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Original Research Article

PROGNOSTIC SIGNIFICANCE OF SERUM ALBUMIN AND TOTAL CHOLESTEROL IN PATIENTS WITH ACUTE DECOMPENSATED HEART FAILURE: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute decompensated heart failure (ADHF) is associated with substantial morbidity and in-hospital mortality. Identification of inexpensive and routinely available biomarkers that can assist in early risk stratification may be clinically useful. Serum albumin and total cholesterol have been proposed as markers reflecting nutritional and inflammatory status and may have prognostic relevance in patients with heart failure. The objective is to evaluate the prognostic significance of serum albumin and serum total cholesterol in patients admitted with acute decompensated heart failure and to assess their association with in-hospital mortality and duration of hospital stay.

Materials and Methods: A hospital-based observational study was conducted among 50 patients aged 18–65 years admitted with acute decompensated heart failure at Mahatma Gandhi Memorial Government Hospital attached to K.A.P.V. Government Medical College, Tiruchirappalli. The study was conducted from December 2017 to December 2018. Patients with acute coronary syndromes, severe arrhythmias, respiratory support requirement, cirrhosis, end-stage renal disease requiring dialysis, nephrotic syndrome and malignancy were excluded. Clinical examination, electrocardiography, echocardiography, chest radiography and laboratory investigations including serum albumin, total cholesterol, haemoglobin, blood urea and serum creatinine were performed. Associations were assessed using chi-square and Student's t tests, with $p<0.05$ considered statistically significant.

Results: The mean age was 54.7 ± 6.72 years and 70% were male. The mean serum albumin concentration was 3.26 ± 0.521 g/dL and mean total cholesterol was 162 ± 26.37 mg/dL. Hypoalbuminemia was present in 70% of participants and hypocholesterolemia in 16%. Nine patients died during hospitalization, giving an in-hospital mortality of 18%. Mean serum albumin was significantly lower among non-survivors than survivors (2.722 vs. 3.383 g/dL, $p<0.001$), while mean total cholesterol was also lower among non-survivors (141.44 vs. 166.56 mg/dL, $p=0.008$). Hypoalbuminemia and hypocholesterolemia were significantly associated with mortality. Among survivors, hypoalbuminemia and hypocholesterolemia were associated with longer hospital stay.

Conclusion: Lower serum albumin and total cholesterol concentrations were associated with adverse in-hospital outcomes among patients with ADHF. These routinely available biochemical parameters may have potential value in early clinical risk assessment, although larger studies with longer follow-up are required.

Keywords: Acute decompensated heart failure, serum albumin, total cholesterol, hypoalbuminemia, hypocholesterolemia.

INTRODUCTION

Acute decompensated heart failure (ADHF) is a major clinical syndrome characterized by the acute onset or worsening of symptoms and signs of heart failure requiring hospitalization. It represents an important cause of morbidity and mortality, particularly among patients with advanced cardiovascular disease and multiple comorbidities.[1, 2] The clinical presentation is heterogeneous and may range from predominantly pulmonary or systemic congestion to severe haemodynamic compromise.[3] Despite advances in the diagnosis and management of heart failure, hospitalized patients with acute heart failure continue to experience substantial short-term mortality and prolonged hospital stays.[4] Early identification of patients at increased risk of adverse outcomes is therefore an important component of clinical management.[5] Heart failure develops as a consequence of structural or functional abnormalities of the heart that impair ventricular filling or ejection of blood.[6] Coronary artery disease, hypertension, cardiomyopathy and chronic pulmonary disease are among the important conditions associated with the development and progression of heart failure. In acute decompensation, neurohormonal activation, haemodynamic disturbances, fluid retention and systemic inflammatory responses may contribute to worsening cardiac function and clinical deterioration.[7] Assessment of disease severity traditionally incorporates clinical examination, blood pressure, heart rate, renal function, electrocardiographic findings, chest radiography, echocardiography and established clinical scoring systems such as the Boston criteria.[8] In addition to conventional clinical parameters, biochemical markers may provide useful information regarding the physiological and nutritional status of patients with heart failure.[9] Serum albumin is an inexpensive and routinely measured laboratory parameter that is influenced by nutritional status, hepatic synthesis, inflammation and fluid distribution. Hypoalbuminemia has been described in patients with cardiovascular disease and heart failure and has been associated with adverse clinical outcomes.[10] The prevalence of hypoalbuminemia may vary according to the severity and clinical characteristics of the population studied, with particularly high frequencies reported among frail patients with acute heart failure.[11] The relationship between serum albumin and outcome in heart failure may be multifactorial. Reduced albumin concentrations may reflect inadequate nutritional intake, systemic inflammation, disease severity and altered protein metabolism. Previous studies cited in the source literature have suggested that hypoalbuminemia may be associated with increased risk of mortality in hospitalized patients with heart failure. In the present study, serum albumin was therefore evaluated as a readily available biomarker that could potentially complement conventional clinical assessment.[12]

