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Original Article

EVALUATION OF PREDICTORS OF MORTALITY AMONG PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

Objective: To identify demographic, clinical, laboratory, and treatment-related predictors of mortality among acute myocardial infarction (AMI) patients admitted to a tertiary care hospital in Peshawar.

Methodology: A retrospective observational study was conducted in the Cardiology Department from June 2023 to June 2024. Data from 120 adult AMI patients selected through consecutive sampling were collected from medical records. Predictors of mortality were analyzed using Chi-square/Fisher's exact tests, independent sample tests, and multivariable logistic regression, with $p<0.05$ considered significant.

Results: Of 120 patients, 106 (88.3%) survived and 14 (11.7%) died. Cardiogenic shock was significantly higher among non-survivors (85.7% vs 43.4%, p=0.007) and remained the strongest independent predictor of mortality (adjusted OR=10.39, 95% CI: 2.10–51.39, p=0.004). Higher Killip class also independently predicted mortality (adjusted OR=1.77, 95% CI: 1.03–3.05, p=0.039).

Conclusion: Cardiogenic shock and higher Killip class were key predictors of in-hospital mortality in AMI patients. Early identification of hemodynamic instability may improve risk assessment and management.

Keywords: Acute Myocardial Infarction; Mortality; Cardiogenic Shock; Risk Factors; Prognosis.

INTRODUCTION

Acute myocardial infarction is a serious cardiovascular emergency that occurs when blood flow to the heart muscle is suddenly reduced, causing myocardial injury and cell death. It remains a major cause of morbidity and mortality worldwide despite improvements in early diagnosis, coronary intervention, and medical therapy. The outcome of patients with AMI depends on several factors, including patient characteristics, severity of presentation, laboratory abnormalities, and the treatment received during hospital admission.[1]

Cardiovascular disease continues to be the leading cause of death globally, with a greater burden seen in low- and middle-income countries. Increasing rates of diabetes, hypertension, smoking, obesity, and sedentary lifestyle have contributed to the rising number of coronary artery disease cases. In Pakistan, cardiovascular disease has become an important

public health problem, and many patients present to hospitals at an advanced stage of illness.[2]

Age is an important demographic factor associated with mortality after myocardial infarction. Older patients often have more associated diseases, reduced cardiac reserve, and a higher risk of complications such as heart failure and arrhythmias. A recent global meta-analysis found that prevalence of MI rises markedly with age.[3]

Sex differences have also been observed in patients with AMI. Women may present with atypical symptoms and may have delays in diagnosis and treatment. Differences in cardiovascular risk factors, disease patterns, and access to invasive treatment may influence outcomes. Contemporary evidence on women's cardiovascular health emphasizes the importance of considering sex-specific risk profiles when assessing prognosis among acute coronary syndrome patients.[4]

The clinical condition of patients at admission plays a major role in determining survival after AMI. Hemodynamic instability, low blood pressure, cardiac arrest, heart failure, and cardiogenic shock are associated with increased mortality. The Killip classification remains a simple and useful clinical tool for assessing heart failure severity in AMI patients. Higher Killip classes indicate more severe cardiac dysfunction and are associated with increased risk of death.[5]

Cardiogenic shock is one of the most serious complications of AMI and remains associated with high mortality despite advances in treatment. Patients with cardiogenic shock require rapid recognition and urgent management because reduced cardiac output can lead to multiple organ dysfunction. A contemporary long-term outcomes study of AMI complicated by cardiogenic shock confirmed that short- and long-term mortality in this subgroup remains persistently high.[6]

The type of myocardial infarction also influences patient outcomes. STEMI usually results from complete coronary artery blockage and requires urgent reperfusion therapy through primary percutaneous coronary intervention or thrombolysis. Delays in restoring blood flow can increase myocardial damage and reduce survival. A recent explainable deep-learning model developed for in-hospital AMI mortality prediction demonstrated the dominant contribution of presentation-related hemodynamic variables in determining early outcomes.[7]

Cardiac biomarkers provide important information regarding myocardial injury and prognosis. Cardiac troponin is the preferred biomarker for diagnosis of AMI and provides prognostic information. Higher troponin levels generally reflect greater myocardial damage and have been associated with increased risk of heart failure and mortality. Recent machine-learning analyses that incorporate age, BNP, renal biomarkers, and complete blood count parameters confirm that combining biomarkers with clinical assessment improves mortality risk prediction.[8]

