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Original Article

Predictors of 30-Day Mortality in Patients with Heart Failure Presenting with Cardiogenic Shock

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Abstract

Objectives: To identify clinical predictors of mortality among heart failure patients presenting with cardiogenic shock.

Methodology: This prospective cohort study was conducted from April 2020 to March 2021, involving 201 heart failure patients who presented to Rouhani Hospital with cardiogenic shock. Demographic and clinical data were collected from medical records, and in-hospital or 30-day mortality was tracked through follow-up phone calls. Statistical analysis was performed using SPSS V22.0.

Results: Among the 201 patients, the average age was 69 ± 15.71 years, with 57.2% being male. Within this cohort, 29 patients (14.5%) died within 30 days post-discharge, while 66 patients (33.1%) succumbed during hospitalization. Mortality rates were significantly higher among patients with underlying diabetes ($p = 0.005$) and coronary artery disease ($p = 0.023$). A mean difference in blood lactate levels of -1.45 was observed ($p < 0.05$). There was no significant difference in the duration from symptom onset to hospitalization between the two groups ($p = 0.102$). Key predictors of mortality included confusion and elevated blood lactate levels.

Conclusion: A history of diabetes is a critical factor in predicting mortality among heart failure patients with cardiogenic shock, while blood pressure at the time of admission does not have the same predictive value. Additionally, the presence of confusion and increased lactate levels were significant predictors of poor outcomes in this population.

Keywords: Cardiogenic Shock, Heart Failure, Mortality, Risk Factors, Diabetes Mellitus

INTRODUCTION

Heart failure is a clinical syndrome characterized by a structural or functional impairment of the heart, leading to a decrease in the volume of blood pumped by the heart or an increase in the heart's internal pressure. This condition manifests with symptoms such as dyspnea, orthopnea, and peripheral edema, often accompanied by signs of pulmonary congestion and elevated jugular venous pressure [1]. Heart failure is typically classified into two categories: heart failure with preserved ejection fraction (HFpEF), where the ejection fraction (EF) is above 50%, and heart failure with reduced ejection fraction (HFrEF), where the EF ranges from 41% to 49% [2].

Cardiogenic shock is a critical state resulting from inadequate tissue perfusion due to compromised cardiac function, which leads to symptoms of tissue hypoxia and systemic hypoperfusion [3-5]. It represents the most severe form of acute heart failure, accounting for less than 5% of cases of acute heart failure in Western populations [6,7]. The predominant cause of cardiogenic shock is acute coronary syndrome (ACS), which accounts for approximately 80% of cases; other contributing factors include chronic heart failure, valvular diseases, myocarditis, and Takotsubo cardiomyopathy [8]. Studies indicate that advanced age, a history of stroke, elevated blood glucose levels, and increased serum creatinine upon admission are significant risk factors associated with both early and in-hospital mortality in patients experiencing cardiogenic shock [9]. Additionally, the therapeutic interventions employed significantly impact mortality rates [10]. Despite the historically poor prognosis associated with cardiogenic shock, survival rates have notably improved over the past three decades [8,10]. However, the management of this condition remains a complex challenge [11,12].

Most research on predictors of mortality in cardiogenic shock has primarily focused on cases of acute myocardial infarction [13,14], leaving a gap in knowledge regarding patients whose cardiogenic shock is induced by heart failure. Consequently, understanding and identifying the risk factors associated with short-term mortality in heart failure patients experiencing cardiogenic shock is essential for improving outcomes and reducing mortality rates. This study aims to explore these predictive factors and quantify their associated risks.

METHODOLOGY

Study Design: This prospective cohort study was conducted from April 2020 to March 2021 at Ayatollah Rouhani Hospital in Babol, focusing on patients diagnosed with heart failure who presented with cardiogenic shock. The study was designed to assess the outcomes of these patients, with an emphasis on understanding mortality rates and associated risk factors.

Ethics: The study received ethical approval from the Ethics Committee in Biological Research of Babol University of Medical Sciences, with the approval # (IR.MUBABOL.REC.1399.021). Informed consent was obtained from all participants prior to their inclusion in the study, ensuring adherence to ethical standards concerning patient rights and confidentiality.

Setting: The research was conducted in Ayatollah Rouhani Hospital, a tertiary care center in Babol, Iran, which provides comprehensive cardiac care. The hospital is equipped to manage complex cases of heart failure and offers access to specialized medical resources, making it an appropriate setting for this study.

