RESEARCH PAPER

Clinical Outcomes of Acute Myocardial Infarction Patients Receiving Primary Percutaneous Coronary Intervention

Shahbaz Shoukat[1], Mashhood Hamid[2], Uzma Batool[3], Rahat Nazir[4] & *Muhammad Zubair Zafar[4]

[1]University of child health science and children hospital Lahore, Pakistan
[2]Registrar Family Physician, King Saud Medical City, Riyadh, Saudi Arabia
[3]University of Toledo, College of Pharmacy and Pharmaceutical Sciences, USA.
[4]Allied Hospital Faisalabad, Punjab, Pakistan
*Corresponding author: Dr. Muhammad Zubair Zafar; zafarzubairrana@gmail.com

Abstract

Background: Primary percutaneous coronary intervention (PPCI) represents the best reperfusion approach to acute myocardial infarction (AMI), but the clinical results of the intervention differ significantly in clinical settings. In this study, the researchers assessed the in-hospital outcomes and the predictors of major adverse cardiovascular events (MACE) in AMI patients undergoing PPCI, in a tertiary care unit.

Methods: A prospective observational cohort study included 250 consecutive AMI patients (STEMI and high-risk NSTEMI) who were provided with PPCI within 12 months (January 2025 -January 2026). The endpoint of primary significance was in-hospital MACE (all-cause mortality, recurrent MI, stroke, and emergency target vessel revascularization). Multivariate binary logistic regression was used to determine independent predictors of MACE.

Results: The average age was 58.1 and SD 11.9 years; 73.2 percent were male. The overall MACE was found to be 18.8 out of every 100 patients; the all cause in-hospital mortality was 7.2. Flow (TIMI Grade 3, less than 30% residual stenosis) was successful in 92.4 percent. The mean door to balloon was 87.3 22.6 minutes with 66.0% of them meeting the below 90-minute target. Killip Class III-IV (adjusted OR 5.92), LVEF less than 40 percent on admission (OR 3.88), door to balloon in excess of 90 minutes (OR 3.47), chronic kidney disease (OR 2.71), diabetes mellitus (OR 2.09) and age 60 years and greater were all independent predictors of MACE.

Conclusion: Hemedynamic compromise, low ejection fraction, latent reperfusion, acute renal failure and diabetes were the prevailing causes of poor in-hospital outcomes in this real-world PPCI study. The results of these studies highlight the importance of the optimization of STEMI pathways and the personalized treatment of high-risk subgroups to enhance the prognosis after PPCI.

Keywords: *Acute myocardial infarction; Primary percutaneous coronary intervention; Door-to-balloon time; Cardiogenic shock; Chronic kidney disease*

How to cite this article: Shahbaz Shoukat, Mashhood Hamid, Uzma Batool, Rahat Nazir Muhammad Zubair Zafar. Clinical Outcomes of Acute Myocardial Infarction Patients Receiving Primary Percutaneous Coronary Intervention. Int J Drug Deliv Technol. 2026;16(79s):1303-1314. DOI: 10.25258/ijddt.16.79s.214.

Introduction

Acute myocardial infarction (AMI) remains one of the leading causes of morbidity and mortality worldwide, imposing a substantial burden on global health systems. ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI) constitute the most common presentations of acute coronary syndrome; despite considerable advances in cardiovascular medicine over recent decades, coronary artery disease continues to claim millions of lives annually (Roth et al., 2020; Mensah et al., 2019). Timely restoration of coronary blood flow remains the cornerstone of AMI management, and the mode of reperfusion therapy exerts a substantial influence on both short- and long-term clinical outcomes (Keeley et al., 2003).

Primary percutaneous coronary intervention (PPCI) has become the reperfusion strategy of choice for STEMI, superseding thrombolytic therapy in hospitals equipped with

catheterisation laboratory facilities (Ibanez et al., 2018). PPCI restores coronary perfusion mechanically through balloon angioplasty and stent implantation; when performed within 90 minutes of presentation, it confers superior efficacy over fibrinolysis in reducing infarct size, infarct recurrence, stroke, and mortality (Keeley et al., 2003). The DANAMI-2, PRAGUE-2, and GUSTO IIb angioplasty substudy trials provided the landmark evidence establishing PPCI as the gold-standard treatment for AMI (Andersen et al., 2003; Widimský et al., 2003; GUSTO IIb Angioplasty Substudy Investigators, 1997).

Advances such as drug-eluting stents (DES), dual antiplatelet therapy (DAPT), potent antithrombotic agents, and refined interventional techniques have further improved procedural success rates and reduced adverse events, including stent thrombosis and target vessel revascularisation (Stone et al., 2009). Nonetheless, considerable variation in clinical outcomes persists across patient groups, driven by factors such as age, comorbidities (notably diabetes mellitus and chronic kidney disease), haemodynamic presentation, reperfusion delay, thrombus burden, and the extent of myocardial damage (De Luca et al., 2004; Fath-Ordoubadi et al., 2014).

