

In-Hospital Mortality and Its Predictors Among Patients with Acute ST-Elevation Myocardial Infarction: A Retrospective Cohort Study

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Abstract:

Background: Acute ST-elevation myocardial infarction (STEMI) is a severe cardiovascular emergency associated with substantial risk of in-hospital mortality. Early identification of high-risk patients is essential for improving clinical outcomes.

Aim: To assess in-hospital mortality and identify its predictors among patients with acute STEMI.

Methodology: A retrospective cohort study was conducted among 80 patients with acute STEMI admitted to the Department of Cardiology, Burdwan Medical College and Hospital, West Bengal. Demographic, clinical, laboratory, echocardiographic, treatment, complication, and outcome data were retrospectively collected. Univariable and multivariable logistic regression analyses were performed using SPSS version 27.0, with statistical significance set at $p < 0.05$.

Results: The study population was predominantly male (72.5%). Hypertension (53.8%) and smoking (48.8%) were common risk factors. LVEF $< 40\%$ was present in 23.8% of patients. Multivariable analysis identified LVEF $< 40\%$ (adjusted OR 3.72; $p = 0.045$), Killip class III–IV (adjusted OR 7.86; $p = 0.003$), and cardiogenic shock (adjusted OR 12.64; $p = 0.002$) as significant predictors of in-hospital mortality.

Conclusion: Reduced LVEF, severe Killip class, and cardiogenic shock were important independent predictors of mortality in STEMI.

Keywords: STEMI; In-Hospital Mortality; Predictors; LVEF; Killip Class; Cardiogenic Shock.

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Introduction

Cardiovascular diseases (CVDs) are still one of the leading causes of mortality and morbidity globally and a growing health burden, especially in LMICs [1]. In recent years age-standardized mortality rates of chronic diseases have decreased in some developed countries, however, the burden and mortality rates of cardiovascular disease have grown significantly in developing countries. Coronary artery disease (CAD) is one of the most relevant cardiovascular diseases and can be a life-threatening clinical event, as acute myocardial infarction (AMI) [2]. AMI is the acute interruption of the blood supply to the myocardium, leading to myocardial injury, and if of long duration, necrosis. ST-elevation myocardial infarction (STEMI) is a particularly severe presentation of AMI and carries significant risk for adverse events and mortality [3].

An etiological classification of myocardial infarction is given by the third global definition of myocardial infarction [4]. The classification in this instance is that Type 1 myocardial infarction is thought to be mostly due to rupture of an atherosclerotic plaque or erosion and other atherothrombotic processes, while Type 2 myocardial infarction is believed to be caused by an imbalance between myocardial oxygen supply and demand without the presence of acute atherothrombosis. This distinction is of clinical significance because the mechanisms and treatment strategies might be different in patients [5]. STEMI traditionally refers to an acute occlusion of a coronary artery, coupled with ST-segment elevation on electrocardiogram (ECG) and are generally associated with myocardial damage and require prompt detection and restoration of coronary blood flow to prevent myocardial damage.

Although cardiac prevention, diagnostic, reperfusion, pharmacological and intensive cardiac care have significantly improved, AMI still remains a significant source of mortality [6]. The death rate due to cardiovascular disease has decreased in North America, Western Europe and Japan in recent decades as a result of better control of risk factors, early detection, emergency treatment, and evidence-based treatment. [7] But in a number of Asian areas, the death toll due to cardiovascular diseases has grown significantly. The highest increase in mortality due to heart diseases has been observed in South Asia, followed by East Asia. On the other hand, there were no significant differences in mortality patterns at the regional level in 1990–2013 across South Latin America and Australia. These differences reflect the impact of differences in population risk factors, healthcare infrastructure, socioeconomic conditions and access to timely cardiovascular care.