Participants: The study population consisted of 201 patients aged over 18 years who were diagnosed with heart failure and exhibited signs of cardiogenic shock at the time of admission or during hospitalization. Cardiogenic shock was defined clinically by a cardiac index of less than 2.2 L/min/m², alongside a systolic blood pressure (SBP) of less than 90 mm Hg persisting for more than 30 minutes, or the necessity for vasopressors to maintain SBP above 90 mm Hg, in the presence of hypoperfusion indicators such as altered mental status, cold extremities, oliguria, or lactate levels greater than 2 mmol/L. Exclusion criteria included patients who experienced shock following cardiac or non-cardiac surgeries and those with arrhythmias in the context of heart failure.

Variables: Key variables in this study included demographic information (age, sex, and comorbidities), clinical characteristics (e.g., cardiac index, blood pressure measurements, signs of hypoperfusion), and outcomes (30-day mortality and hospital mortality).

Data Sources/Measurement: Data were collected through a structured checklist that captured demographic, clinical, and paraclinical information.

Hospital records were reviewed to document mortality outcomes at discharge and at 30 days post-admission. Additionally, follow-up for survival data was conducted through telephone calls, ensuring comprehensive data collection on patient outcomes.

Bias: To minimize selection bias, participants were recruited using a convenience sampling method within the defined inclusion criteria. Potential confounding factors were identified and considered in the statistical analysis. Efforts were made to ensure that data collection was consistent and systematic to mitigate information bias.

Study Size: The sample size of 201 patients was determined based on previous literature, taking into account a significance level (α) of 0.05, a power (β) of 0.2, and an odds ratio (OR) of 10.7. This sample size was calculated to provide adequate power to detect significant differences and associations within the study population.

Quantitative Variables: Quantitative variables measured included age, cardiac index, systolic blood pressure, and laboratory results such as lactate levels. These variables were analyzed to establish their relationship with mortality outcomes.

Statistical Methods: Data were analyzed using SPSS Statistics V22.0. Descriptive statistics were computed for demographic and clinical characteristics, presenting results as frequency percentages, means, and standard deviations. The T-test was utilized to compare the means of continuous variables, while chi-square tests and logistic regression analyses were employed to explore relationships between categorical variables and mortality outcomes. A p-value of less than 0.05 was considered statistically significant. A risk prediction model was developed, leveraging the sufficient sample size to enhance the understanding of mortality predictors among patients with heart failure in cardiogenic shock.

RESULTS

Participants: A total of 201 patients with heart failure presenting with cardiogenic shock participated in this prospective cohort study conducted from April 2020 to March 2021 at Ayatollah Rouhani Hospital in Babol. Among the participants, 115 (57.2%) were male and 86 (42.8%) were female, with an average age of 69 ± 71.15 years (age range: 19 to 96 years). The demographic characteristics of the participants are summarized in Table 1**.**

Table 1: Relationship between mortality and medical records of heart failure patients with cardiogenic shock

	Number	mortality		P-value*
		Alive (%)	Death (%)	
Atrial Fibrillation				
Yes	77	40 (52.6)	36 (46.7)	0.99
No	124	64 (52.0)	59 (48.0)	
Stroke				
Yes	20	7 (35.0)	13 (65.0)	0.155
No	181	97 (54.2)	82 (45.8)	
Asthma				
Yes	16	11 (68.8)	5 (31.3)	0.199
No	185	93 (50.8)	90 (49.2)	
Diabetes				
Yes	61	23 (37.7)	38 (62.3)	*0.009
No	140	81 (58.7)	57 (41.3)	
Renal Failure				
Yes	25	14 (58.3)	10 (41.7)	0.667
No	176	90 (51.4)	85 (48.6)	
High Blood Pressure				
Yes	105	45 (42.9)	60 (57.1)	*0.007
No	96	59 (62.8)	35 (37.2)	
Pci				
Yes	46	28 (62.2)	17 (37.8)	0.174
No	155	76 (49.4)	78 (50.6)	
Coronary Artery Disease				
Yes	113	51 (45.1)	62 (54.9)	*0.023
No	86	53 (61.6)	33 (38.4)	
Myocardial Infarction				
Yes	86	37 (43.0)	49 (57.0)	*0.031
No	113	67 (59.3)	46 (40.7)	
CABG				
Yes	29	17 (58.6)	12 (41.4)	0.548
No	170	87 (51.0)	83 (48.8)	

**Significance Level in Chi-Square Test Is P < 0.05*

Descriptive Data: The analysis of the 30-day follow-up revealed that 104 patients (52.3%) were alive at the end of this period, while 29 patients (14.5%) died after discharge, and 66 patients (33.1%) died during hospitalization. It is noteworthy that two patients could not be contacted via phone, contributing to the missing data in the study. No statistically significant difference in mortality was observed between male and female participants (p = 0.390).