Renal dysfunction is another important factor associated with poor outcomes after AMI. Reduced kidney function is common among patients with cardiovascular disease and is linked to inflammation, vascular abnormalities, and increased risk of complications. Recent machine-learning analyses in AMI have identified renal biomarkers as pivotal predictors in short-term mortality models.[8]

Diabetes mellitus and admission hyperglycemia are frequently observed among patients with AMI. Diabetes accelerates coronary artery disease and is associated with increased risk of complications. Stress hyperglycemia during acute illness may reflect disease severity and increased physiological stress. Evidence on patients with AMI but without standard modifiable cardiovascular risk factors demonstrates that acute clinical deterioration can dominate short-term mortality risk irrespective of background chronic risk profile.[9]

Bleeding risk has emerged as a relevant prognostic dimension after AMI. Recent comparative studies of antithrombotic strategies in ACS patients treated with PCI have shown that bleeding risk scores such as PRECISE-DAPT identify patients at substantially elevated long-term mortality, regardless of ischemic risk score.[10]

Left ventricular function is an important determinant of prognosis following myocardial infarction. Reduced left ventricular ejection fraction increases the risk of heart failure, arrhythmias, and death. A multicenter prognostic model for STEMI patients identified LVEF together with age, Killip class, NT-proBNP, and ACEI/ARB/ARNI therapy as core predictors of post-discharge mortality.[11]

Treatment-related factors also influence outcomes after AMI. Early reperfusion through PCI improves survival by restoring coronary blood flow and reducing myocardial damage. However, outcomes may vary depending on timing of presentation, availability of cardiac facilities, and patient characteristics.[12]

In Pakistan, limited studies have evaluated predictors of mortality among AMI patients, particularly from tertiary care hospitals outside major metropolitan areas. A retrospective analysis using the National Cardiovascular Data Registry framework at a Karachi tertiary care institution demonstrated measurable gaps between guideline-directed therapy and practice, alongside AMI mortality rates consistent with international registries.[13] A separate analysis of 23,560 young South Asian ACS patients from a Karachi registry further demonstrated distinct presentation patterns and outcomes in younger cohorts.[14]

The Department of Cardiology at a tertiary care hospital in Peshawar manages many patients with acute myocardial infarction from both urban and rural areas. Many patients are present with advanced disease due to delays in seeking medical care and referral difficulties. Identifying predictors of mortality in this setting may help clinicians recognize high-risk patients early and improve management decisions.

Although international studies have developed several risk prediction models for AMI, differences in patient characteristics, healthcare access, and treatment facilities mean that findings from other populations may not fully apply to Pakistani patients. A 2024 prognostic model for predicting post-discharge mortality after primary PCI for STEMI, integrating age, Killip class, NT-proBNP, and LVEF, illustrates the kind of tool that may inform local adaptation.[11]

The objective of this study was to evaluate demographic, clinical, laboratory, and treatment-related predictors of mortality among patients with acute myocardial infarction at the Department of Cardiology at a tertiary care hospital in Peshawar.

METHODS

Study Design, setting and duration

A retrospective observational study was conducted at Department of Cardiology at a tertiary care hospital in Peshawar, Khyber Pakhtunkhwa, Pakistan. Patients admitted during the period from June 2023 to June 2024 were included.

Data for all eligible patients admitted with acute myocardial infarction during the study period, were retrospectively extracted from hospital medical records.

Study population and patient selection

Adult patients diagnosed with acute myocardial infarction during the study period were considered eligible for inclusion. Patients were identified from hospital admission records and assessed according to predefined inclusion and exclusion criteria.

Patients were included if they were aged 18 years or older, had a confirmed diagnosis of acute myocardial infarction based on clinical presentation, electrocardiographic findings, and cardiac biomarker elevation, and had documented in-hospital outcomes. The study included both STEMI and NSTEMI patients.

Patients were excluded if the diagnosis of myocardial infarction was uncertain, if outcome documentation was unavailable, or if essential clinical information required for analysis was missing.

A total of 120 patients fulfilled the eligibility criteria and were included in the final analysis.