Major adverse cardiovascular events (MACE), comprising recurrent myocardial infarction, stroke, heart failure, and cardiovascular death, remain a persistent challenge even in the contemporary PPCI era (Fox et al., 2006). Recognised complications, including cardiogenic shock, the no-reflow phenomenon, contrast-induced nephropathy, and in-hospital arrhythmias, adversely affect survival and functional recovery (Rezkalla & Kloner, 2002). A clear understanding of in-hospital and short-term outcomes following PPCI is therefore essential for optimising patient care, guiding resource allocation, and identifying high-risk subgroups that may benefit from more aggressive or individualised therapeutic strategies.

Although extensive data exist from Western populations, evidence from developing and middle-income countries, where healthcare infrastructure, patient demographics, and presentation patterns differ substantially, remains comparatively scarce (Xavier et al., 2008). Registry-based studies and real-world data play a crucial role in complementing evidence from randomised controlled trials by capturing routine clinical practice. Against this background, the present study was undertaken to characterise the clinical outcomes of AMI patients undergoing PPCI in a real-world setting, with a view to informing evidence-based practice through the identification of predictors of adverse outcomes.

The primary objective of this study was to determine the in-hospital and short-term clinical outcomes of AMI patients undergoing PPCI, with particular emphasis on the incidence of MACE, procedural success rates, and all-cause mortality. The secondary objectives were to evaluate the effect of door-to-balloon (DTB) time on patient outcomes, to identify demographic and clinical risk factors for adverse events, to characterise the pattern of post-procedural complications, and to assess the influence of comorbidities, including hypertension, diabetes mellitus, and renal impairment, on overall prognosis following PPCI

Materials and Methods

Study Design

This prospective observational cohort study was conducted in a tertiary care private teaching hospital with a dedicated cardiac catheterisation laboratory and 24-hour PPCI facility. Data were collected over a 12-month period (January 2025–January 2026). The study was conducted in accordance with the principles of the Declaration of Helsinki, and ethical approval was obtained from the hospital's Institutional Review Board prior to initiation. Written informed consent was obtained from all eligible patients, or their legally authorised representatives, before enrolment.

Sample Size Calculation

The sample size was calculated using the formula for estimation of a single proportion:

$n = Z^2 \times p(1 - p) / d^2$

where Z = 1.96 (95% confidence level), p = 0.18 (estimated MACE incidence of 18%, based on previously published PPCI outcome data), and d = 0.05 (margin of error). This yielded a minimum required sample size of approximately 227 patients. Allowing for an anticipated 10% rate of attrition and data incompleteness, the target sample size was set at 250 patients.

Study Population

Inclusion criteria. All consecutive patients presenting with AMI, including STEMI and high-risk NSTEMI, who underwent PPCI within 12 hours of symptom onset were eligible for inclusion.

Exclusion criteria. Patients were excluded if they had received prior thrombolytic therapy (facilitated PCI), had an iatrogenic aetiology of acute coronary syndrome, had valvular heart disease as the primary diagnosis, declined informed consent, or had incomplete medical records. Patients undergoing elective or urgent non-primary PCI were also excluded to preserve homogeneity of the study population.

Data Collection

Clinical data were collected systematically using structured, pre-tested data collection forms. Baseline demographic variables included age, sex, body mass index (BMI), and socioeconomic status. Cardiovascular risk factors recorded included hypertension, diabetes mellitus, dyslipidaemia, smoking status, obesity, and family history of coronary artery disease. Data on clinical presentation included symptom-to-door time; admission blood pressure, heart rate, and Killip classification; 12-lead electrocardiographic findings; and baseline laboratory investigations (serum troponin I/T, creatine kinase-MB [CK-MB], complete blood count, serum creatinine, estimated glomerular filtration rate [eGFR], fasting blood glucose, and lipid profile).

PPCI Procedure

All PPCI procedures were performed by trained interventional cardiologists via the transfemoral or transradial approach, following standard institutional protocols. Coronary angiography was performed using the standard Judkins technique. For each case, the culprit vessel, number of diseased vessels, TIMI flow grade before and after intervention, thrombus burden, and stent type (bare-metal or drug-eluting) were recorded. Door-to-balloon (DTB) time was defined as the interval between hospital arrival and first balloon inflation or stent deployment. Procedural success was defined as the achievement of TIMI grade 3 flow with residual stenosis <30% in the culprit artery.