The demographic and clinical characteristics, including underlying health conditions, are detailed in Table 1. Notably, patients with a history of diabetes and hypertension exhibited significantly higher mortality rates compared to their non-afflicted counterparts (p = 0.005 and p = 0.004, respectively). Additionally, those with a history of coronary artery disease or previous myocardial infarction also experienced significantly higher mortality rates (p =

0.023 and p = 0.031, respectively). However, no significant differences were found regarding other medical history variables. Furthermore, the duration of hospitalization did not differ significantly between survivors and non-survivors (p = 0.263).

Outcome Data: An evaluation of symptom onset to hospital admission durations indicated that patients who presented within 0 to 3 hours after symptom onset had the highest survival rates. Conversely, those who sought care more than 24 hours after the onset had the highest mortality rates, although this relationship was not statistically significant (p = 0.102). These findings are presented in Table 2.

Table 2: Relationship between the mortality of heart failure patients with cardiogenic shock with duration of symptom onset to hospital admission

Duration of symptom (hours)	(N)	Mortality		P-value*
		Alive (%)	Death (%)	
0-3	105	64 (60.9)	41 (39.1)	
3-6	44	21 (47.7)	23 (52.3)	
6-12	26	11 (42.3)	15 (57.7)	0.102
12-24	17	6 (35.3)	11 (64.7)	
>24	6	1 (25.0)	3 (75.0)	

**Significance level in chi-square test is p < 0.05.*

Laboratory factors showed significant differences between survivors and non-survivors. Elevated lactate levels (p < 0.001) and altered pH (p = 0.004) were associated with higher mortality, whereas no significant differences were noted for sodium, creatinine, or potassium levels (p = 0.981, p = 0.141, p = 0.784, respectively). Cardiovascular function indicators, including systolic and diastolic blood pressure, heart rate, shock index, and left ventricular ejection fraction (LVEF), did not show significant relationships with mortality outcomes (p-values ranging from 0.166 to 0.813) as detailed in Table 3.

Main Results: Regarding clinical symptoms, 55.3% (110 patients) experienced oliguria, while 63.8% (127 patients) exhibited confusion. The analysis indicated no significant relationship between oliguria and mortality (p = 0.285); however, confusion was significantly correlated with mortality (p < 0.001).

The patients were categorized based on the type of inotropic agent received: 33 patients received dopamine, with a survival rate of 45.0% (15 patients); 144 patients received norepinephrine, yielding a survival rate of 56.0% (82 patients); and 22 patients received a combination of dopamine and norepinephrine, with a survival rate of 31.8% (7 patients). While the type of inotropic agent did not show a statistically significant association with mortality (p = 0.062), a significant correlation was found between the duration of inotrope administration and mortality (p = 0.003).

The effects of various factors on mortality were analyzed, yielding significant results as shown in Table 4. Diabetes, confusion, and lactate levels were identified as significant predictors of mortality in heart failure patients with cardiogenic shock, with odds ratios of 2.149, 4.167, and 1.467, respectively

Table 3: Relationship between the mortality of heart failure patients with cardiogenic shock with biochemical and functional heart factors.

Variable	Mean difference	Standard deviation error difference	confidence interval of 95%, changes		P-value*
			Lower	Upper	
Lactate	-1.45	0.33	-2.11	-0.78	<0.001
Ph	0.47	0.01	0.01	0.07	0.004
Na	-0.024	1	-2	1.95	0.981
Cr	-0.12	0.16	-0.45	0.2	0.452
K	-0.16	0.1	-3.68	0.04	0.126
Systolic blood pressure	0.89	1.01	-1.11	2.9	0.383
Diastolic blood pressure	1.38	1.02	-1.13	2.92	0.264
heart beat	-1.49	1.94	-5.34	2.34	0.442
Shock index	0.023	0.03	-0.08	0.03	0.455
Modified shock index	0.009	0.17	-0.32	0.34	0.956
LVEDD	2.04	1.4	-0.72	4.81	0.146
LVEF	-2.4	1.53	-5.42	0.62	0.19

**Significance level in chi-square test is p < 0.05.*

Table 4: Intensity of effect of factors affecting mortality in heart failure patients with cardiogenic shock

Variable	Statistics B	p-value*	confidence interval of 95%, changes		Odds ratio
			Lower	Upper	
Diabetes	0.76	0.052	0.99	4.64	2.149
Confusion	1.42	<0.001	1.91	9.09	4.167
Lactate	0.38	<0.001	1.2	1.78	1.467
Dopamine	-	-	-	-	1
Norepinephrine	-0.87	0.076	0.15	1.09	0.416
Dopamine + Norepinephrine	0.86	0.681	0.34	5.19	1.331
Na	-0.009	0.74	0.94	1.045	0.991