Serum total cholesterol has traditionally been recognized as an important cardiovascular risk factor, particularly in relation to coronary artery disease. However, among patients with established heart failure, the relationship between cholesterol concentration and outcome appears to be more complex.[13] Several studies have reported an association between low serum cholesterol and poor prognosis in patients with congestive heart failure. Hypocholesterolemia may reflect severe systemic illness, altered metabolism, inflammation or poor nutritional status rather than simply indicating reduced cardiovascular risk.[14] The simultaneous assessment of serum albumin and total cholesterol may therefore provide information regarding the overall biological and nutritional state of patients presenting with acute decompensated heart failure. Both parameters are inexpensive, widely available and can be obtained using routine laboratory investigations. Previous work has reported associations between these biomarkers and hospital mortality in patients with severe acute heart failure, but their clinical relevance may vary according to patient characteristics and disease severity.[15] The present study was undertaken to evaluate the prognostic significance of serum albumin and serum total cholesterol in patients with acute decompensated heart failure, with particular emphasis on their association with in-hospital mortality and duration of hospital stay. The study also assessed the relationship of these biochemical parameters with clinical severity indicators, including heart rate, Boston score and left ventricular ejection fraction. By evaluating these routinely available biomarkers alongside established clinical parameters, the study aimed to determine their potential usefulness in the early assessment of patients with ADHF.

MATERIALS AND METHODS

Study Design and Setting: The present study was a hospital-based observational study conducted among patients admitted with acute decompensated heart failure (ADHF). The study was carried out in the emergency department of Mahatma Gandhi Memorial Government Hospital, attached to K.A.P.V. Government Medical College, Tiruchirappalli, Tamil Nadu. The study was conducted over a period of one year, from December 2017 to December 2018.

Study Population and Sample Size: A total of 50 patients admitted with acute decompensation of heart failure were included in the study. The study population was evaluated with respect to the severity of illness, serum albumin concentration, serum total cholesterol concentration, in-hospital mortality, and duration of hospital stay.

Inclusion Criteria

Patients were eligible for inclusion if they fulfilled the following criteria:

1. Age between 18 and 65 years.
2. Patients with a primary diagnosis of acute decompensated heart failure.
3. Presence of clinical symptoms and signs suggestive of heart failure.
4. Clinical improvement/response to intravenous furosemide therapy.
5. Willingness to participate in the study and provision of informed consent.

Exclusion Criteria

Patients were excluded if they fulfilled any of the following criteria:

1. Age <18 years or >65 years.
2. Acute coronary syndrome identified by ECG and echocardiography.
3. Permanent pacemaker pacing.
4. Severe cardiac arrhythmias, including atrial fibrillation, ventricular tachycardia, or ventricular fibrillation.
5. Requirement for respiratory support.
6. 6.Liver cirrhosis.
7. End-stage renal disease requiring dialysis.
8. Nephrotic syndrome.
9. Malignancy.
10. Patients unwilling to participate in the study.

Ethical Considerations: Approval for conducting the study was obtained from the Institutional Ethical Committee. Written informed consent was obtained from all study participants and from relatives wherever necessary. The purpose and design of the study were explained to the participants before enrolment, and participation was voluntary. Refusal to participate did not affect the medical treatment provided to the patient.

Clinical Assessment and Data Collection: At admission, all eligible patients underwent a detailed clinical examination. Relevant clinical information, including vital parameters, was recorded to assess the presence and severity of acute decompensated heart failure. Patients were evaluated for the severity of heart failure using clinical parameters and the Boston heart failure score. Echocardiographic assessment was performed to determine the left ventricular ejection fraction (LVEF). The study also recorded relevant underlying cardiac diseases and associated comorbidities.

Laboratory Investigations: Blood samples were collected at the time of admission, and a fasting blood sample was collected the following morning. Samples were sent immediately to the laboratory for analysis.

The following laboratory investigations were performed:

- Serum albumin
- Serum total cholesterol
- Blood urea
- Serum creatinine
- Hemoglobin
- Cardiac enzymes

In addition, the following investigations were performed as part of the clinical evaluation:

- Electrocardiogram (ECG)
- Echocardiography
- Chest radiography

The source study specifically reports serum albumin, total cholesterol, urea, creatinine, cardiac enzymes and hemoglobin as laboratory investigations performed, along with ECG and echocardiography.

Assessment of Serum Albumin: Serum albumin concentration was assessed in all study participants. For analysis, patients were categorized according to serum albumin concentration.

Hypoalbuminemia was defined as: Serum albumin <3.5 g/dL

Patients with serum albumin ≥3.5 g/dL were considered to have normal albumin levels. The original study classified 15 patients (30%) as having normal albumin and 35 patients (70%) as having hypoalbuminemia.

Assessment of Serum Total Cholesterol: Serum total cholesterol was measured in all study participants. For the purpose of analysis, hypocholesterolemia was defined as serum total cholesterol <135 mg/dL, as used in the study. The study subsequently compared serum cholesterol concentrations between survivors and non-survivors and evaluated the association between hypocholesterolemia and in-hospital mortality.