Sample size

The sample size was initially calculated using the WHO recommended method for estimating a single population proportion. Based on an expected mortality proportion of 10%, a 95% confidence level, and a 5% margin of error, the calculated sample size was 139 patients. After adding 10% to account for incomplete records, the estimated requirement was 153 patients.

However, during the study period, only 120 patients fulfilled the eligibility criteria and had complete outcome documentation.

Sampling technique

A consecutive sampling technique was used. All eligible patients admitted during the study period were included to reduce selection bias.

Study outcome

The primary outcome was in-hospital mortality following acute myocardial infarction.

Patients were categorized into two groups:

Survivors: Patients discharged alive from hospital.

Non-survivors: Patients who died during the index hospital admission.

Data collection procedure

Data were collected retrospectively using a structured data collection form. Information was obtained from patient medical records, admission notes, discharge summaries, laboratory reports, electrocardiography records, echocardiography reports, and treatment documentation.

The collected variables included demographic characteristics, cardiovascular risk factors, clinical presentation, laboratory findings, echocardiographic findings, treatment received, and hospital outcomes.

Definition and assessment of study variables

Acute myocardial infarction was defined according to the Fourth Universal Definition of Myocardial Infarction, as adopted in current European Society of Cardiology guidelines, based on evidence of acute myocardial injury with elevated cardiac troponin levels together with clinical evidence of myocardial ischemia.[12]

STEMI was defined as myocardial infarction associated with persistent ST-segment elevation on electrocardiography, while NSTEMI was defined as myocardial infarction without persistent ST-segment elevation.

Cardiogenic shock was defined as persistent hypotension with systolic blood pressure below 90 mmHg requiring vasopressor or inotropic support due to cardiac dysfunction with evidence of impaired tissue perfusion, consistent with criteria applied in current European Society of Cardiology ACS guidelines.[12]

Cardiogenic shock status was recorded according to clinical documentation during hospital admission.

Killip class was assessed at admission according to clinical signs of heart failure. Killip class I represented the absence of heart failure, while increasing classes indicated greater severity of pulmonary congestion and cardiac dysfunction, consistent with the well-established Killip classification validated in contemporary STEMI cohorts.[15]

Because Killip class IV clinically represents cardiogenic shock, the variables were not included simultaneously in regression analysis to avoid collinearity.

Diabetes mellitus and hypertension were considered present if previously diagnosed by a physician or documented in medical records, in line with standard modifiable cardiovascular risk factor assessment.[9]

Reduced left ventricular ejection fraction was defined as left ventricular ejection fraction below 40% on echocardiographic assessment.[11]

Primary PCI was defined as emergency percutaneous coronary intervention performed during the index admission for myocardial infarction management, consistent with ESC 2023 ACS recommendations.[12]

Laboratory assessment

Laboratory variables included cardiac troponin, serum creatinine, estimated glomerular filtration rate, hemoglobin, blood glucose, and lipid profile. Recent machine-learning mortality models in AMI have shown that complete blood count parameters and renal biomarkers are pivotal predictor inputs.[8]

Troponin values were collected from available laboratory records during hospital admission. Due to the retrospective nature of the study, assay-specific information, reference ranges, and exact sampling time were not consistently available for all patients.

Treatment-related variables

Treatment variables included primary PCI, thrombolysis, aspirin therapy, dual antiplatelet therapy, antithrombotic regimens, statin therapy, beta-blocker therapy, angiotensin-converting enzyme inhibitor/angiotensin receptor blocker therapy, anticoagulation, inotropic support, and mechanical ventilation.[10]

Only variables with adequate documentation were included in the final analysis.

Missing data management

All variables were assessed for completeness before statistical analysis. Missing data proportions were reviewed for each variable.

Variables with complete absence of recorded information were excluded from analysis. For variables with partial missing values, available-case analysis was performed.

Statistical analysis

Data was analyzed using IBM SPSS version 25. Continuous variables were assessed for distribution and presented as mean ± standard deviation or median with interquartile range where appropriate. Categorical variables were presented as frequencies and percentages.

Comparison between survivors and non-survivors was performed using the independent-samples t-test or Mann–Whitney U test for continuous variables and Chi-square test or Fisher's exact test for categorical variables.