** The significance level is p < 0.05.*

DISCUSSION

This study aimed to investigate the predictive factors of 30-day mortality in heart failure patients presenting with cardiogenic shock. Our findings indicated that 52.2% of the patients had a history of hypertension, and a significant relationship was observed between this history and mortality in cardiogenic shock patients. However, no significant correlation was found between systolic and diastolic blood pressure at the time of presentation and mortality. Similarly, heart rate did not appear to correlate with patient outcomes. This aligns with the study by Pourafkari et al., which noted a low predictive value of heart rate and systolic blood pressure in acute heart failure, as compared to mean arterial pressure (MAP) [15]. In contrast, Schmitz et al. identified shock index (SI) and modified shock index (MSI) as significant predictors of long-term mortality [16]. It is plausible that beta-blocker therapy in our patient cohort suppressed heart rate, contributing to the lack of significant findings related to SI and MSI.

Our analysis revealed that patients with a history of coronary artery disease (CAD) and myocardial infarction experienced higher mortality rates. However, no significant relationship was noted between mortality and a history of coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI). Notably, when examining heart failure etiology, we found a significant difference in mortality rates between ischemic and non-ischemic causes (p=0.023), highlighting the impact of ischemia on mortality in cardiogenic shock patients. The relationship can be interpreted in the context of coronary perfusion dynamics, where the difference between aortic end-diastolic pressure and ventricular end-diastolic pressure influences coronary reserve. In critical conditions, diminished blood pressure may exacerbate ischemic damage, a finding supported by Formika et al., who concluded that reducing ischemia duration is crucial for improving management and prognosis in this patient group [17-19].

Regarding treatment history, the duration of inotropic therapy was associated with patient mortality; however, the specific type of inotrope administered did not affect outcomes. Interestingly, patients receiving a combination of dopamine and norepinephrine exhibited higher mortality than those receiving either agent alone, possibly reflecting the more severe condition of those needing dual therapy. Additionally, dopamine treatment was linked to higher mortality compared to norepinephrine, potentially due to catecholamine depletion in patients experiencing cardiogenic shock, where norepinephrine is critical for maintaining hemodynamic stability.

Acharya et al. identified the time from symptom onset to hospital admission as a crucial factor influencing both early and late mortality in patients with acute infarction and cardiogenic shock [20]. In our study, laboratory results demonstrated a significant difference in lactate levels between deceased and surviving patients, with elevated lactate being the most influential factor on mortality, indicating prolonged tissue hypoxia. Changes in pH levels were also significant, while no substantial differences were found in sodium, creatinine, or potassium levels between the two groups. This corroborates findings by Acharya et al., who identified lactate and creatinine as critical mortality predictors in cardiogenic shock patients [20]. Moreover, the study by Xin Li et al. indicated that blood glucose levels could be useful in predicting mortality and informing treatment decisions [21]. Our results similarly showed a significant relationship between diabetes and mortality in cardiogenic shock.

Clinical symptoms commonly observed in cardiogenic shock include dyspnea, pallor, anxiety, sweating, and altered consciousness. Patients typically present with weak but rapid pulses, and severe bradycardia may occur due to high-degree heart block. Although oliguria and anuria are frequent in this condition [22,23], our study found no significant relationship between oliguria and mortality. Conversely, confusion was significantly associated with mortality. This aligns with findings by Harjola et al., which also reported a significant link between confusion, low ejection fraction, and mortality [8]. Our study emphasizes the critical role of confusion as a predictor of mortality among the clinical symptoms and biochemical factors associated with cardiogenic shock.

One of the main limitations of this study is the small sample size, as it was conducted at a single hospital. Future research should aim for a multi-center approach with a larger sample size to enhance the reliability of results and allow for a more precise evaluation of the investigated variables.

CONCLUSION

In summary, a history of hypertension significantly contributes to mortality risk in patients presenting with cardiogenic shock; however, blood pressure levels at the time of hospital admission do not hold the same predictive value. Instead, chronic hypertension and the presence of diabetes emerge as critical underlying factors influencing outcomes. Additionally, patients exhibiting confusion, elevated lactate levels—indicative of hypoperfusion—and those receiving dual inotropic therapy demonstrated poorer prognoses. These findings underscore the importance of these clinical parameters as predictive factors in assessing mortality risk in this patient population.

AUTHORS' CONTRIBUTION

RI, NZ, FJ, PT, and HGA: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. RI, NZ, FJ, PT, and HGA: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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