Echocardiographic Assessment: Two-dimensional echocardiography was performed as part of the evaluation of patients with acute decompensated heart failure. Left ventricular ejection fraction (LVEF) was recorded and used as an indicator of cardiac systolic function. The relationship between LVEF and serum albumin and serum total cholesterol was also evaluated in the statistical analysis.

Study Outcomes: The principal outcome assessed in the study was in-hospital mortality among patients admitted with acute decompensated heart failure. The secondary outcome was duration of hospital stay. The study also evaluated the relationship of serum albumin and serum total cholesterol with selected clinical and echocardiographic parameters, including:

- Age
- Heart rate
- Boston heart failure score
- Left ventricular ejection fraction
- Duration of hospital stay

The original study specifically evaluated 50 patients with respect to disease severity, mortality and duration of hospital stay.

Statistical Analysis: All collected data were tabulated and analyzed using SPSS version 22.0. Continuous variables were expressed using mean and standard deviation (SD). The Chi-square test was used to assess associations between qualitative variables. The Student's t-test was used for comparison of quantitative variables between groups. Correlation analysis was performed to evaluate relationships between serum albumin, serum total cholesterol and other clinical parameters. A p-value

<0.05 was considered statistically significant. The source document confirms the use of SPSS 20, mean and standard deviation, Chi-square testing for qualitative variables, and t-test for quantitative comparisons.

RESULTS

As shown in [Table 1], the study population consisted of 50 patients with ADHF. The age of the patients ranged from 40 to 65 years, with a mean age of 54.7 ± 6.72 years [Figure 1]. The largest proportion of patients belonged to the 56–60-year age group (28%), followed by patients aged 51–55 years (24%). Patients aged 46–50 years and 61–65 years constituted 20% each, whereas 8% belonged to the 40–45-year age group. With regard to sex distribution, 35 patients (70%) were male and 15 (30%) were female, demonstrating a male predominance in the study population [Figure 2]. The mean heart rate was 100.66 ± 18.398 beats/min, with a range of 56–142 beats/min. The mean systolic and diastolic blood pressures were approximately 114.04 mmHg and 70.00 mmHg, respectively. Thus, the baseline profile demonstrated a predominantly middle-aged/older male study population with a relatively high mean heart rate.

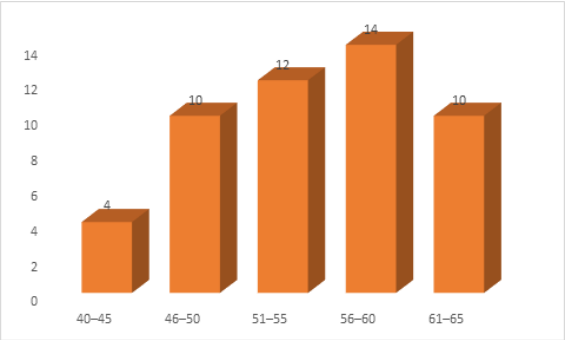

Figure.1: Age-Wise Distribution of study population

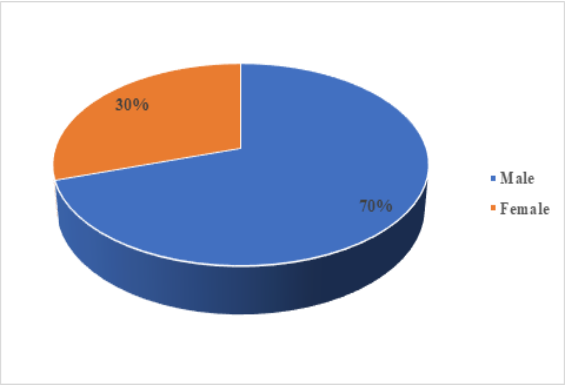

Figure 2: Gender-Wise Distribution of study population

Table 1: Demographic and baseline clinical characteristics of patients with acute decompensated heart failure

Variable	Category/Statistic	n	% / Mean ± SD
Age (years)	40–45	4	8
	46–50	10	20
	51–55	12	24
	56–60	14	28
	61–65	10	20
	Mean age		54.7 ± 6.72
	Range		40–65
Sex	Male	35	70
	Female	15	30
Heart rate (beats/min)	Mean ± SD	-	100.66 ± 18.398
	Range	-	56–142
Systolic BP (mmHg)	Mean ± SD	-	114.04 ± 6.66
Diastolic BP (mmHg)	Mean ± SD	-	70.00 ± 2.91