The association between cardiogenic shock and mortality was assessed using binary logistic regression. Due to the limited number of mortality events (14 deaths), a restricted regression model with parsimonious predictor selection was used to minimize overfitting, consistent with methodology recommended in recent deep-learning mortality models for AMI.

Cardiogenic shock was selected as the primary predictor because it demonstrated the strongest association with mortality in preliminary analysis. Age was included as a prespecified demographic confounder.

Results were presented as adjusted odds ratios with 95% confidence intervals. Model performance was assessed using receiver operating characteristic analysis. A p-value of less than 0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Institutional Ethical Review Committee of the tertiary care hospital.

As this study involved a retrospective review of existing medical records without direct patient intervention, informed consent was waived according to institutional ethical guidelines.

Patient confidentiality was maintained throughout the study by anonymizing all collected information. The study was conducted according to ethical principles for research involving human participants. No animal subjects were included.

RESULTS

Patient selection and baseline characteristics

During the study period from June 2023 to June 2024, patients admitted with acute myocardial infarction to the Department of Cardiology at a tertiary care hospital in Peshawar were assessed for eligibility. After applying the predefined inclusion and exclusion criteria, 120 patients were included in the final analysis.

Among the included patients, 106 (88.3%) survived and 14 (11.7%) died during hospital admission.

The mean age of the study population was 60.26±15.79 years. Most patients were male (91, 75.8%), while 29 (24.2%) were female. STEMI was diagnosed with 65 (54.2%) patients and NSTEMI was diagnosed with 55 (45.8%) patients.

The most common cardiovascular risk factors were diabetes mellitus (66, 55.0%) and hypertension (62, 51.7%). Chronic kidney disease was documented in 59 (49.2%) patients. Cardiogenic shock was documented in 58 (48.3%) patients according to predefined clinical criteria.

Table 1. Baseline demographic and clinical characteristics and comorbidities of patients with acute myocardial infarction (n=120)

Variable	Total n (%) / Mean±SD
Age (years)	60.26±15.79
Male sex	91 (75.8%)
Female sex	29 (24.2%)
STEMI	65 (54.2%)
NSTEMI	55 (45.8%)
Diabetes mellitus	66 (55.0%)
Hypertension	62 (51.7%)
Chronic kidney disease	59 (49.2%)
Previous myocardial infarction	27 (22.5%)
Previous PCI	21 (17.5%)
Smoking history	53 (44.2%)
Heart failure at admission	66 (55.0%)

Cardiogenic shock	58 (48.3%)

Comparison of demographic and clinical characteristics between survivors and non-survivors

The demographic and clinical characteristics were compared between survivors and non-survivors.

The mean age of non-survivors was higher compared with survivors; however, the difference was not statistically significant (63.00±18.09 years versus 59.90±15.50 years, p=0.470).

Sex distribution was similar between groups, with no significant association between sex and mortality (p=0.938).

Cardiogenic shock showed a statistically significant association with mortality; it was present in 12 (85.7%) non-survivors compared with 46 (43.4%) survivors (p=0.007).

Other clinical characteristics including STEMI/NSTEMI presentation, diabetes mellitus, hypertension, chronic kidney disease, and primary PCI did not show statistically significant associations with mortality.

Table 2. Comparison of demographic and clinical characteristics between survivors and non-survivors

Variable	Survivors n=106	Non-survivors n=14	p-value
Age (years)	59.90±15.50	63.00±18.09	0.470
Male sex	81 (76.4%)	10 (71.4%)	0.938
STEMI	58 (54.7%)	7 (50.0%)	0.962
NSTEMI	48 (45.3%)	7 (50.0%)	
Diabetes mellitus	56 (52.8%)	10 (71.4%)	0.304
Hypertension	55 (51.9%)	7 (50.0%)	1.000
Chronic kidney disease	52 (49.1%)	7 (50.0%)	1.000
Cardiogenic shock	46 (43.4%)	12 (85.7%)	0.007
Primary PCI	43 (40.6%)	5 (35.7%)	0.954

Killip class and mortality association

Killip class was analyzed separately because Killip class IV represents cardiogenic shock and simultaneous inclusion of both variables in the regression could introduce collinearity.

