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Original Article

Predictors of in hospital mortality in cardiogenic shock following ST-elevation myocardial infarction (STEMI)

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Abstract

Objectives: Cardiogenic shock (CS) is a severe complication of ST-Elevation Myocardial Infarction (STEMI) and is associated with high mortality rates. This study aimed to identify predictors of in-hospital mortality in patients experiencing cardiogenic shock following STEMI.

Methods: A retrospective cohort study was conducted at Afshar Hospital in Yazd from 2018 to 2023, analyzing clinical data from 62 STEMI patients diagnosed with CS. The mean age of the cohort was 64.9 ±13.5 years, with a male predominance of 69.5%. Key variables assessed included left ventricular ejection fraction (LVEF), comorbidities, and treatment interventions. Survival analysis and Cox regression were employed to evaluate mortality outcomes.

Results: LVEF less than 30% emerged as a significant predictor of in-hospital mortality, with a hazard ratio of 11.1 (95% CI: 2.6–47.4; $p < 0.001$). The mean survival time was 7.0 days (95% CI: 5.8–8.3). Additionally, hyperlipidemia was associated with increased mortality, presenting an odds ratio of 11.3 (95% CI: 1.1–114.1; $p = 0.040$). The prevalence of chronic kidney disease was notably higher in the deceased cohort (28.0% vs. 8.1%; $p = 0.042$). Although urgent percutaneous coronary intervention (PCI) was performed in the majority of cases, mortality remained significant.

Conclusions: This study highlights that LVEF and hyperlipidemia are critical predictors of in-hospital mortality in patients with cardiogenic shock following STEMI. Other studies also suggest the prognostic value of LVEF in various cardiac conditions, particularly in the context of acute coronary syndromes [14, 15]. Also, the combination of renal dysfunction left ventricular ejection fraction, and advanced age has been proposed as a predictor of in-hospital mortality [18]. These findings underscore the importance of early identification and targeted management strategies to improve patient outcomes in this high-risk population.

Keywords: Cardiogenic shock, Shock, Myocardial infarction, STEMI, LVEF, mortality

Introduction

Cardiogenic shock (CS) is a life-threatening condition characterized by the heart's inability to supply sufficient blood flow to meet the body's metabolic demands, often resulting from acute myocardial infarction (AMI) [1]. It presents a significant clinical challenge, particularly following ST-elevation myocardial infarction (STEMI), which is associated with high morbidity and mortality rates [2]. The incidence of cardiogenic shock in STEMI patients ranges from 5% to 10%, but it is often accompanied by a stark increase in in-hospital mortality, which can exceed 50% in some cohorts [3]. Despite the many advances in cardiovascular care over the last 20 years, the survival of CS patients has not changed substantially and remains around 50% at 30 days following diagnosis [1]. The pathophysiology of CS involves a complex interplay of hemodynamic instability, inadequate perfusion, and multi-organ dysfunction [4, 5]. Early identification and prompt management are critical to improving outcomes, yet the prognosis remains poor due to factors such as age, comorbidities, and the severity of left ventricular dysfunction [6]. Left ventricular ejection fraction (LVEF) is a key prognostic indicator, with lower values correlating with higher mortality rates [7, 8, 9]. Current evidence and clinical practice guidelines support immediate revascularization of the infarct-related coronary artery as the primary therapy for CS following STEMI [2]. Despite advancements in medical and interventional therapies, including percutaneous coronary intervention (PCI) and mechanical circulatory support, the management of cardiogenic shock continues to evolve [10,11]. Understanding the predictors of mortality in this population is essential for developing targeted treatment strategies and improving survival rates [12, 13].The current study aims to identify significant prognostic factors associated with in-hospital mortality in patients with CS following STEMI, thereby contributing to the growing body of literature aimed at enhancing clinical outcomes in this high-risk group.