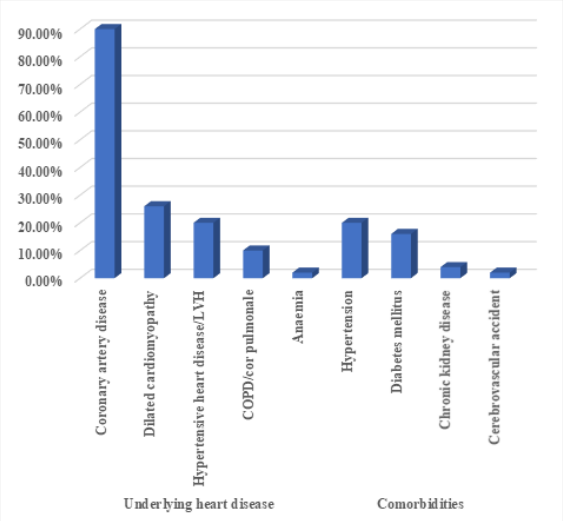

Figure 3: Distribution of underlying heart disease and comorbidities among study participants

As presented in [Figure 3], coronary artery disease (CAD) was the predominant underlying cardiac disease, being reported in 45 of the 50 patients (90%). Dilated cardiomyopathy was identified in 26% of patients, while hypertensive heart disease/left ventricular hypertrophy was present in 20%. COPD/cor pulmonale was documented in 10% and anaemia in 2% of the study population. Regarding associated comorbidities, hypertension was the most frequent comorbidity (20%), followed by diabetes mellitus (16%). Chronic kidney disease and cerebrovascular accident were documented in 4% and 2%, respectively. The predominance of CAD indicates that ischemic heart disease constituted the major underlying cardiac condition among patients presenting with ADHF in this study.

The clinical severity and cardiac assessment findings are summarized in [Table 2]. Evidence of fluid overload was present in 41 patients (82%), while 9

patients (18%) were described as euvolemic. In addition, 48 patients (96%) were receiving chronic medications for their underlying cardiac disease or associated comorbidities. Chest radiography showed cardiomegaly in 58% of patients and radiological evidence of pulmonary oedema in 40%, while approximately 8% had non-specific radiological findings. These findings demonstrate that radiological evidence of cardiac enlargement and pulmonary congestion was common in the study population. The Boston score was used to assess the clinical likelihood and severity of heart failure. As shown in [Table 3], the mean Boston score was 8.88 ± 1.745, with scores ranging from 4 to 12. A total of 41 patients (82%) had a definite Boston score of 8–12, 8 patients (16%) had a possible score of 5–7, and 1 patient (2%) had an unlikely score. Echocardiographic assessment demonstrated a mean EF of 37.92 ± 5.746%. Moderate systolic dysfunction was present in 19 patients (38%), while severe systolic dysfunction was present in 14 patients (28%). Mild systolic dysfunction was observed in 16 patients (32%), and only one patient had an EF of approximately 55%. Thus, 66% of the study population had moderate or severe systolic dysfunction.

Table 2: Clinical severity, congestion, chest radiographic and echocardiographic characteristics

Parameter	Category	n	% / Mean ± SD
Fluid status	Fluid overload	41	82.00%
	Euvolemic	9	18.00%
Chronic medication intake	Present	48	96.00%
	Absent	2	4.00%
Chest X-ray	Cardiomegaly	29	58.00%
	Pulmonary oedema	20	40.00%
	Non-specific findings	4	8.00%
Boston score	Definite HF (8–12)	41	82.00%
	Possible HF (5–7)	8	16.00%
	Unlikely (<4)	1	2.00%

The biochemical profile of the study population is presented in [Table 3]. The mean serum albumin concentration was 3.26 ± 0.521 g/dL, with values ranging from 2.0 to 4.5 g/dL. Hypoalbuminemia was defined in the study as a serum albumin concentration below 3.5 g/dL. The overall distribution table in the dissertation reported hypoalbuminemia in 35 of 50 patients (70%). The mean serum total cholesterol concentration was 162 ± 26.37 mg/dL, ranging from 112 to 202 mg/dL. Using the study definition of hypocholesterolemia as total cholesterol below 135 mg/dL, 8 patients (16%) were classified as having hypocholesterolemia. The mean haemoglobin concentration was 11.522 ± 1.898 g/dL, while the mean blood urea and serum creatinine concentrations were 41.04 ± 11.817 mg/dL and 1.288 ± 0.619 mg/dL, respectively.

Table 3: Distribution of serum albumin, total cholesterol and other laboratory parameters

Biochemical parameter	Mean ± SD	Minimum	Maximum
Serum albumin (g/dL)	3.26 ± 0.521	2	4.5
Total cholesterol (mg/dL)	162 ± 26.37	112	202
Hemoglobin (g/dL)	11.522 ± 1.898	5.4	16.6
Blood urea (mg/dL)	41.04 ± 11.817	25	84
Serum creatinine (mg/dL)	1.288 ± 0.619	0.8	3.9

As shown in [Table 4], among the 50 patients with ADHF, 41 patients (82%) survived and 9 patients (18%) died during hospitalization. Therefore, the observed in-hospital mortality rate in the study population was 18%. The overall median duration of hospital stay was 6 days. The reported mean duration of hospitalization was 6.41 days among survivors and 6.00 days among non-survivors. The study therefore demonstrated substantial in-hospital mortality, while the overall duration of hospitalization did not differ significantly according to survival status.