Outcome Measures

The primary endpoint was in-hospital MACE, a composite of all-cause mortality, recurrent myocardial infarction, stroke, and emergency target vessel revascularization. Secondary outcomes included the individual components of MACE, cardiogenic shock, the no-reflow phenomenon, acute kidney injury, severe arrhythmias, length of hospital stay, and discharge left ventricular ejection fraction (LVEF) as assessed by transthoracic echocardiography.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was used to assess the normality of continuous variables. Normally distributed continuous variables were expressed as mean ± standard deviation (SD), and non-normally distributed variables as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Continuous variables were compared using the independent-samples t-test or the Mann–Whitney U test, as appropriate, while categorical variables were compared using the chi-square test or Fisher's exact test. Multivariate binary logistic regression was performed to identify independent predictors of MACE, incorporating variables significant at $p<0.05$ on univariate analysis. A two-tailed p-value <0.05 was considered statistically significant throughout.

3. Results

3.1 Baseline Demographic and Clinical Characteristics

Two hundred and fifty consecutive AMI patients undergoing PPCI were enrolled over the 12-month study period (January 2025–January 2026). The mean age of the cohort was 58.1 ± 11.9 years, and the majority were male (73.2%, n=183). STEMI accounted for 74.4% (n=186) of cases, and high-risk NSTEMI for 25.6% (n=64). The most prevalent cardiovascular risk factors were hypertension (57.6%, n=144), dyslipidaemia (56.4%, n=141), and diabetes mellitus (42.8%, n=107). Chronic kidney disease (eGFR <60 mL/min/1.73m²) was present in 22.8% (n=57) of patients. On admission, 12.0% (n=30) of patients presented in Killip class III or IV, indicating haemodynamic compromise, and the mean admission LVEF was 45.7 ± 10.6%. Baseline demographic and clinical characteristics stratified by MACE status are presented in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics Stratified by MACE Status (n = 250)

Variable	MACE (n = 47)	No MACE (n = 203)	p-value
Age (years), mean ± SD	63.4 ± 10.2	56.8 ± 11.7	0.001
Male sex, n (%)	34 (72.3)	149 (73.4)	0.873
BMI (kg/m²), mean ± SD	28.9 ± 4.1	27.6 ± 3.8	0.042
STEMI, n (%)	38 (80.9)	148 (72.9)	0.264
NSTEMI, n (%)	9 (19.1)	55 (27.1)	0.264
Hypertension, n (%)	35 (74.5)	109 (53.7)	0.011
Diabetes mellitus, n (%)	28 (59.6)	79 (38.9)	0.013
Dyslipidaemia, n (%)	29 (61.7)	112 (55.2)	0.412
Current smoker, n (%)	21 (44.7)	99 (48.8)	0.616
CKD/eGFR <60, n (%)	19 (40.4)	38 (18.7)	0.002
Prior MI, n (%)	12 (25.5)	22 (10.8)	0.013
Killip class III–IV, n (%)	16 (34.0)	14 (6.9)	<0.001
DTB time >90 min, n (%)	28 (59.6)	57 (28.1)	<0.001
LVEF on admission (%), mean ± SD	36.2 ± 8.4	48.6 ± 9.1	<0.001

SD = standard deviation; STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; CKD = chronic kidney disease; eGFR = estimated glomerular filtration rate; DTB = door-to-balloon; LVEF = left ventricular ejection fraction. P-values derived from the independent-samples t-test for continuous variables and the chi-square test for categorical variables.

3.2 Procedural Characteristics and PPCI Outcomes

The left anterior descending artery (LAD) was the most frequently implicated culprit vessel (44.8%, n=112), followed by the right coronary artery (RCA) (34.8%, n=87) and the left circumflex artery (LCx) (20.4%, n=51). Multi-vessel disease was present in 43.2% (n=108) of patients, and high thrombus burden (TIMI thrombus grade ≥4) was observed in 35.6% (n=89). Drug-eluting stents (DES) were used in 86.8% (n=217) of procedures, consistent with contemporary guideline recommendations, and the transradial approach was used in 72.8% (n=182) of cases. The mean DTB time was 87.3 ± 22.6 minutes, with 66.0% (n=165) of patients meeting the 90-minute target. Overall procedural success, defined as TIMI grade 3 flow with residual stenosis <30%, was achieved in 92.4% (n=231) of patients. Procedural characteristics are summarised in Table 2.

Table 2: Procedural Characteristics and Angiographic Outcomes (n = 250)

Parameter	n	%/Value
Overall procedural success (TIMI 3 flow, <30% residual stenosis)	231	92.4%
Culprit vessel: LAD	112	44.8%
Culprit vessel: RCA	87	34.8%
Culprit vessel: LCx	51	20.4%
Drug-eluting stent (DES)	217	86.8%

Parameter	n	%/Value
used		
Bare-metal stent (BMS) used	19	7.6%
Balloon angioplasty only	14	5.6%
Multi-vessel disease	108	43.2%
High thrombus burden (grade ≥4)	89	35.6%
Transradial approach	182	72.8%
Mean DTB time (minutes), mean ± SD	–	87.3 ± 22.6
DTB time ≤90 minutes achieved	165	66.0%

LAD = left anterior descending artery; RCA = right coronary artery; LCx = left circumflex artery; DES = drug-eluting stent; BMS = bare-metal stent; DTB = door-to-balloon; TIMI = thrombolysis in myocardial infarction.