In particular, acute myocardial infarction has its mortality concentrated in the early phase of the disease [8]. This happens to about 1 million people each year, and almost one-third of them die because of this complication. High mortality rates of acute myocardial infarction highlight the need to identify those patients who are at higher risk of complications and worse outcomes at an early stage. Delay in diagnosis and reperfusion, myocardial damage, hemodynamic instability, arrhythmias and associated co-morbidities can play a significant role in mortality in STEMI [9]. Hence, the determination of factors associated with poor outcomes is critical to better clinical decision making and to the best management of patients in a hospital setting.

Cardiovascular diseases are the main cause of death in Iran and most of the west Asian countries, causing about 46% of total death rate [10]. These populations have a considerable burden of cardiovascular disease, thus stressing the need to identify preventable and potentially modifiable determinants of AMI-related mortality. To prevent mortality due to acute myocardial infarction and other cardiovascular diseases, a multi-faceted approach is necessary, encompassing environmental changes, health promotion and prevention activities, early detection of cardiovascular disease, and clinical management. There is evidence that, for a significant proportion of people who die from cardiovascular disease, potentially fatal events could be avoided if interventions were targeted at those with high risk, especially early in the course of disease.

Thus, risk prediction has become an important part of the modern cardiovascular treatment [11]. Demographic, clinical, laboratory and treatment-related characteristics which are associated with mortality can help in early identification of high risk and prompt intervention in patients and enable healthcare professionals to identify patients in need of intensive monitoring and early intervention. The

ability to develop predictive models to identify individuals who are at high risk of poor outcomes could enable appropriate therapeutic interventions to be taken earlier and help to decrease mortality. The importance of the predictors of in-hospital mortality among patients with STEMI is particularly relevant in this particular context given that the hospital period is a critical time when patients can suffer from rapid deterioration.

The use of a retrospective cohort study of acute STEMI patients can yield important insight into the magnitude and factors associated with in-hospital mortality. Knowing these predictors could be beneficial to identifying patients at risk of death at admission, to better monitoring and management, and to the creation of more effective strategies for reducing preventable deaths. In light of this, the present study was conducted to evaluate the in-hospital mortality and its risk factors in AMI patients to determine clinically relevant risk factors for in-hospital mortality.”

Methodology

Study Design: The present study was conducted as a retrospective cohort study to evaluate in-hospital mortality and identify its predictors among patients diagnosed with acute ST-elevation myocardial infarction (STEMI). Patient data were retrospectively retrieved from hospital medical records maintained in the Department of Cardiology. The study evaluated demographic characteristics, cardiovascular risk factors, clinical presentation, laboratory parameters, electrocardiographic findings, echocardiographic findings, treatment-related factors, in-hospital complications, and outcomes. The primary outcome was in-hospital mortality, defined as death occurring during the index hospitalization following admission with STEMI.

Study Area: The study was conducted in the Department of Cardiology, Burdwan Medical College and Hospital, West Bengal, India.

Study Duration: The study was conducted over a period of one year.

Study Participants: The study participants consisted of patients admitted to the Department of Cardiology with a diagnosis of acute ST-elevation myocardial infarction during the study period. Patient records were reviewed retrospectively, and relevant demographic, clinical, investigation, treatment, and outcome-related information was extracted using a structured data collection format.

Inclusion Criteria

- Patients aged ≥ 18 years.
- Patients admitted with a confirmed diagnosis of acute ST-elevation myocardial infarction (STEMI).

- Patients who fulfilled the clinical, electrocardiographic, and biochemical criteria for acute myocardial infarction.
- Patients with complete or sufficiently available medical records for assessment of clinical characteristics and hospital outcomes.
- Patients who were managed and followed until discharge or death during the index hospitalization.

Exclusion Criteria

- Patients aged <18 years.
- Patients diagnosed with non-ST-elevation myocardial infarction or unstable angina.
- Patients with myocardial infarction occurring as a secondary consequence of another major acute condition, where STEMI could not be established as the primary diagnosis.
- Patients transferred to another hospital before completion of in-hospital outcome assessment.
- Patients with substantially incomplete or missing medical records.
- Patients with documented death before hospital admission.