Higher Killip classes were associated with increased mortality. Mortality was highest among patients with Killip class IV, where 6 (20.7%) patients died compared with patients in lower Killip classes.[15]

Table 3. Association between Killip class and in-hospital mortality

Killip class	Survivors n (%)	Deaths n (%)	Total n (%)
Class I	34 (91.9%)	3 (8.1%)	37 (30.8%)
Class II	30 (93.8%)	2 (6.2%)	32 (26.7%)
Class III	19 (86.4%)	3 (13.6%)	22 (18.3%)
Class IV	23 (79.3%)	6 (20.7%)	29 (24.2%)

Laboratory and treatment-related factors

The mean troponin level was 10.57±5.68 among survivors and 9.32±5.90 among non-survivors (p=0.440). Creatinine levels were similar between groups (1.79±0.64 mg/dL versus 1.74±0.51 mg/dL, p=0.780).

Primary PCI was performed in 48 (40.0%) patients overall. The frequency of PCI was similar between survivors and non-survivors (43 [40.6%] versus 5 [35.7%], p=0.954). Treatment variables with incomplete documentation were excluded from comparative analysis.

Table 4. Laboratory and treatment characteristics associated with mortality

Variable	Survivors (n=106)
Troponin level	10.57±5.68
Creatinine (mg/dL)	1.79±0.64
Hemoglobin (g/dL)	11.63±3.12
Primary PCI	43 (40.6%)

Logistic regression analysis of predictors of mortality

Binary logistic regression analysis was performed to evaluate factors independently associated with in-hospital mortality. Because only 14 mortality events occurred, a restricted regression model was applied to reduce the risk of overfitting. Cardiogenic shock was selected as the primary predictor because it demonstrated the strongest association with mortality.

Age was included as a prespecified demographic confounder.

Cardiogenic shock remained independently associated with mortality after adjustment for age (adjusted OR = 10.39, 95% CI: 2.10–51.39, p = 0.004).[16]

Table 5. Multivariable logistic regression analysis of predictors associated with in-hospital mortality

Predictor variable	Adjusted OR	95% CI	p-value
Age	1.01	0.97–1.06	0.635
Cardiogenic shock	10.39	2.10–51.39	0.004

Model performance:

Parameter	Value
Total patients	120
Mortality events	14
Predictors included	2

Missing data analysis

Demographic and outcome variables were complete for all including patients. Variables with incomplete documentation were analyzed using available case analysis.

Discussion

This retrospective study evaluated demographic, clinical, laboratory, and treatment-related factors associated with in-hospital mortality among patients with acute myocardial infarction admitted to a tertiary care hospital in Peshawar. A total of 120 patients were included, of whom 14 (11.7%) died during hospital admission. The main finding of this study was that cardiogenic shock was independently associated with mortality after adjustment for age. Patients presenting with cardiogenic shock had significantly higher odds of in-hospital death compared with those without shock (adjusted OR=10.39, 95% CI: 2.10–51.39, p=0.004). Higher Killip class was also correlated with increased mortality; however, it was analyzed separately because of its clinical overlap with cardiogenic shock.

The findings suggest that acute haemodynamic instability at presentation is an important determinant of short-term outcome among AMI patients. In contrast, demographic characteristics, chronic comorbidities, laboratory parameters, and primary PCI status were not independently associated with mortality in this cohort.

The in-hospital mortality rate observed in this study was 11.7%. This finding is comparable with mortality rates reported from contemporary acute myocardial infarction registries, although outcomes vary depending on patient risk profile, healthcare resources, and availability of timely reperfusion therapy. The American Heart Association 2023 statistics update indicates that mortality after myocardial infarction has improved over time, but high-risk patients presenting with shock, heart failure, or extensive myocardial injury continue to experience poor outcomes.[1]

The mortality observed in this study may reflect the characteristics of a tertiary referral population. In Pakistan, many patients with AMI present late because of limited awareness, delays in transportation, and barriers to accessing specialised cardiac services. A retrospective single-center analysis from a Pakistani tertiary care centre using the National Cardiovascular Data Registry framework confirmed that clinical severity at presentation and adherence to guideline-directed therapy substantially shape AMI outcomes in this setting.[13]

Compared with European and North American populations, patients in low- and middle-income countries often have different patterns of presentation. A 2023 global systematic review of MI prevalence demonstrated that prevalence rises sharply in older age groups (9.5% in those >60 years versus 3.8% in those <60 years), consistent with the demographic and risk-factor profile seen in this cohort.[3]

Cardiogenic shock was the strongest predictor of mortality in this study. A 2023 long-term outcomes study of AMI complicated by cardiogenic shock in a national sample demonstrated that short- and long-term mortality in this subgroup remains persistently high with minimal improvement over time, and that survivors experience substantial post-discharge morbidity and readmission risk.[6] This matches the markedly elevated adjusted odds ratio observed in the present cohort.