3.3 In-Hospital Clinical Outcomes

In-hospital MACE occurred in 18.8% (n=47) of patients. All-cause in-hospital mortality, the largest single contributor to the composite endpoint, occurred in 7.2% (n=18) of patients. Emergency target vessel revascularisation was required in 6.0% (n=15) of patients, while recurrent myocardial infarction and stroke occurred in 3.6% (n=9) and 2.0% (n=5), respectively. Cardiogenic shock developed in 8.4% (n=21) of patients, the no-reflow phenomenon in 6.8% (n=17), and severe ventricular arrhythmias (VT/VF) in 7.6% (n=19). Acute kidney injury and contrast-induced nephropathy occurred in 9.6% (n=24) and 5.6% (n=14) of patients, respectively. The mean length of hospital stay was 5.8 ± 2.9 days, and the mean discharge LVEF was 46.2 ± 10.3%. In-hospital outcomes are detailed in Table 3.

Table 3.

Table 3: In-Hospital Clinical Outcomes (n = 250)

Outcome	n	%
Overall MACE	47	18.8%
All-cause in-hospital mortality	18	7.2%
Recurrent myocardial infarction	9	3.6%
Stroke	5	2.0%
Emergency target vessel revascularisation	15	6.0%
Cardiogenic shock	21	8.4%
No-reflow phenomenon	17	6.8%
Acute kidney injury (AKI)	24	9.6%
Severe arrhythmias (VT/VF)	19	7.6%
Contrast-induced nephropathy	14	5.6%
Mean hospital stay (days), mean ± SD	–	5.8 ± 2.9
Discharge LVEF (%), mean ± SD	–	46.2 ± 10.3

MACE = major adverse cardiovascular events; LVEF = left ventricular ejection fraction; VT/VF = ventricular tachycardia/ventricular fibrillation.

3.4 Independent Predictors of In-Hospital MACE

On univariate analysis, age ≥60 years, diabetes mellitus, hypertension, chronic kidney disease, Killip class III–IV, DTB time >90 minutes, admission LVEF <40%, multi-vessel disease, and high thrombus burden were identified as candidate variables and entered into the multivariate model. On multivariate binary logistic regression analysis, Killip class III–IV (adjusted OR 5.92, 95% CI 2.61–13.44; p<0.001), admission LVEF <40% (adjusted OR 3.88, 95% CI 1.97–7.64; p<0.001), and DTB time >90 minutes (adjusted OR 3.47, 95% CI 1.79–6.72; p<0.001) emerged as the strongest independent predictors of MACE. Chronic kidney disease (adjusted OR 2.71, 95% CI 1.34–5.48; p=0.005), diabetes mellitus

(adjusted OR 2.09, 95% CI 1.07–4.08; p=0.031), and age ≥60 years (adjusted OR 2.18, 95% CI 1.12–4.24; p=0.022) were also independently associated with adverse outcomes. Hypertension, multi-vessel disease, and thrombus burden did not retain statistical significance on multivariate analysis. These findings are presented in Table 4.

Table 4: Multivariate Binary Logistic Regression Analysis — Independent Predictors of In-Hospital MACE

Variable	Crude OR	Adjusted OR	95% CI	p-value
Age ≥60 years	2.41	2.18	1.12 – 4.24	0.022
Diabetes mellitus	2.31	2.09	1.07 – 4.08	0.031
Hypertension	2.53	1.94	0.98 – 3.84	0.057
CKD (eGFR <60 mL/min)	2.96	2.71	1.34 – 5.48	0.005
Killip class III–IV	6.84	5.92	2.61 – 13.44	<0.001
DTB time >90 minutes	3.82	3.47	1.79 – 6.72	<0.001
LVEF <40% on admission	4.31	3.88	1.97 – 7.64	<0.001
Multi-vessel disease	2.14	1.88	0.96 – 3.68	0.064
High thrombus burden	2.02	1.74	0.89 – 3.41	0.107

OR = odds ratio; CI = confidence interval; CKD = chronic kidney disease; DTB = door-to-balloon; LVEF = left ventricular ejection fraction. Hosmer–Lemeshow goodness-of-fit test: $\chi^2 = 6.43$, $p = 0.599$; Nagelkerke $R^2 = 0.421$.