Sample Size: A total of 80 patients with acute ST-elevation myocardial infarction who fulfilled the predefined eligibility criteria were included in the study. All eligible patient records available during the specified study period were reviewed and analyzed.

Procedure: Relevant patient records were retrospectively reviewed using a structured data collection proforma. Information regarding age, sex, presenting symptoms, time from symptom onset to hospital presentation, and cardiovascular risk factors such as hypertension, diabetes mellitus, smoking, dyslipidemia, and family history of cardiovascular disease was recorded. Clinical parameters including blood pressure, heart rate, oxygen saturation, and Killip class at admission were documented. Electrocardiographic findings, cardiac biomarkers, hemoglobin, renal function, blood glucose, lipid profile,

and other relevant laboratory investigations were extracted from the records. Echocardiographic parameters, particularly left ventricular ejection fraction, were also recorded. Details of treatment, including antiplatelet agents, anticoagulants, statins, thrombolytic therapy, and percutaneous coronary intervention when performed, were documented. In-hospital complications such as cardiogenic shock, arrhythmias, heart failure, and cardiac arrest were recorded. The final hospital outcome was classified as survival to discharge or in-hospital death. The collected data were checked for completeness and consistency before statistical analysis.

Statistical Analysis: Data were entered and analyzed using IBM SPSS Statistics version 27.0. Continuous variables were expressed as mean $\pm$ SD or median (IQR), and categorical variables as frequencies and percentages. Appropriate t-test/Mann-Whitney U test and Chi-square/Fisher's exact test were applied. Univariable and multivariable logistic regression analyses were performed to identify independent predictors of in-hospital mortality. Adjusted odds ratios with 95% CIs were reported. A p-value <0.05 was considered statistically significant."

Result

Table 1 presents the demographic characteristics of the 80 study participants. The age distribution showed that the majority of participants belonged to the 41–60 years age group, comprising 29 (36.2%) participants, closely followed by those aged 61–75 years, with 28 (35.0%) participants. Participants aged >75 years accounted for 15 (18.8%), while the youngest age group of 18–40 years included only 8 (10.0%) participants. Thus, the study population was predominantly middle-aged to elderly, with 64 (80.0%) participants being older than 40 years. Regarding sex distribution, males constituted the majority of the study population, with 58 (72.5%) participants, whereas females accounted for 22 (27.5%). Overall, the findings demonstrated a marked male predominance and a higher representation of older adults among the 80 participants.

Table 1: Demographic characteristics of study participants (N = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–40	8	10
	41–60	29	36.2
	61–75	28	35
	>75	15	18.8
Sex	Male	58	72.5
	Female	22	27.5
Total		80	100

Table 2 presents the distribution of cardiovascular risk factors among the 80 patients with STEMI. Hypertension was the most common risk factor, being present in 43 (53.8%) patients, while 37 (46.2%) patients did not have hypertension. Smoking was

reported in 39 (48.8%) participants, indicating that nearly half of the study population had a history of smoking, whereas 41 (51.2%) were non-smokers. Dyslipidemia was observed in 35 (43.8%) patients and was absent in 45 (56.2%). Diabetes mellitus was

present in 31 (38.8%) participants, while 49 (61.2%) did not have diabetes. A family history of cardiovascular disease was reported by 17 (21.2%) patients, whereas the majority, 63 (78.8%), had no such

history. Overall, hypertension, smoking, and dyslipidemia were the predominant cardiovascular risk factors, while diabetes mellitus and a positive family history were less frequently reported.