Table 4: In-hospital outcomes and duration of hospital stay

Outcome parameter	n	% / Mean ± SD
Hospital stay		
<5 days	25	50
6–10 days	20	40
>10 days	5	10
Mean duration of stay	50	6.4 ± 2.5 days
Median duration of stay	50	5.5 days
IQR	50	5–8 days
Hospital outcome		
Survivors	41	82
Non-survivors	9	18

The comparison of baseline and clinical parameters according to hospital outcome is presented in Table 5. Survivors had a mean age of 54.17 ± 6.982 years, compared with 57.11 ± 5.011 years among non-survivors. Although non-survivors were older on average, this difference was not statistically significant (p=0.239). The proportion of males was 73.2% among survivors and 55.6% among non-survivors, while females constituted 26.8% and 44.4%, respectively. The difference in sex distribution was not statistically significant (p=0.296). A statistically significant difference was observed in heart rate. Non-survivors had a higher mean heart rate (111.44 beats/min) than survivors (98.29 beats/min; p=0.048). In contrast, systolic and diastolic blood pressures did not differ significantly between the two groups. The Boston score was significantly higher among non-survivors than survivors (10.22 ± 1.202 vs. 8.59 ± 1.717; p=0.009), indicating a higher clinical severity score among patients who died during hospitalization. The mean EF was lower among non-survivors (35.33 ± 5.408%) compared with survivors (38.49 ± 5.723%); however, this difference was not statistically significant (p=0.137).

Table 5: Comparison of demographic, haemodynamic, clinical severity and echocardiographic parameters between survivors and non-survivors

Parameter	Survivors (n=41) Mean ± SD	Non-survivors (n=9) Mean ± SD	p value
Age (years)	54.17 ± 6.982	57.11 ± 5.011	0.239
Heart rate (beats/min)	98.29	111.44	0.048
Systolic BP (mmHg)	115.17 ± 6.282	108.89	0.231
Diastolic BP (mmHg)	70.49 ± 2.710	67.78	0.472
Boston score	8.59 ± 1.717	10.22 ± 1.202	0.009
Ejection fraction (%)	38.49 ± 5.723	35.33 ± 5.408	0.137

The comparison of the principal biomarkers between survivors and non-survivors is shown in [Table 6]. A substantial difference was observed in serum albumin concentration. Survivors had a mean serum albumin level of 3.383 g/dL, whereas non-survivors had a considerably lower mean level of 2.722 g/dL. This difference was statistically significant (mean difference 0.6607 g/dL; p<0.001). Similarly, mean serum total cholesterol was significantly lower among non-survivors. The mean total cholesterol concentration was 166.56 mg/dL among survivors, compared with 141.44 mg/dL among non-survivors, with a mean difference of 25.117 mg/dL (p=0.008). In contrast, the mean haemoglobin concentration did not differ significantly between survivors and non-survivors (11.622 vs. 11.067 g/dL; p=0.432). The available analysis also did not demonstrate statistically significant associations of blood urea or serum creatinine with mortality.

Table 6: Comparison of serum albumin, total cholesterol and other laboratory parameters between survivors and non-survivors (n=50)

Parameter	Survivors (n=41) Mean ± SD	Non-survivors (n=9) Mean ± SD	p value
Serum albumin (g/dL)	3.383	2.722	<0.001
Total cholesterol (mg/dL)	166.56	141.44	0.008
Hemoglobin (g/dL)	11.622	11.067	NS
Blood urea (mg/dL)	40.71	42.56	0.675
Serum creatinine (mg/dL)	1.305	1.211	0.685

The association between biomarker abnormalities and mortality is presented in [Table 7]. Hypoalbuminemia was present in 23 of 41 survivors (56.1%), whereas it was present in all 9 non-survivors (100%). The association between hypoalbuminemia and in-hospital mortality was statistically significant (p=0.013). Similarly, hypocholesterolemia was observed in 4 of 41 survivors (9.8%) compared with 4 of 9 non-survivors (44.4%). The difference was statistically significant (p=0.010). Thus, the proportion of patients with hypocholesterolemia was considerably higher among those who died during hospitalization.

Table 7: Association of hypoalbuminemia and hypocholesterolemia with in-hospital mortality

Biomarker status	Survivors n (%)	Non-survivors n (%)	Total n (%)	p value
Hypoalbuminemia				
Present	23 (56.1)	9 (100.0)	32 (64.0)	0.013
Absent	18 (43.9)	0 (0)	18 (36.0)	
Hypocholesterolemia				
Present	4 (9.8)	4 (44.4)	8 (16.0)	0.01
Absent	37 (90.2)	5 (55.6)	42 (84.0)	

The relationship between biomarker status and duration of hospitalization among survivors is shown in [Table 8]. Among the 41 patients who survived, those with hypoalbuminemia had a mean hospital stay of 7.17 ± 2.640 days, compared with 5.44 ± 1.886 days among survivors without

hypoalbuminemia. The mean difference was 1.729 days and was statistically significant (p=0.024). Similarly, survivors with hypocholesterolemia had a mean hospital stay of 8.75 ± 3.862 days, whereas those without hypocholesterolemia had a mean stay of 6.16 ± 2.205 days. The difference of 2.588 days was statistically significant (p=0.045).