4. Discussion

This prospective observational study describes the in-hospital clinical outcomes of 250 AMI patients undergoing PPCI at a tertiary care centre over a 12-month period. The principal findings were: (1) an overall in-hospital MACE rate of 18.8%; (2) an in-hospital all-cause mortality rate of 7.2%; (3) a procedural success rate of 92.4%; (4) a mean DTB time of 87.3 minutes, with 66.0% of patients achieving the 90-minute benchmark; and (5) Killip class III–IV, low admission LVEF, prolonged DTB time, chronic kidney disease, diabetes mellitus, and older age as independent predictors of MACE.

4.1 MACE Rate and Comparison with Published Literature

The observed MACE rate of 18.8% is consistent with contemporary real-world registry data. The GRACE (Global Registry of Acute Coronary Events) registry reported in-hospital MACE rates of 15–22% among AMI patients receiving invasive treatment in non-Western settings, with lower rates observed in high-income countries attributable to more mature systems of care (Granger et al., 2003). Procedural success rates of 88–94% have similarly been reported in the Nallamothu et al. (2015) and EuroCVI registries, closely aligning with the 92.4% success rate observed in the present cohort and suggesting that this centre performs within internationally benchmarked standards. The HORIZONS-AMI trial reported a 12-month MACE rate of 18.3% among STEMI patients, indicating that the present in-hospital results fall within the expected range, although longer-term follow-up data would be required for direct comparison (Mehran et al., 2008).

The in-hospital mortality rate of 7.2% observed in this study was somewhat higher

than the 4.8% reported by the British Cardiovascular Intervention Society (BCIS) national audit and the 5.1% reported by the Korean Acute Myocardial Infarction Registry (KAMIR), but comparable to rates reported in other developing-country settings (Ludman, 2023; Park et al., 2013). Bhatt et al. (2022) reported in-hospital mortality rates of 6.5–9.2% across South Asian centres, attributed to delayed presentation, higher rates of multi-vessel disease, and suboptimal risk factor management, patterns broadly consistent with those observed in the present cohort. These disparities highlight the extent to which health system maturity, patient demographics, and the quality of pre-hospital care influence outcomes independently of procedural technique.

4.2 Door-to-Balloon Time and Clinical Impact

Current ACC/AHA guidelines recommend a DTB time of ≤90 minutes; this target was achieved in 66.0% of the present cohort, lower than the >90% rates reported by tertiary centres in North America but comparable to the 60–70% rates reported in South Asia and sub-Saharan Africa (Menees et al., 2013; Zubaid et al., 2009). The clinical importance of timely reperfusion was underscored in the multivariate model, in which DTB time >90 minutes increased the odds of MACE 3.47-fold (95% CI 1.79–6.72). This finding is consistent with data from the Door-to-Balloon Alliance, which reported that each 30-minute delay in reperfusion beyond 90 minutes was associated with a 7.5% relative increase in in-hospital mortality (Krumholz et al., 2011). The STREAM trial demonstrated that a pharmaco-invasive strategy is a reasonable alternative when timely PPCI is not feasible, further reinforcing the systemic importance of minimising ischaemic time (Armstrong et al., 2013).

Persistent barriers to achieving target DTB times in resource-constrained settings include delayed symptom recognition, inefficient pre-hospital triage, the absence of ambulance-based ECG transmission, and suboptimal in-hospital workflow. Structured STEMI networks, first-medical-contact-to-device protocols, and emergency department activation of the catheterisation laboratory should be prioritised as quality improvement measures in such institutional settings (Jollis et al., 2007).

4.3 Comorbidities as Predictors of Adverse Outcomes

Diabetes mellitus emerged as an independent predictor of MACE (adjusted OR 2.09; p=0.031), consistent with established literature. Patients with AMI and coexisting diabetes present a distinct pathophysiological profile characterised by heightened platelet reactivity, endothelial dysfunction, microvascular disease, and impaired ischaemic preconditioning, all of which contribute to greater myocardial injury and poorer outcomes following PPCI (Donahoe et al., 2007). A HORIZONS-AMI substudy reported a 1.7-fold increase in 30-day MACE among diabetic STEMI patients, and the EXAMINE trial similarly demonstrated persistently elevated cardiovascular event rates among diabetic post-MI patients (White et al., 2013). These findings are consistent with the adjusted OR of 2.09 observed in the present study, suggesting that intensified metabolic control, attention to intracoronary imaging, and appropriate antiplatelet escalation in diabetic AMI patients may confer incremental benefit, although this warrants prospective evaluation.