Table 2: Cardiovascular risk factors among patients with STEMI (N = 80)

Risk factor	Present n (%)	Absent n (%)	Total
Hypertension	43 (53.8)	37 (46.2)	80
Diabetes mellitus	31 (38.8)	49 (61.2)	80
Smoking	39 (48.8)	41 (51.2)	80
Dyslipidemia	35 (43.8)	45 (56.2)	80
Family history of cardiovascular disease	17 (21.2)	63 (78.8)	80

Table 3 presents the clinical and laboratory characteristics of the 80 patients with STEMI at admission. The majority of patients, 47 (58.8%), were classified as Killip class I, followed by 18 (22.5%) in class II, 8 (10.0%) in class III, and 7 (8.8%) in class IV, indicating that most patients had no or mild signs of heart failure at presentation. Regarding systolic blood pressure, 69 (86.2%) patients had a blood pressure of ≥ 90 mmHg, whereas 11 (13.8%) had

systolic blood pressure < 90 mmHg. A heart rate < 100 beats/min was observed in 52 (65.0%) patients, while 28 (35.0%) had a heart rate ≥ 100 beats/min. Left ventricular ejection fraction (LVEF) was $< 40\%$ in 19 (23.8%) patients and $\geq 40\%$ in 61 (76.2%). Elevated cardiac biomarkers were present in 76 (95.0%) patients, confirming myocardial injury in the vast majority of participants.

Table 3: Clinical and laboratory characteristics at admission (N = 80)

Parameter	Category	Frequency (n)	Percentage (%)
Killip class	I	47	58.8
	II	18	22.5
	III	8	10
	IV	7	8.8
Systolic BP	< 90 mmHg	11	13.8
	≥ 90 mmHg	69	86.2
Heart rate	< 100 beats/min	52	65
	≥ 100 beats/min	28	35
LVEF	$< 40\%$	19	23.8
	$\geq 40\%$	61	76.2
Elevated cardiac biomarkers	Yes	76	95
	No	4	5

Table 4 presents the treatment received and in-hospital complications among the 80 STEMI patients. Percutaneous coronary intervention (PCI) was performed in 46 (57.5%) patients, whereas 34 (42.5%) did not undergo PCI. Thrombolytic therapy was administered to 18 (22.5%) patients, while 62 (77.5%) did not receive thrombolysis. Dual antiplatelet therapy was received by 76 (95.0%) patients, indicating its widespread use in the study population, while 4 (5.0%) did not receive it. Regarding in-hospital complications, heart failure was the most frequently observed complication, occurring in 17 (21.2%) patients, followed by significant arrhythmia in 14 (17.5%) patients. Cardiogenic shock was present in 10 (12.5%) patients, while cardiac arrest occurred in 6 (7.5%) patients. Overall, PCI and dual antiplatelet therapy were commonly used, whereas heart failure and significant arrhythmia represented the predominant in-hospital complications.

Table 5 presents the predictors of in-hospital mortality among the 80 patients with STEMI. Mortality

was higher among patients aged > 60 years (20.9%), those with diabetes mellitus (22.6%), hypertension (18.6%), and LVEF $< 40\%$ (36.8%). On multivariable analysis, LVEF $< 40\%$ was significantly associated with increased in-hospital mortality (adjusted OR 3.72, 95% CI: 1.03–13.43; $p=0.045$). Similarly, Killip class III–IV was a significant predictor of mortality, with patients having nearly eight-fold higher odds of death (adjusted OR 7.86, 95% CI: 2.02–30.56; $p=0.003$). Cardiogenic shock showed the strongest association with mortality, with an adjusted OR of 12.64 (95% CI: 2.65–60.25; $p=0.002$). In contrast, age > 60 years, male sex, diabetes mellitus, hypertension, smoking, and non-performance of PCI were not statistically significant predictors ($p>0.05$). Overall, impaired ventricular function, severe Killip class, and cardiogenic shock emerged as the major independent predictors of in-hospital mortality.