Table 8: Duration of hospital stay according to hypoalbuminemia and hypocholesterolemia among survivors

Biomarker status	n	Mean hospital stay (days) ± SD	Mean difference	p value
Hypoalbuminemia present	23	7.17 ± 2.640	1.729	0.024
Hypoalbuminemia absent	18	5.44 ± 1.886		
Hypocholesterolemia present	4	8.75 ± 3.862	2.588	0.045
Hypocholesterolemia absent	37	6.16 ± 2.205		

The correlation analysis is summarized in [Table 9]. Serum albumin showed a significant positive correlation with ejection fraction (r=0.405, p<0.05). In contrast, serum albumin demonstrated significant negative correlations with age (r=−0.301), heart rate (r=−0.419), Boston score (r=−0.427) and duration of hospital stay (r=−0.443). The findings in Table 10 further demonstrate that serum total cholesterol was positively correlated with EF (r=0.471, p<0.05). Significant inverse correlations were observed between total cholesterol and heart rate (r=−0.413), Boston score (r=−0.539) and duration of hospital stay (r=−0.533). The correlation between total cholesterol and age was not statistically significant (r=−0.184). A significant positive correlation was also observed between serum albumin and serum total cholesterol (r=0.635, p<0.05), indicating that patients with higher albumin concentrations tended to have higher total cholesterol concentrations. Serum albumin did not show significant correlations with haemoglobin, blood urea or serum creatinine

Table 9: Correlation of serum albumin and total cholesterol with clinical parameters

Parameter	Serum albumin r	p value	Total cholesterol r	p value
Age	-0.301	<0.05	-0.184	NS
Heart rate	-0.419	<0.05	-0.413	<0.05
Boston score	-0.427	<0.05	-0.539	<0.05
Ejection fraction	0.405	<0.05	0.471	<0.05
Duration of hospital stay	-0.443	<0.05	-0.533	<0.05
Serum cholesterol	0.635	<0.05	—	—

The univariate logistic regression analysis evaluated demographic, haemodynamic, clinical severity, echocardiographic and biochemical variables in relation to in-hospital mortality [Table 10]. As reported in the source, Boston score was significantly associated with mortality, with an odds ratio of 2.047 (95% CI: 1.149–3.649; p=0.015). Age, sex, systolic blood pressure, diastolic blood pressure, heart rate and EF did not reach statistical significance in the reported model. Serum albumin was also reported to have an odds ratio of 0.042 (95% CI: 0.005–0.356; p=0.004), while serum total cholesterol had an odds ratio of 0.958 (95% CI: 0.924–0.993; p=0.018). Blood urea and serum creatinine were not statistically significant in the reported analysis. Because the source specifies this analysis as univariate logistic regression, the findings should be described as univariate associations with mortality. They should not be described as independent predictors unless a multivariable logistic regression analysis was performed.

Table 10: Univariate logistic regression for in-hospital mortality

Independent variable	Odds ratio	95% CI	p value
Age (years)	1.075	0.953–1.212	0.238
Male gender	0.458	0.104–2.024	0.303
Heart rate (beats/min)	1.046	0.998–1.096	0.06
Systolic BP (mmHg)	0.961	0.900–1.026	0.232
Diastolic BP (mmHg)	0.971	0.898–1.051	0.465
Boston score	2.047	1.149–3.649	0.015
Ejection fraction (%)	0.901	0.786–1.034	0.139
Serum albumin (g/dL)	0.042	0.005–0.356	0.004
Total cholesterol (mg/dL)	0.958	0.924–0.993	0.018
Blood urea (mg/dL)	1.013	0.956–1.072	0.669
Serum creatinine (mg/dL)	0.745	0.183–3.030	0.681

DISCUSSION

Acute decompensated heart failure (ADHF) is associated with substantial in-hospital morbidity and mortality, and early identification of patients at increased risk remains an important component of clinical management. In the present hospital-based observational study of 50 patients with ADHF, the in-hospital mortality was 18%. This finding is consistent with the mortality reported in previous studies of

patients hospitalized with acute or severe heart failure. Arques et al. reported an in-hospital mortality of approximately 19% among 207 elderly patients with severe acute heart failure, which is very similar to the 18% mortality observed in the present study.[3] The dissertation also cites reports indicating that hospital mortality in acute heart failure may exceed 10–20%, particularly among patients with severe clinical illness.[3,16] The demographic characteristics of the present study showed a male predominance, with 70% of participants being men, and a mean age of 54.7 ± 6.72 years. Coronary artery disease was the most frequent underlying cardiac disease, occurring in 90% of patients, followed by dilated cardiomyopathy in 26% and hypertensive heart disease/left ventricular hypertrophy in 20%. These findings indicate that ischemic heart disease constituted an important substrate for acute decompensation in this study population. The relatively younger mean age compared with several international ADHF cohorts may reflect differences in the study population, inclusion criteria, referral patterns and cardiovascular risk profile. The original study similarly noted a male predominance and identified coronary artery disease as the commonest underlying cardiac condition.