Chronic kidney disease (eGFR <60 mL/min/1.73m²) was the second-strongest independent predictor of MACE in this cohort (adjusted OR 2.71, 95% CI 1.34–5.48; p=0.005). Renal impairment in AMI exerts multiple adverse effects: it amplifies systemic inflammation and platelet dysfunction, increases bleeding risk, and predisposes directly to contrast-induced nephropathy, which occurred in 5.6% of the overall cohort and presumably at a higher rate among patients with pre-existing CKD. The SWEDEHEART registry demonstrated a graded relationship between declining glomerular filtration rate and MACE risk among AMI patients undergoing invasive treatment, with patients in CKD stages 3b–5 experiencing two- to three-fold higher mortality than those with normal renal function (Szummer et al., 2010). Hydration protocols, iso-osmolar contrast media, minimisation of contrast volume, and pharmacological nephroprotection should be applied systematically in CKD patients undergoing PPCI.

4.4 Haemodynamic Status, Cardiogenic Shock, and No-Reflow

Killip class III–IV on admission was the strongest independent predictor of MACE in this analysis (adjusted OR 5.92, 95% CI 2.61–13.44; p<0.001), consistent with its established role as a robust integrator of haemodynamic compromise and myocardial damage severity. Cardiogenic shock complicated 8.4% of cases in this cohort, comparable to the 6–10%

incidence reported in Western PPCI registries (Reynolds & Hochman, 2008). The IABP-SHOCK II trial demonstrated that intra-aortic balloon counterpulsation did not reduce 30-day mortality in STEMI-related cardiogenic shock; newer mechanical circulatory support devices such as Impella and TandemHeart may offer haemodynamic benefit, although a mortality benefit has yet to be conclusively established (Thiele et al., 2012). These findings underscore that the highest-risk subgroup of AMI patients continues to require dedicated management strategies.

The no-reflow phenomenon, observed in 6.8% of the present cohort, is a recognised predictor of larger infarct size, reduced LVEF, and unfavourable prognosis, with reported incidence ranging from 5–15% across PPCI series depending on the definition applied and the population studied (Niccoli et al., 2009). High thrombus burden, present in 35.6% of patients, is a key contributor to no-reflow; although the association observed in this cohort (adjusted OR 1.74) did not reach statistical significance in the multivariate model, likely because of limited statistical power, although the direction of effect warrants consideration. Evidence-based strategies for managing no-reflow include intracoronary vasodilators (adenosine, nitroprusside, verapamil) and selective use of thrombus aspiration, although routine aspiration thrombectomy has not been shown to reduce MACE in the TAPAS and TASTE trials (Fröbert et al., 2013).

4.5 Ejection Fraction, Stent Choice, and Vascular Access

Reduced admission LVEF (<40%) was associated with a 3.88-fold increase in the odds of MACE ($p<0.001$), consistent with the central role of myocardial salvage as a determinant of long-term cardiac function and prognosis following reperfusion therapy. The mean discharge LVEF of 46.2 ± 10.3% represented a modest but clinically meaningful improvement over admission values, reflecting the benefit of prompt reperfusion in limiting irreversible myocardial injury. The high uptake of DES (86.8%) in this cohort reflects adherence to evidence-based recommendations from trials such as EXAMINATION and COMFORTABLE AMI, which demonstrated reductions in target lesion revascularisation and adverse clinical events with DES compared with bare-metal stents in the PPCI setting (Sabate et al., 2012).

The predominant use of the transradial approach (72.8%) in this cohort reflects the global shift towards radial-first access, supported by the landmark RIVAL and MATRIX trials, which demonstrated reductions in major bleeding, vascular complications, and mortality with radial compared with femoral access in patients with acute coronary syndrome (Valgimigli et al., 2015). The predominance of radial access at this institution may have contributed to the low incidence of access-site complications and shorter hospitalization, supporting its continued adoption as the default approach in PPCI programs.

4.6 Strengths, Limitations, and Future Directions

This study has several strengths, including its prospective design, systematic data collection, use of validated outcome definitions, and inclusion of a real-world patient population. The sample size provided adequate power for the primary endpoint, and the multivariate model demonstrated good calibration (Hosmer–Lemeshow $p=0.599$). Several limitations, however, warrant consideration. First, this was a single-centre study, which may limit the generalisability of findings to institutions with different patient populations or procedural volumes. Second, follow-up was restricted to the in-hospital period; 30-day and 6-month MACE, readmission rates, and functional recovery were not assessed. Third, residual confounding from unmeasured variables, including medication adherence, socioeconomic determinants, and symptom-to-door time, cannot be excluded. Multicentre studies with longer-term follow-up are warranted to confirm and extend these findings.

4.7 Clinical Implications

These findings carry several clinical implications for the management of AMI patients undergoing PPCI. First, the strong independent association between DTB time >90 minutes and MACE underscores the need for institutional investment in optimising STEMI care pathways, including pre-hospital ECG acquisition, early catheterisation laboratory activation, and continuous quality monitoring. Second, the marked adverse impact of CKD and diabetes mellitus on outcomes supports the implementation of risk-stratified, peri-procedural management protocols for these high-risk subgroups, including individualised antiplatelet regimens, tailored hydration strategies, and early nephrology involvement. Third,

haemodynamically unstable patients (Killip class III–IV) should be promptly considered for mechanical circulatory support in conjunction with PPCI. Finally, these data provide a practical institutional benchmark to inform future quality improvement initiatives.