Table 4: Treatment received and in-hospital complications among STEMI patients (N = 80)			
Variable	Category	Frequency (n)	Percentage (%)
Percutaneous coronary intervention (PCI)	Performed	46	57.5
	Not performed	34	42.5
Thrombolytic therapy	Received	18	22.5
	Not received	62	77.5
Dual antiplatelet therapy	Received	76	95
	Not received	4	5
Cardiogenic shock	Present	10	12.5
	Absent	70	87.5
Heart failure	Present	17	21.2
	Absent	63	78.8
Significant arrhythmia	Present	14	17.5
	Absent	66	82.5
Cardiac arrest	Present	6	7.5
	Absent	74	92.5

Table 5: Predictors of in-hospital mortality among patients with STEMI (N = 80)				
Predictor	In-hospital death n/N (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value
Age >60 years	9/43 (20.9)	2.35 (0.62–8.90)	2.18 (0.54–8.73)	0.272
Male sex	8/58 (13.8)	0.78 (0.23–2.69)	0.83 (0.22–3.12)	0.783
Diabetes mellitus	7/31 (22.6)	2.14 (0.65–7.08)	1.91 (0.52–7.01)	0.327
Hypertension	8/43 (18.6)	1.70 (0.50–5.81)	1.48 (0.40–5.48)	0.557
Smoking	5/39 (12.8)	0.74 (0.23–2.44)	0.81 (0.23–2.83)	0.746
LVEF <40%	7/19 (36.8)	4.11 (1.25–13.50)	3.72 (1.03–13.43)	0.045
Killip class III–IV	8/15 (53.3)	10.00 (2.83–35.33)	7.86 (2.02–30.56)	0.003
Cardiogenic shock	7/10 (70.0)	18.38 (4.47–75.55)	12.64 (2.65–60.25)	0.002
PCI not performed	8/34 (23.5)	2.62 (0.77–8.91)	2.31 (0.62–8.61)	0.211

Discussion

In the present retrospective cohort study, 80 patients with acute ST-elevation myocardial infarction (STEMI) were evaluated and revealed that in-hospital death was more closely associated with myocardial dysfunction and haemodynamic compromise, not with demographic parameters or the traditional cardiovascular risk factors. The study population was mostly male (72.5%) and above average age, with 36.2% aged 41–60 years and 35.0% aged 61–75 years. This is generally similar to the epidemiological pattern of acute coronary disease, which rises with age and has been higher in men than in women in the past. The significant role of age, male sex, hypertension, smoking, diabetes and dyslipidaemia in the burden of cardiovascular disease was also noted by Yusuf et al. (2001) [12], which is consistent with the substantial risk-factor burden in the present cohort."

"In the present study, the most common cardiovascular risk factors were hypertension (53.8%), smoking (48.8%), dyslipidaemia (43.8%) and diabetes mellitus (38.8%). But after adjusting for these traditional risk factors, none were independent predictors of in-hospital mortality. These results indicate that, after STEMI, the initial prognosis could be more closely related to the myocardial injury and

physiological deterioration rather than chronic risk factors. This is in part similar to Takii et al., 2010 [13] who showed that despite the same amount of cardiovascular risk factors, patients with AMI who experienced better treatment had a lower mortality rate, highlighting the importance of the severity of the disease and its treatment.

In the present study, the severity of presentation was also of particular importance. 58.8% of patients had a Killip class of I, 22.5% class of II, 10.0% class of III and 8.8% class of IV. Therefore, 18.8% admitted with Killip class III–IV, signifying significant haemodynamic compromise. The adjusted odds of mortality were about 8 times higher for patients who were categorized into Killip class III–IV, with more than half dying. The results obtained are clinically plausible as pulmonary congestion, severe heart failure and cardiogenic deterioration, indicate that myocardial dysfunction exists. The contemporary heart-failure literature supports the strong prognostic value of clinical heart failure severity, whereas worsening ventricular function and congestion are both consistently associated with adverse outcomes (Murphy et al., 2020) [14].