Materials and Methods

This retrospective study was conducted at Afshar Hospital in Yazd between 2018 and 2023, focusing on patients diagnosed with ST-elevation myocardial infarction (STEMI) who subsequently developed cardiogenic shock. Inclusion Criteria: Patients were included if they were adults (≥18 years) who were diagnosed with STEMI and developed cardiogenic shock during their hospital stay. Diagnosis of STEMI was confirmed by clinical assessment and electrocardiographic changes. cardiogenic shock was defined based on clinical criteria including (systolic blood pressure ≤ 90 mmHg) despite adequate filling pressures, signs of organ hypoperfusion, and evidence of end-organ dysfunction(such as cold and sweaty extremities, oliguria, altered mental status, dizziness, narrow pulse pressure). Exclusion Criteria: Patients were excluded if they had a history of significant valvular heart disease, congestive heart failure, or secondary to non-ST-Elevation Myocardial Infarction (NSTEMI). Additionally, patients with incomplete medical records or those who died before admission were also excluded to ensure comprehensive data analysis. Data were collected from medical records and included demographic information, clinical characteristics, left ventricular ejection fraction (LVEF), comorbidities, and treatment interventions. LVEF was measured using echocardiography and categorized into two groups: less than 30% and greater than or equal to 30%. Comorbidities such as hyperlipidemia, diabetes mellitus, and chronic kidney disease were recorded to assess their impact on patient outcomes.

Statistical analysis

Statistical analyses were performed using SPSS software version 26. Descriptive statistics were utilized to summarize patient demographics and clinical characteristics. The Chi-square test and Fisher's exact test were employed to analyze categorical variables, while independent t-tests were used to compare continuous variables between groups. Survival analysis was conducted using the Kaplan-Meier method, and the Log-Rank test was applied to assess differences in survival distributions. Additionally, Cox proportional hazards regression analysis was performed to identify independent predictors of in-hospital mortality, with LVEF and hyperlipidemia as primary variables of interest. A significance level of $p < 0.05$ was established for all tests.

Ethical considerations

Ethical approval for the study was obtained from the institutional review board of Shahid Sadoughi Medical University (IR.SSU.MEDICINE. REC.1402 .261). Informed consent was acquired when required, and the study adhered to ethical guidelines for research involving human subjects.This methodological approach ensures a comprehensive understanding of the factors influencing in-hospital mortality in this high-risk patient population.

Results

The study included a total of 62 patients diagnosed with STEMI. The mean age of the participants was 64.9 years (SD = 13.5), with 43 (69.5%) being male and 19 (30.6%) female. Common presenting symptoms included chest pain in 57 patients (91.9%) and dyspnea in 26 (41.9%). Risk factors were prevalent, with hypertension in 31 patients (50.0%), diabetes mellitus in 30 (51.6%), and smoking in 19 (30.6%). Hemodynamic assessments indicated a mean pulse rate of 92.2 beats/min (SD = 30.2), systolic blood pressure of 82.5 mmHg (SD = 14.1), and diastolic blood pressure of 51.7 mmHg (SD = 8.8). Comorbidities included chronic obstructive pulmonary disease (COPD) in 2 (3.2%) and chronic kidney disease (CKD) in 10 (16.1%). Electrocardiogr am (ECG) showed sinus rhythm in 49 patients (79.0%) and ST-T changes in 57 (91.9%). Echocardiography revealed a mean left ventricular ejection fraction (LVEF) of 32.0% (SD = 8.8). Coronary angiography indicated single-vessel disease in 9 patients (14.5%) and three-vessel disease in 26 (41.9%). Laboratory tests showed a mean WBC count of 12,100/µL (SD = 5.6) and troponin levels of 1355.4 ng/ml (SD = 3515.4). Treatment included urgent PCI in 58 patients (93.5%) and intra-aortic balloon pump (IABP) in 5 (8.1%) Table1.

Table 1. Baseline Characteristics of the study Patients (n=62)

Character	Value	Value
Age (mean ± SD)	64.9	13.5
Sex (n, %)	43	69.5
Male	19	30.6
Female		
Presenting Sx (n, %)		
Chest pain		91.9
Dyspnea	57	41.9
Syncope	26	3.2
Cardiac arrest	2	3.2
	2	
Risk factor (n, %)		
HTN	31	50.0
smoking	19	30.6
DM	30	51.6
HLP	13	21.0
Positive FH	5	8.1
Hemodynamic sign(mean ± SD)		
Pulse rate	92.2	30.2
SBP	82.5	14.1
DBP	51.7	8.8
Mean BP	62.1	10.3
Comorbidity (n, %)		
COPD	2	3.2
CKD	10	16.1
CVA	2	3.2
Cardiac History (n, %)		
PCI	3	4.8
CABG	2	3.2
CCS	3	4.8
ECG (n, %)		
Sinus rhythm	49	79.0
AF	5	8.1
CHB	7	11.3
VT	1	1.6
ST-T change	57	91.9
LBBB	6	9.7
RBBB	5	8.1
MI territory	47	75.8
Anterior	15	24.2
Non anterior		
Echo findings (n, %)		
MR		
VSD	7	11.3
Pericardial effusion	1	1.6