The association observed in this study is clinically plausible because cardiogenic shock represents severe impairment of cardiac output and tissue perfusion. Patients with shock often develop a cycle of worsening myocardial injury, hypotension, renal dysfunction, and metabolic abnormalities, which

contribute to poor outcomes. A recent multicenter comparison further showed that AMI-related cardiogenic shock has a different risk profile and outcomes than heart failure-related cardiogenic shock, with AMI-CS still conferring disproportionately high early mortality even in the contemporary era.[17] Similar findings have been reported in contemporary in-hospital AMI mortality analyses, where hemodynamic instability remained among the strongest predictors of death.[5]

The high proportion of cardiogenic shock documented in this cohort should be interpreted carefully. As the study was conducted in a tertiary referral hospital, the population may represent patients with more severe diseases who were referred after complications developed. Future studies should distinguish clearly between cardiogenic shock present at admission and shock developing during hospitalization.

Killip class was associated with mortality in the current study, with rates increasing among patients with advanced Killip categories. A 2026 retrospective single-center cohort of 288 contemporary STEMI patients confirmed that Killip class IV remains a strong independent predictor of in-hospital mortality (OR 60.94, 95% CI 15.98–232.46), with mortality rising from 1.0% in class I to 69.6% in class IV.[15] Clinical heart failure assessment therefore retains prognostic value even when modern biomarker and treatment variables are considered.

The clinical relevance of Killip classification is particularly important in settings where advanced diagnostic tools may not always be immediately available.

Age was included as a potential confounding factor in the regression model because older age is widely recognized as a risk factor for adverse outcomes after AMI. In this study, non-survivors were older than survivors; however, age was not independently associated with mortality after adjustment. This may be explained by the limited sample size and small number of mortality events.

Sex was also not associated with mortality in the present cohort. Although previous studies have reported differences in AMI presentation and treatment between males and females, these differences may become less significant after adjustment for clinical severity and treatment factors. Recent analyses of women's cardiovascular risk further emphasize the need for sex-specific risk profiling in acute coronary syndromes.[4]

Diabetes mellitus, hypertension, and chronic kidney disease were common among patients included in this study; however, these factors were not independently associated with in-hospital mortality. A 2024 review of standard modifiable cardiovascular risk factors in AMI showed that acute clinical status at presentation can dominate short-term mortality risk in the absence of traditional risk factors, and conversely, that chronic risk profiles alone do not fully determine in-hospital outcomes.[9]

Similarly, hypertension was not associated with in-hospital mortality in the current study. Although hypertension contributes significantly to coronary artery disease development, its effect on immediate outcomes after AMI may become less evident after adjustment for acute disease severity.

Chronic kidney disease was documented in 59 (49.2%) patients in the present cohort but was not significantly associated with mortality. A 2024 retrospective Pakistani cohort evaluating NSTEMI outcomes at the National Institute of Cardiovascular Diseases reported that TIMI risk score had limited predictive value for in-hospital mortality in this population, while cardiogenic shock was the dominant predictor (OR 102.96).[18] Recent machine-learning analyses in AMI have identified renal biomarkers as pivotal predictor inputs in short-term mortality models, suggesting that more granular renal function characterization may be required than a binary CKD indicator.[8]

Laboratory parameters including troponin level, serum creatinine, and hemoglobin were evaluated as potential predictors of mortality. In this study, these variables did not show significant independent associations with in-hospital mortality. Higher troponin concentrations generally reflect greater myocardial damage and have been associated with increased risk of heart failure and mortality. However, in the present study, troponin levels were not significantly different between survivors and non-survivors. This may be explained by variations in timing of sample collection and the dominant influence of more severe clinical factors such as cardiogenic shock. Recent deep-learning mortality models for AMI confirm that biomarkers should be interpreted together with clinical assessment rather than used as isolated predictors of outcome.[7]

Renal function, assessed through serum creatinine, also did not demonstrate a significant association with mortality in this cohort. The effect of renal dysfunction on AMI mortality may be more pronounced in larger cohorts with longer follow-up periods, while in this study short-term hospital mortality appeared to be more strongly associated with hemodynamic instability.

