be attributed to age-related vascular alterations and a greater prevalence of comorbidities. Erameh CO et al.10 determined that the average age of the patients was 62.81 ± 12.71 years. The research indicated that females represented 51.9% of cases, contrasting with the current study.

Hypertension (72.3%) and diabetes mellitus (60%) were the most prevalent risk factors, followed by smoking (36.9%) and dyslipidemia (26.2%). These findings corroborate the acknowledged significance of vascular risk factors in the etiology of ischemic stroke. Atrial fibrillation and previous stroke or TIA were observed in a limited subset of patients, highlighting the complex aspects of stroke pathogenesis.
Erameh CO et al.10 identified the prevalent risk factors as hypertension (76.9%), hyperlipidemia (38.5%), alcohol consumption (26.9%), and diabetes mellitus (26.9%). In the study conducted by Saini S et al.12 alcohol consumption was seen in 34.5% of cases, smoking in 32.1%, tobacco use in 9.5%, diabetes mellitus in 53.57%, and hypertension in 82.1% of patients.

Notably, hypoalbuminemia (serum albumin <3.5 g/dL) was observed in 58.5% of the patients. This discovery was clinically significant, as serum albumin serves as an indicator of nutritional status and systemic inflammation, both of which affect recovery after a stroke. Multiple pathways may elucidate the detrimental effects of decreased albumin: diminished antioxidant defense, compromised endothelial function, and heightened vulnerability to infections and consequences.Aman H et al.13 conducted a study with 196 acute ischemic stroke pati ents, of whom 90 (45.9%) exhibited hypoalbuminemia, while 106 (54.1%) did not. In the study conducted by Shaikh F et al.14 a total of 90 cases, representing 45.9%, exhibited hypoalbuminemia.

The severity of stroke, indicated by the NIHSS score, was markedly elevated in the low albumin cohort (mean 14.2 ± 3.5) relative to the normal albumin cohort (mean 9.8 ± 2.7), exhibiting a robust negative correlation ($r = -0.56$, $p < 0.01$). This signifies that diminished albumin levels correlate with more severe neurological impairments upon presentation. These findings align with previous research indicating that diminished albumin levels signify an increased inflammatory burden and inferior baseline health state, both of which may intensify stroke severity.

At three months, functional results, evaluated via the modified Rankin Scale, were markedly superior in patients with normal albumin levels. In patients with normal albumin levels, 66.7% achieved favorable outcomes (mRS 0–2), whereas only 28.9% of those with low albumin levels did so ($p < 0.01$, $r = -0.49$). This reinforces the concept that serum albumin serves as a dependable prognostic indicator in ischemic stroke,

with elevated levels correlating with improved recovery and functional autonomy.

Pantha B et al.15 demonstrated a substantial association between blood albumin levels and the NIHSS score in their investigation. The study demonstrated a moderate to severe negative connection between serum albumin levels and mRS scores.

Furthermore, diminished albumin levels correlated with an extended hospital stay (mean 10.4 ± 3.2 days) relative to the normal albumin cohort (mean 7.6 ± 2.5 days), exhibiting a weak to moderate negative correlation ($r = -0.41$, $p < 0.05$). This indicates that hypoalbuminemic individuals may encounter increased problems or delayed recovery, necessitating extended hospitalization.

Thongprayoon C et al.16 reported that an entrance serum albumin level of <4.0 g/dl was substantially correlated with an exten ded hospital stay, whereas an admission serum albumin level of ≥4.5 g/dl was significantly linked to a reduced hospital stay, in comparison to serum albumin levels of 4.0–4.4 g/dl.

The in-hospital mortality rate was elevated in the low albumin group (13.2%) relative to the normal albumin group (3.7%), with this disparity being statistically significant ($p < 0.05$). This discovery is significant, since it suggests that blood albumin levels upon admission may act as an early indicator of mortality risk in individuals with acute ischemic stroke.

Violi F et al.17 noted that acutely unwell hospitalized medical patients with serum albumin levels ≤3.4 g/dL face an elevated risk of all -cause death and ischemia events; thus, measuring albumin may assist in identifying hospitalized patients with a worse prognosis. Akirov A et al.18 also found that in patients presenting with hypoalbuminaemia, the normalization of albumin levels prior to discharge correlated with a reduced risk of short-term (12% vs 1%) and long-term mortality (42% vs 17%).

This study highlights the predictive significance of serum albumin in acute ischemic stroke. Reduced blood albumin levels were consistently linked to greater stroke severity, inferior functional outcomes, extended hospitalizations, and elevated mortality rates. The findings indicate that serum albumin, a straightforward, cost-effective, and readily accessible test, can serve as an auxiliary instrument for risk stratification and the formulation of early intervention strategies in stroke therapy.

CONCLUSION

The study established a notable correlation between blood albumin concentrations and clinical outcomes in individuals with acute ischemic stroke. Patients with low blood albumin levels (<3.5 g/dL) had more severe neurological impairments, endured prolonged hospit alizations, shown inferior functional outcomes at three months, and had an elevated in-hospital death rate relative to those with normal serum albumin levels. These findings indicate that serum albumin may function as a significant, economical predictive biomarker for the early evaluation of stroke severity and outcome prediction. Systematic assessment of serum albumin upon admission may assist in identifying high-risk patients who may require enhanced surveillance, intensive supportive care, and nutritional optimization.

Integrating serum albumin assessment into stroke diagnostic methods may enhance the management of patients and resource allocation due to its easy availability and clinical significance. Larger multicentric studies are necessary to corroborate these findings and investigate potential treatment implications.

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Conflicts Of Interest

There are no conflicts of interest

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