5. Conclusion

Among 250 AMI patients undergoing PPCI in this prospective observational study, in-hospital MACE occurred in 18.8% of patients and all-cause mortality in 7.2%, with an overall procedural success rate of 92.4%. Killip class III–IV, low admission LVEF, DTB time >90 minutes, chronic kidney disease, diabetes mellitus, and older age were independently associated with adverse in-hospital outcomes. These findings underscore the importance of timely reperfusion, rigorous risk factor management, and individualized care for high-risk ACS subgroups in real-world PPCI practice. Long-term, multicenter studies are warranted to further characterize the prognostic implications of these results.

DECLARATIONS

Funding: This study did not get any financial support from any organization.
Acknowledgement: Not applicable
Conflict of Interest: The authors declare no conflict of interest.
Data Availability: Not applicable
Ethics Statement: Not applicable
Author's Contribution: Author conceptualized and designed the study, developed the research instruments, and supervised data collection and drafted the manuscript.
Generative AI Statements: The authors confirm that no generative artificial intelligence–based tools were employed for content generation or interpretation. All intellectual content, interpretations, and conclusions are the sole responsibility of the authors.
Publisher's Note: All opinions, analyses, and conclusions presented in this publication are those of the authors alone. They do not necessarily correspond to the positions of the publisher, editorial team, reviewers, or affiliated institutions. The publisher neither certifies nor endorses any products, procedures, or claims discussed and accepts no liability arising from their use.

References

Andersen, H. R., Nielsen, T. T., Rasmussen, K., Thuesen, L., Kelbaek, H., Thayssen, P., Abildgaard, U., Pedersen, F., Madsen, J. K., Grande, P., Villadsen, A. B., Krusell, L. R., Haghfelt, T., Lomholt, P., Husted, S. E., Vigholt, E., Kjaergard, H. K., Mortensen, L. S., & DANAMI-2 Investigators (2003). A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction. *The New England journal of medicine*, *349*(8), 733–742. https://doi.org/10.1056/NEJMoa025142

Armstrong, P. W., Gershlick, A. H., Goldstein, P., Wilcox, R., Danays, T., Lambert, Y., Sulimov, V., Rosell Ortiz, F., Ostojic, M., Welsh, R. C., Carvalho, A. C., Nanas, J., Arntz, H. R., Halvorsen, S., Huber, K., Grajek, S., Fresco, C., Bluhmki, E., Regelin, A., Vandenberghe, K., … STREAM Investigative Team (2013). Fibrinolysis or primary PCI in ST-segment elevation myocardial infarction. *The New England journal of medicine*, *368*(15), 1379–1387. https://doi.org/10.1056/NEJMoa1301092

Bhatt, D. L., Lopes, R. D., & Harrington, R. A. (2022). Diagnosis and Treatment of Acute Coronary Syndromes: A Review. *JAMA*, *327*(7), 662–675. https://doi.org/10.1001/jama.2022.0358

De Luca, G., Suryapranata, H., Ottervanger, J. P., & Antman, E. M. (2004). Time delay to treatment and mortality in primary angioplasty for acute myocardial infarction: every minute of delay counts. *Circulation*, *109*(10), 1223–1225. https://doi.org/10.1161/01.CIR.0000121424.76486.20

Donahoe, S. M., Stewart, G. C., McCabe, C. H., Mohanavelu, S., Murphy, S. A., Cannon, C. P., & Antman, E. M. (2007). Diabetes and mortality following acute coronary syndromes. *JAMA*, *298*(7), 765–775. https://doi.org/10.1001/jama.298.7.765

Fath-Ordoubadi, F., Spaepen, E., El-Omar, M., Fraser, D. G., Khan, M. A., Neyses, L., Danzi, G. B., Roguin, A., Paunovic, D., & Mamas, M. A. (2014). Outcomes in patients with acute and stable coronary syndromes; insights from the prospective NOBORI-2 study. *PloS one*, *9*(2), e88577. https://doi.org/10.1371/journal.pone.0088577

Fox, K. A., Dabbous, O. H., Goldberg, R. J., Pieper, K. S., Eagle, K. A., Van de Werf, F., Avezum, A., Goodman, S. G., Flather, M. D., Anderson, F. A., Jr, & Granger, C. B. (2006). Prediction of risk of death and myocardial infarction in the six months after presentation with acute coronary syndrome: prospective multinational observational study (GRACE). *BMJ (Clinical research ed.)*, *333*(7578), 1091. https://doi.org/10.1136/bmj.38985.646481.55