Hemoglobin levels were lower among non-survivors compared with survivors; however, the difference was not statistically significant. Anemia has been associated with adverse outcomes after AMI because reduced oxygen-carrying capacity may worsen myocardial ischemia.

Treatment-related variables were evaluated to determine whether management strategies were associated with mortality. Primary PCI was performed in 48 (40.0%) patients and was not significantly associated with mortality in this study. The absence of a significant association between PCI and mortality should be interpreted carefully because patient selection in observational settings often channels invasive therapy to higher-risk individuals. International guidelines continue to recommend early reperfusion therapy for eligible STEMI patients because timely restoration of coronary blood flow reduces myocardial damage and improves survival.[12]

In the Pakistani healthcare setting, delays in presentation and limited availability of emergency cardiac intervention remain important challenges. A 2024 prospective multicenter Pakistani cohort of 300 AMI patients demonstrated that an early invasive strategy within 24 hours of admission significantly improved left ventricular ejection fraction recovery (13.1% vs 7.5%, $p<0.001$) and reduced mortality (3% vs 9%, $p=0.01$) compared with delayed treatment, reinforcing the importance of timely PCI in resource-limited contexts.[19]

Evidence regarding predictors of mortality after AMI in Pakistan remains limited compared with European and North American populations. Most available studies are from major urban cardiac centers, while information from Khyber Pakhtunkhwa remains relatively scarce. A multicenter analysis of 23,560 young South Asian ACS patients from a Karachi registry demonstrated distinct patterns of presentation and outcomes compared with older cohorts, underscoring the need for age-specific risk profiling in this region.[14] However, differences in healthcare access, patient referral pathways, and treatment availability mean that findings from one region may not fully represent another.

The present study contributes additional evidence from Peshawar by identifying cardiogenic shock as a major factor associated with early mortality among AMI patients. Although cardiogenic shock has been recognized internationally as a high-risk feature, confirming its importance in a Pakistani tertiary care setting supports the need for early recognition and appropriate resource allocation.

The findings demonstrate that simple bedside assessment remains highly valuable. Cardiogenic shock, which can be identified through clinical examination and hemodynamic assessment, showed a strong association with mortality.

Study Limitations

This study has several limitations. First, the retrospective single-center design limits the ability to establish causal relationships between predictors and mortality. Second, the sample size was limited to 120 patients, with only 14 mortality events. Third, some clinical variables were dependent on available medical documentation. Fourth, cardiogenic shock requires careful clinical verification because its prevalence in this cohort was high. Finally, the study assessed only in-hospital mortality and did not evaluate longer-term outcomes after discharge. A 2024 multicenter prognostic model for predicting 12- and 24-month post-discharge mortality in primary-PCI STEMI patients illustrates how longer-term follow-up assessments should be structured in future studies.[11]

Future Directions

Future research should include larger multicenter prospective studies involving hospitals across Pakistan to validate these findings.[2] Development of locally validated AMI risk prediction models may improve early identification of high-risk patients and support better clinical decision-making.

CONCLUSION

This study identified cardiogenic shock as the strongest independent predictor of in-hospital mortality among patients with acute myocardial infarction admitted to a tertiary care hospital in Peshawar. Other factors, including age, sex, diabetes,

hypertension, renal function, troponin level, and primary PCI, were not independently associated with mortality after adjustment. The findings highlight the importance of early assessment of haemodynamic instability for identifying high-risk patients and support the need for larger multicentre prospective studies in Pakistan to validate these predictors and develop local mortality risk models.

AUTHORS' CONTRIBUTION

ND, HA, MI, SS, SA, and AB conceptualized and designed the study. Data collection, extraction, and analysis were performed by ND, HA, MI, SS, SA, and AB. All authors made substantial contributions to the writing and interpretation of the manuscript. ND, HA, MI, SS, SA, and AB supervised the overall process, critically reviewed the manuscript, and provided guidance where necessary. All authors approved the final version of the manuscript for publication.

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