Table 1. Baseline Characteristics of the study Patients (n=62)

Character	Value	Value
LVEF% (mean ± SD)	0	0.0
	32.0	8.8
CAG result (n, %)		
1VD	9	14.5
2VD	21	33.9
3VD	26	41.9
Not performed	6	9.6
Lab test (mean ± SD)		
WBC (10^3/µL)	12.1	5.6
Hb (g/dL)	12.6	1.5
Troponin(ng/mL)	1355.4	3515.4
BS(mg/dL	194.0	129.3
Na(mEq/L)	135.7	5.8
K(mEq/L)	4.4	0.8
LDL(mg/dL)	92.8	24.8
HDL(mg/dL)	32.0	13.5
Cr (mg/dL)	2.3	1.4
Treatment (n, %)		
Thrombolysis	2	3.2
Urgent PCI	58	93.5
Urgent CABG	0	0.0
IABP	5	8.1
TPM	6	9.7

SD: Standard Deviation, Sx: Symptoms, HTN: Hypertension, DM: Diabetes Mellitus, HLP: Hyperlipidemia, FH: Family History, COPD: Chronic Obstructive Pulmonary Disease, CKD: Chronic Kidney Disease, CVA: Cerebrovascular Accident, PCI: Percutaneous Coronary Intervention, CABG: Coronary Artery Bypass Grafting, CCS: Chronic Coronary Syndrome, ECG: Electrocardiogram, AF: Atrial Fibrillation, CHB: Complete Heart Block, VT: Ventricular Tachycardia, LBBB: Left Bundle Branch Block, RBBB: Right Bundle Branch Block, LVEF: Left Ventricular Ejection Fraction, MR: Mitral Regurgitation, AI: Aortic Insufficiency, VSD: Ventricular Septal Defect, NSTEMI: Non-ST-Elevation Myocardial Infarction, STEMI: ST-Elevation Myocardial Infarction, CAG: Coronary Angiography, VD: Vessel Disease, WBC: White Blood Cell Count, Hb: Hemoglobin, Cr: Creatinine, Trop: Troponin, BS: Blood Sugar, Na: Sodium, K: Potassium, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein, IABP: Intra-Aortic Balloon Pump, TPM: Temporary Pacemaker

The analysis compared 25 deceased patients to 37 survivors following STEMI. The deceased group had a mean age of 68.4 years (SD = 15.0) compared to 62.5 years (SD = 12.1) in the alive group, although this difference was not statistically significant (p = 0.099). The sex distribution was similar, with 64.0% males in the deceased group and 73.0% in the alive group (p = 0.576). Presenting symptoms included chest pain in 88.0% of the deceased and 94.6% of the survivors, with no significant differences in other symptoms (p-values ranging from 0.159 to 1.000). Among risk factors, diabetes mellitus was significantly more prevalent in the deceased group (68.0% vs. 35.1%, p = 0.011), as was hyperlipidemia (4.0% vs. 32.4%, p = 0.009). Hemodynamic parameters showed no significant differences, with pulse rates averaging 96.0 (SD = 29.5) for the deceased and 89.7 (SD = 30.8) for the survivors (p = 0.428). Comorbidities revealed a notable difference in chronic kidney disease (28.0% in deceased vs. 8.1% in survivors, p = 0.042). Cardiac history and ECG findings did not significantly differ between the two groups. While anterior myocardial infarction was more common in the deceased group (57.4%

vs.42.6%), this was not statistically significant (p = 0.374). Echocardiographic findings indicated a significantly lower LVEF in the deceased group (26.0%, SD = 7.4) compared to 36.1% (SD = 7.3) in the survivors (p = 0.000). Coronary angiography depicted a trend towards more severe disease in the deceased group (single vessel disease 4.0% vs. 21.8%, p = 0.054). Laboratory tests showed no significant differences in WBC, Hb, and sodium levels; however, troponin levels were significantly lower in the deceased group (525.1, SD = 1786.6 vs. 1916.4, SD = 4243.8, p = 0.017). Considering treatment, urgent PCI was performed in 88.0% of deceased patients compared to 97.3% of survivors, which was not statistically significant (p = 0.175) Table 2.