Serum albumin and mortality: The principal finding of this study was the strong association between lower serum albumin concentration and adverse in-hospital outcome. The mean serum albumin concentration in the overall study population was 3.26 ± 0.521 g/dL. Survivors had a substantially higher mean albumin concentration than non-survivors (3.383 vs. 2.722 g/dL), and this difference was statistically significant ($p<0.001$). Furthermore, hypoalbuminemia was considerably more frequent among non-survivors than survivors. Among survivors, 56.1% had hypoalbuminemia, compared with 100% of non-survivors, demonstrating a significant association between low serum albumin and in-hospital mortality ($p=0.013$). These observations are in agreement with the findings of Arques et al., who prospectively evaluated 207 patients aged >70 years with severe acute heart failure. Their study reported a mean serum albumin concentration of approximately 3.05 ± 0.5 g/dL, and patients who died had significantly lower albumin concentrations than survivors. Serum albumin was also reported as the strongest predictor of hospital death in their analysis.[3] The similarity between their findings and those of the present study supports the potential value of serum albumin as a readily available marker for short-term risk stratification in patients with ADHF. The present findings are also consistent with Uthamalingam et al., who studied 438 patients with ADHF and found that hypoalbuminemia was common and associated with increased mortality. In that study, hypoalbuminemia was associated with approximately a two-fold increase in adjusted one-year mortality, with an even stronger association among patients with systolic heart failure.[17] Similarly, Bonilla-Palomas et al., in a cohort of 362 patients with acute heart failure, reported that hypoalbuminemia was associated with higher hospital mortality and independently predicted long-term mortality.[18] Polat et al. also reported a high prevalence of hypoalbuminemia among patients with acute decompensated systolic heart failure and demonstrated a significant association between low albumin and adverse outcome.[7] In their study, hypoalbuminemia was detected in 69.6% of patients, which is comparable to the high prevalence observed in the present study. The convergence of findings across different patient populations suggests that serum albumin may reflect several clinically relevant processes in heart failure, including nutritional status, systemic inflammation, hepatic congestion, altered protein metabolism and disease severity.

The biological basis for this association is likely multifactorial. Albumin is not merely a nutritional marker; its concentration may also reflect systemic inflammatory activity, hepatic synthetic function, vascular permeability and fluid distribution. In advanced heart failure, venous congestion and hepatic dysfunction may impair albumin synthesis, while inflammation may increase vascular permeability and alter albumin distribution. Reduced albumin may therefore act as an integrated marker of the physiological burden associated with acute heart failure rather than representing a single pathogenic mechanism.[16,19] The present study also demonstrated a negative correlation between albumin and Boston score, heart rate and duration of hospitalization, while albumin showed a positive correlation with ejection fraction. These findings further suggest that lower albumin concentrations were associated with greater clinical severity.

Serum total cholesterol and mortality: The second major observation was the association between lower serum total cholesterol and adverse outcome. The mean total cholesterol concentration in the study population was 162 ± 26.37 mg/dL. Survivors had significantly higher mean total cholesterol than non-survivors (166.56 vs. 141.44 mg/dL; $p=0.008$). Hypocholesterolemia was observed in 9.8% of survivors compared with 44.4% of non-survivors, and this difference was statistically significant ($p=0.010$). Patients with hypocholesterolemia also had a longer mean duration of hospitalization than those without hypocholesterolemia (8.75 vs. 6.16 days; $p=0.045$). These findings are consistent with the study by Arques et al., in which patients who died from severe acute heart failure had lower serum total cholesterol concentrations than survivors. Their study reported a median total cholesterol concentration of approximately 170 mg/dL and hypocholesterolemia in approximately 22% of patients.[3] The prevalence of hypocholesterolemia in the present study was somewhat lower, at 16%, although the association with mortality was similarly observed. The relationship between cholesterol and outcome in heart failure is complex. Although elevated cholesterol is an established risk factor for