Another important factor in determining mortality was left ventricular systolic dysfunction. A total of 23.8% of patients in the present study had an LVEF

of less than 40%, with a mortality rate of 36.8% and adjusted odds of death 3.7-fold greater than in patients with LVEF $\geq 40\%$. This observation is similar to what was observed in the analysis of the Yazd registry, where patients with EF $< 40\%$ had about 3.6 times the risk of death as patients with EF $> 40\%$. In the same way, Daneault et al. in 2013 [15] showed data of the HORIZONS-AMI trial, which showed significantly worse clinical outcomes in patients with LVEF $< 40\%$ compared to those with LVEF $\geq 40\%$ after primary PCI. In addition, the prognostic value of LVEF in STEMI has been validated by Alkhalil et al. (2020), who also found that LVEF was an important marker of the short-term risk, which is confirmed by the present study.

In the present study, the independent strongest predictor for death was cardiogenic shock. The mortality rate for patients that developed cardiogenic shock was 70.0% while the adjusted odds of in-hospital mortality were 12.64 times greater in the cardiogenic shock group. This may highlight the importance of circulatory failure immediately after STEMI as a prognostic factor. Association is comparable to that previously noted in other cohorts that cardiogenic shock is one of the most deadly complications of acute myocardial infarction despite the progress made in reperfusion and intensive care. High mortality rates could be due to the presence of severe left ventricular dysfunction, multiorgan injury, malignant arrhythmias and/or systemic hypoperfusion in this population.

Significant arrhythmia (17.5%) and heart failure (21.2%) occurred in 12.5% and 7.5% of patients, respectively, and cardiac arrest and cardiogenic shock occurred in 12.5% and 7.5% of patients, respectively. The risks associated with these complications offer a possible clinical pathway linking decreased LVEF with mortality and high Killip class with decreased LVEF. Gabriel-Costa, 2018 [16] explained how myocardial infarction (MI) induced ventricular remodeling and contractility impairment can lead to heart failure, and also to adverse outcomes. For this reason, the relationship between LVEF $< 40\%$, severe Killip class and mortality found in the present study makes a pathophysiological sense.

PCI was done in 57.5% of patients, 42.5% did not undergo PCI and 22.5% had thrombolysis. The PCI status was not statistically significant after adjusting for mortality but numerically higher in patients not undergoing PCI. This is in contrast to the body of evidence that's established in favor of reperfusion therapy in STEMI, which could be due to sample size and selection bias. Patients who were ineligible for PCI may have arrived late, had contraindications, been highly unstable, or had other clinical factors that could have affected the clinical decision of which treatment to use. Thus, the absence of statistical significance should not be interpreted as proof that early reperfusion is not beneficial.

The present findings showed that LVEF $< 40\%$, Killip class III-IV and cardiogenic shock were the most clinically relevant predictors of in-hospital mortality. However, age, diabetes and hypertension, as well as lack of PCI were not independent predictors after adjustment. These findings indicate that early assessment of ventricular function, early classification of Killip, continuous haemodynamic monitoring and aggressive treatment of cardiogenic shock are important elements in risk stratification of patients with STEMI."

Conclusion

The present study concluded that in-hospital mortality among patients with acute STEMI was predominantly associated with the severity of myocardial dysfunction and haemodynamic instability rather than conventional cardiovascular risk factors. Among the 80 patients evaluated, reduced left ventricular ejection fraction (LVEF $< 40\%$), Killip class III-IV, and cardiogenic shock emerged as significant independent predictors of mortality. Patients with LVEF $< 40\%$ had 3.72-fold higher adjusted odds of death, while Killip class III-IV and cardiogenic shock were associated with 7.86-fold and 12.64-fold higher odds, respectively. In contrast, age, sex, diabetes, hypertension, smoking, and non-performance of PCI were not independently associated with mortality. These findings emphasize the importance of early risk stratification, prompt assessment of ventricular function, close haemodynamic monitoring, and aggressive management of cardiogenic shock to improve outcomes in patients with acute STEMI.

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