Table 2. Comparison of the Characteristics of alive and deceased patients following cardiogenic shock secondary to STEMI

Variable	Deceased n=25	Alive n=37	P value
Age (mean ± SD)	68.4 ± 15.0	62.5 ± 12.1	0.099
Sex (n, %)			0.576
Male	16(64.0)	27(73.0)	
Female	9(36.0)	10(27.0)	
Presenting Sx (n, %)			0.385
Chest pain	22(88.0)	35(94.6)	0.445
Dyspnea	12(48.0)	14(37.8)	0.159
Syncope	2(8.0)	0(0.0)	1.000
Cardiac arrest	1(4.0)	1(2.7)	
Risk factor (n, %)			
HTN	12(48.0)	19(51.4)	1.000
Tobacco smoking	7(28.0)	12(32.4)	0.467
DM	17(68.0)	13(35.1)	0.011
HLP	1(4.0)	12(32.4)	0.009
Positive FH	3(12.0)	2(5.4)	0.385
Hemodynamic sign (mean ± SD)			
Pulse rate/min	96.0 ±29.5	89.7 ± 30.8	0.428
SBP	85.9 ±12.8	80.2 ±14.7	0.125
DBP	52.6 ±9.8	51.2 ±8.2	0.442
Mean BP	63.4±13.6	61.3±7.5	0.435
Comorbidity (n, %)			
COPD	0(0.0)	2(5.4)	0.352
CKD	7(28.0)	3(8.1)	0.042
CVA	1(4)	1(2.7)	0.648
Cardiac History (n, %)			
PCI	0(0.0)	3(8.1)	0.205
CABG	2(8.0)	0(0.0)	0.159
CCS	1(4.0)	2(5.4)	0.646
ECG (n, %)			
Sinus rhythm			
Non sinus rhythm	18(72.0)	31(83.8)	0.211
ST-T change	7(28.0)	6(16.2)	0.344
LBBB	23(92.0)	34(91.9)	1.000
RBBB	2(8.0)	4(10.8)	1.000
	2(8.0)	3(8.1)	1.000
MI territory (n, %)			0.374
Anterior	20(42.6)	27(57.4)	
Non anterior	5(33.3)	10(66.7)	
Echo findings (n, %)			
MR	2(8.0)	5(13.5)	0.405

Table 2. Comparison of the Characteristics of alive and deceased patients following cardiogenic shock secondary to STEMI

Variable	Deceased n=25	Alive n=37	P value
VSD	1(4.0)	0(0.0)	0.403
Pericardial effusion	0(0.0)	0(0.0)	1.000
LVEF% (mean ± SD)	26.0 ±7.4	36.1 ±7.3	0.000
CAG result (n, %)	1(4.0)		0.054
1VD	7(28.0)	8(21.8)	0.585
2VD	12(48.0)	14(37.8)	0.297
3VD	5(20.0)	14(37.8)	0.025
Not performed		1(2.7)	
Lab test (mean ± SD)	12.1 ±6.4	12.2 ±5.1	0.513
WBC (10^3/μL)	12.1 ±2.9	12.9 ±2.2	0.583
Hb (g/dL)	525.1	1916.4 ±4243.8	0.017
Troponin(ng/mL)	±1786.6	195.1 ±121.3	0.706
BS(mg/dL	192.3	135.8 ±5.4	0.283
Na(mEq/L)	±143.0	4.5 ±0.8	0.785
K(mEq/L)	135.6 ±6.5	96.4 ±25.5	0.794
LDL(mg/dL)	4.3 ±0.8	32.6 ±13.8	0.856
HDL(mg/dL)	84.0 ±29.7	2.2 ±1.1	0.606
Cr (mg/dL)	34.0 ±18.4		
	2.4 ±1.9		
Treatment (n, %)			
Thrombolysis	1(4.0)	1(2.7)	1.000
Urgent PCI	22(88.0)	36(97.3)	0.175
Urgent CABG	0(0.0)	0(0.0)	1.000
IABP	3(12.0)	2(5.4)	0.172
TPM	4(16.0)	2(5.4)	0.317

Abbreviations:

SD: Standard Deviation, Sx: Symptoms, HTN: Hypertension, DM: Diabetes Mellitus, HLP: Hyperlipidemia, FH: Family History, COPD: Chronic Obstructive Pulmonary Disease, CKD: Chronic Kidney Disease, CVA: Cerebrovascular Accident, PCI: Percutaneous Coronary Intervention, CABG: Coronary Artery Bypass Grafting, CCS: Chronic Coronary Syndrome, ECG: Electrocardiogram, AF: Atrial Fibrillation, CHB: Complete Heart Block, VT: Ventricular Tachycardia, LBBB: Left Bundle Branch Block, RBBB: Right Bundle Branch Block, LVEF: Left Ventricular Ejection Fraction, MR: Mitral Regurgitation, AI: Aortic Insufficiency, VSD: Ventricular Septal Defect, NSTEMI: Non-ST-Elevation Myocardial Infarction, STEMI: ST-Elevation Myocardial Infarction, CAG: Coronary Angiography, VD: Vessel Disease, WBC: White Blood Cell Count, Hb: Hemoglobin, Cr: Creatinine, Trop: Troponin, BS: Blood Sugar, Na: Sodium, K: Potassium, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein, IABP: Intra-Aortic Balloon Pump, TPM: Temporary Pacemaker

The logistic regression analysis revealed several significant predictors of in-hospital mortality among STEMI patients. A left ventricular ejection fraction (LVEF) greater than 30% was associated with significantly reduced odds of mortality, with a coefficient (B) of -3.140 (SE = 0.871), resulting in an odds ratio of 0.043 (95% CI: 0.01-0.24, $p < 0.001$). Conversely, the presence of hyperlipidemia was linked to an increased risk of mortality, with a coefficient of 2.425 (SE = 1.180), yielding an odds ratio of 11.3 (95% CI: 1.1-114.1, p = 0.040). Age above 70 years did not demonstrate a significant association with mortality, with a coefficient of 0.279 (SE = 0.727) and an odds ratio of 1.3 (95% CI: 0.32-5.5, p = 0.701). Additionally, three-vessel disease showed no significant effect on mortality, as indicated by a coefficient of 0.009 (SE = 1.273) and an odds ratio of 1.01 (95% CI: 0.25-4.1, p = 0.990). These findings suggest that LVEF and hyperlipidemia are important factors in predicting in-hospital mortality in this patient population Table 3.

Table 3. Logistic Regression Analysis of Variables for Predicting In-Hospital Mortality Following Cardiogenic Shock Secondary to STEMI

Variable	B	SE	Odds ratio	95% CI	P value
LVEF>30%	-3.140	0.871	0.043	0.01-0.24	0.000
Hyperlipidemia	2.425	1.180	11.3	1.1-114.1	0.040
Age>70 yr	0.279	0.727	1.3	0.32-5.5	0.701
Three vessle disease	0.009	1.273	1.01	0.25-4.1	0.990

B: coefficient of variable, S.E.: standard errors, C.I: confidence intervals, LVEF: Left Ventricular Ejection Fraction, STEMI: ST-Elevation Myocardial Infarction

The Cox regression analysis revealed that an LVEF of less than 30% was a significant independent predictor of in-hospital mortality following STEMI. Patients with an LVEF below 30% had a hazard ratio of 11.1 (95% CI: 2.6–47.4) for mortality compared to those with an LVEF greater than 30%, which was statistically significant (p < 0.001). The survival analysis showed that patients with LVEF under 30% had significantly higher in-hospital mortality compared to those with LVEF above 30% (P=0.000), as depicted in Figure 1.

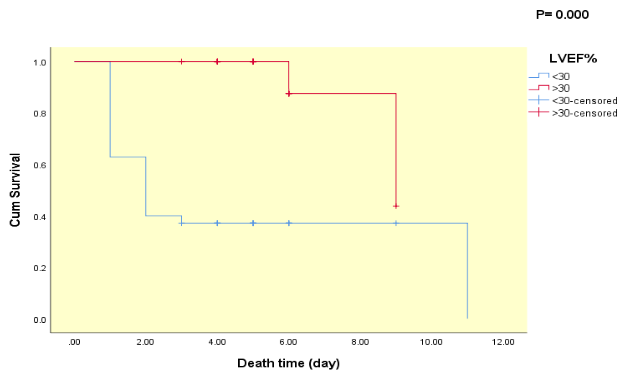

Figure1. Kaplan-Meier survival curves depicting in-hospital mortality following ST elevation myocardial infarction (STEMI) stratified by left ventricular ejection fraction (LVEF)