coronary artery disease, several studies have reported a paradoxical association between low cholesterol concentrations and poor outcomes among patients with established heart failure.[19,8] In a large study of patients hospitalized with heart failure, lower total cholesterol concentrations were associated with increased in-hospital mortality; each 10-mg/dL increase in total cholesterol was associated with approximately a 4% reduction in the adjusted odds of in-hospital mortality.[8] Sakatani et al. demonstrated that the prognostic association of cholesterol may differ according to the presence or absence of coronary artery disease.[20] Their findings suggested that the relationship between cholesterol and mortality is not necessarily linear or uniform across all heart failure populations. In patients with coronary artery disease, the association differed from that observed in patients without coronary artery disease, emphasizing that cholesterol should be interpreted in the broader clinical context rather than as an isolated marker. One possible explanation for the association between low cholesterol and poor prognosis is the interaction between cholesterol metabolism, inflammation and nutritional status. Acute severe illness can produce alterations in lipid metabolism, while systemic inflammation may reduce circulating lipoprotein concentrations. Low cholesterol may therefore represent a marker of the severity of systemic illness, reduced nutritional reserve or inflammatory activity rather than a direct cause of adverse outcome. The present study also demonstrated a positive correlation between serum albumin and total cholesterol ($r=0.635$, $p<0.05$), supporting the possibility that these two biochemical parameters may partly reflect a common nutritional or disease-severity pathway.

Clinical severity and other prognostic parameters: The present study also identified clinical severity as an important component of outcome assessment. Non-survivors had a significantly higher mean heart rate than survivors (111.44 vs. 98.29 beats/min; $p=0.048$) and a significantly higher Boston clinical score (10.22 vs. 8.59; $p=0.009$). In contrast, differences in systolic blood pressure, diastolic blood pressure and ejection fraction were not statistically significant. The association between a higher Boston score and mortality is clinically plausible because the Boston score incorporates several manifestations of congestion and cardiac dysfunction and therefore provides an overall measure of clinical heart failure severity.

The absence of a statistically significant difference in ejection fraction between survivors and non-survivors should not be interpreted as evidence that ventricular systolic function is clinically unimportant. The present study had a relatively small sample size, and the majority of patients had reduced ejection fraction. In addition, acute heart failure outcome is influenced by multiple factors, including congestion, renal function, systemic inflammation, blood pressure, arrhythmias and comorbid disease, and therefore ejection fraction alone may not adequately discriminate short-term risk. The correlation analysis further supported the relationship between the two biomarkers and disease severity. Serum albumin showed negative correlations with heart rate, Boston score and duration of hospitalization and a positive correlation with ejection fraction. Total cholesterol similarly showed negative correlations with heart rate, Boston score and duration of hospital stay and a positive correlation with ejection fraction. These findings suggest that lower albumin and cholesterol concentrations were associated with greater clinical severity and prolonged hospitalization.

Prognostic implications: An important practical feature of serum albumin and total cholesterol is their accessibility. Both are inexpensive, routinely available biochemical parameters that can be measured early during hospitalization. The findings of the present study suggest that these markers may provide additional clinical information during the initial assessment of patients with ADHF. However, they should be considered complementary markers rather than replacements for established clinical assessment, echocardiography and other prognostic biomarkers. The present study found significant associations in univariate logistic regression for serum albumin and total cholesterol. Lower albumin was associated with higher odds of in-hospital mortality, while higher cholesterol was associated with lower odds of mortality. These findings are directionally consistent with previous studies reporting prognostic associations for both biomarkers.[3,18,8] However, because the present analysis was based on univariate logistic regression, these results should be interpreted as associations rather than proof that albumin or cholesterol are independent predictors after adjustment for other clinical variables.

Limitations: This study has several limitations. First, it was a single-center observational study with a relatively small sample size of 50 patients and a limited study period, which may restrict the generalizability of the findings. Second, only in-hospital mortality was assessed; long-term mortality, heart-failure readmissions and other post-discharge outcomes were not evaluated. Third, the mechanisms responsible for hypocholesterolemia in acute heart failure were not specifically investigated. Nutritional status and body mass index could not be adequately assessed in all patients because weight measurements were unavailable in some bedridden and fatal cases. In addition, serial measurements of serum albumin and total cholesterol were not performed, limiting assessment of changes during treatment. Although significant associations were observed between low albumin, low cholesterol and mortality, the analysis was primarily univariate; therefore, potential confounding by disease severity, comorbidities and other prognostic factors cannot be excluded. Larger multicenter prospective studies with multivariable analysis, comprehensive nutritional and

inflammatory assessment, serial biomarker measurements and long-term follow-up are required to validate these findings.

CONCLUSION

In this hospital-based observational study of patients with acute decompensated heart failure, in-hospital mortality was 18%. Lower serum albumin and lower serum total cholesterol were significantly associated with increased mortality. Non-survivors had significantly lower mean serum albumin and total cholesterol levels than survivors, while hypoalbuminemia and hypocholesterolemia were associated with prolonged hospital stay. Serum albumin and total cholesterol also showed significant correlations with clinical severity parameters, including the Boston score and duration of hospitalization. These findings suggest that serum albumin and total cholesterol may serve as simple, readily available biochemical markers for identifying patients with ADHF who are at increased risk of poor short-term outcomes. However, larger prospective multicenter studies with multivariable analysis and long-term follow-up are required to confirm their prognostic utility.

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