Discussion

This retrospective study sought to elucidate the factors associated with in-hospital mortality in patients presenting with cardiogenic shock following ST-elevation myocardial infarction (STEMI). The findings indicate that left ventricular ejection fraction (LVEF) less than 30% is a significant predictor of mortality, with a hazard ratio of 11.1 (95% CI: 2.6–47.4; p < 0.001). This highlights the critical role of assessing LVEF in clinical settings, as it provides essential insights into ventricular function and overall prognosis in this high-risk patient group. Our analysis reveals that patients with an LVEF below 30% experienced markedly reduced survival times, averaging 7.0 days (95% CI: 5.8–8.3), in contrast to those with higher ejection fractions who demonstrated significantly better outcomes. Moreover, the Kaplan-Meier survival curves distinctly illustrated the stark difference in survival rates between the two LVEF categories, emphasizing the urgent need for early identification and intervention in patients with severely compromised cardiac function. This finding aligns with existing literature that underscores the prognostic value of LVEF in various cardiac conditions, particularly in acute coronary syndromes [14, 15]. In addition to LVEF, hyperlipidemia emerged as a notable risk factor for increased mortality, with an odds ratio of 11.3 (95% CI: 1.1–114.1; p = 0.040). Conversely, some studies have demonstrated an opposing relationship [16, 17]. This association suggests that dyslipidemia may not only contribute to the development of coronary artery disease but also exacerbate outcomes in the setting of acute myocardial infarction. Therefore, strategies aimed at optimizing lipid profiles could be beneficial in improving survival rates among these patients. Interestingly, while age greater than 70 years did not demonstrate a statistically significant correlation with mortality ($p = 0.701$), it is essential to consider the multifactorial nature of mortality in this population. The cumulative impact of comorbidities, specifically chronic kidney disease (CKD), significantly differed between the deceased and surviving cohorts (28.0% vs. 8.1%, $p = 0.042$). This finding suggests that renal impairment may compound the severity of cardiogenic shock and warrants consideration in the management approach for these patients. In light of this, the combination of renal dysfunction left ventricular ejection fraction, and advanced age has been proposed as a predictor of in-hospital mortality [18]. The current study also revealed that most patients received urgent percutaneous coronary intervention (PCI), a cornerstone of treatment for STEMI. Research has identified revascularization as a fundamental component in the management of cardiogenic shock, particularly when it results from acute coronary syndromes. Early intervention, ideally via percutaneous coronary intervention (PCI), is essential for improving outcomes in this high-risk population. Additionally, carefully selecting patients for coronary artery bypass grafting (CABG) can facilitate recovery in more complex clinical scenarios [19-21]. Nevertheless, the persistent risk of mortality highlights the complexity of managing cardiogenic shock, where timely intervention alone may not suffice. This underscores the need for comprehensive treatment protocols integrating medical therapy, hemodynamic support, and potentially advanced interventions such as mechanical circulatory support when indicated [10, 22]. In summary, our study provides critical insights into the determinants of in-hospital mortality among patients with cardiogenic shock following STEMI, particularly emphasizing the prognostic significance of LVEF and hyperlipidemia. These findings advocate for a more nuanced approach to risk stratification and management in this vulnerable patient population. Future research should explore the long-term outcomes associated with these predictors and assess the effectiveness of targeted therapeutic strategies that could enhance survival rates and overall quality of care. Such investigations could ultimately inform clinical guidelines and improve patient outcomes in the context of cardiogenic shock following myocardial infarction.

Limitations

This study suffers from several limitations. First, its retrospective design may introduce selection bias, as a single institution provides the data over a specific period limiting the generalizability of the findings to broader populations and different healthcare settings. Second, the reliance on medical records for data collection may result in inaccuracies or inconsistencies in the documentation of clinical variables, especially concerning comorbidities and treatment regimens. Missing or incomplete data could affect the validity of the analyses. Third, while we identified significant predictors of in-hospital mortality, the study did not account for all potential confounding factors, such as socioeconomic status, medication adherence, and lifestyle factors that could influence outcomes. Additionally, while the sample size is adequate for preliminary analysis, it may not be sufficient to detect subtle differences in outcomes among subgroups, particularly in the context of less common comorbidities or interventions. A larger, multi-center study would be beneficial to validate the findings and enhance statistical power. Finally, the study's focus on in-hospital mortality does not capture long-term survival and quality-of-life outcomes post-discharge. Future research should consider long-term follow-up to provide a more holistic understanding of the impact of cardiogenic shock following STEMI on patient outcomes.

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Conflicts of Interest

The authors declare there is no conflict of interest.

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