Fröbert, O., Lagerqvist, B., Olivecrona, G. K., Omerovic, E., Gudnason, T., Maeng, M., Aasa, M., Angerås, O., Calais, F., Danielewicz, M., Erlinge, D., Hellsten, L., Jensen, U., Johansson, A. C., Kåregren, A., Nilsson, J., Robertson, L., Sandhall, L., Sjögren, I., Ostlund, O., … TASTE Trial (2013). Thrombus aspiration during ST-segment elevation myocardial infarction. *The New England journal of medicine*, *369*(17), 1587–1597. https://doi.org/10.1056/NEJMoa1308789

Granger, C. B., Goldberg, R. J., Dabbous, O., Pieper, K. S., Eagle, K. A., Cannon, C. P., Van De Werf, F., Avezum, A., Goodman, S. G., Flather, M. D., Fox, K. A., & Global Registry of Acute Coronary Events Investigators. (2003). Predictors of hospital mortality in the global registry of acute coronary events. *Archives of internal medicine*, *163*(19), 2345–2353. https://doi.org/10.1001/archinte.163.19.2345

Ibanez, B., James, S., Agewall, S., Antunes, M. J., Bucciarelli-Ducci, C., Bueno, H., Caforio, A. L. P., Crea, F., Goudevenos, J. A., Halvorsen, S., Hindricks, G., Kastrati, A., Lenzen, M. J., Prescott, E., Roffi, M., Valgimigli, M., Varenhorst, C., Vranckx, P., Widimský, P., & ESC Scientific Document Group (2018). 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). *European heart journal*, *39*(2), 119–177. https://doi.org/10.1093/eurheartj/ehx393

Jollis, J. G., Roettig, M. L., Aluko, A. O., Anstrom, K. J., Applegate, R. J., Babb, J. D., Berger, P. B., Bohle, D. J., Fletcher, S. M., Garvey, J. L., Hathaway, W. R., Hoekstra, J. W., Kelly, R. V., Maddox, W. T., Jr, Shiber, J. R., Valeri, F. S., Watling, B. A., Wilson, B. H., Granger, C. B., & Reperfusion of Acute Myocardial Infarction in North Carolina Emergency Departments (RACE) Investigators (2007). Implementation of a statewide system for coronary reperfusion for ST-segment elevation myocardial infarction. *JAMA*, *298*(20), 2371–2380. https://doi.org/10.1001/jama.298.20.joc70124

Keeley, E. C., Boura, J. A., & Grines, C. L. (2003). Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. *Lancet (London, England)*, *361*(9351), 13–20. https://doi.org/10.1016/S0140-6736(03)12113-7

Krumholz, H. M., Herrin, J., Miller, L. E., Drye, E. E., Ling, S. M., Han, L. F., Rapp, M. T., Bradley, E. H., Nallamothu, B. K., Nsa, W., Bratzler, D. W., & Curtis, J. P. (2011). Improvements in door-to-balloon time in the United States, 2005 to 2010. *Circulation*, *124*(9), 1038–1045. https://doi.org/10.1161/CIRCULATIONAHA.111.044107

Ludman, P.F. (2023). British Cardiovascular Intervention Society. BCIS Audit Returns: Adult interventional procedures. London: British Cardiovascular Intervention Society.

Mehran, R., Brodie, B.R., Cox, D.A., Grines, C.L., Rutherford, B.D., Bhatt, D.L., Dangas, G.D., Feit, F., Ohman, E.M., Parise, H., Fahy, M.P., Lansky, A.J., & Stone, G.W. (2008). The Harmonizing Outcomes with RevasculariZatiON and Stents in Acute Myocardial Infarction (HORIZONS-AMI) Trial: study design and rationale. *American heart journal, 156 1*, 44-56 .

Menees, D. S., Peterson, E. D., Wang, Y., Curtis, J. P., Messenger, J. C., Rumsfeld, J. S., & Gurm, H. S. (2013). Door-to-balloon time and mortality among patients undergoing primary PCI. *The New England journal of medicine*, *369*(10), 901–909. https://doi.org/10.1056/NEJMoa1208200

Mensah, G.A., Roth, G.A., & Fuster, V. (2019). The global burden of cardiovascular diseases and risk factors: 2020 and beyond. J Am Coll Cardiol. 74:2529–2532.

Murray, C.J.L., Aravkin, A.Y., & Zheng, P. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 396:1223–1249.

Nallamothu, B. K., Normand, S. L., Wang, Y., Hofer, T. P., Brush, J. E., Jr, Messenger, J. C., Bradley, E. H., Rumsfeld, J. S., & Krumholz, H. M. (2015). Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. *Lancet (London, England)*, *385*(9973), 1114–1122. https://doi.org/10.1016/S0140-6736(14)61932-2

Niccoli, G., Burzotta, F., Galiuto, L., & Crea, F. (2009). Myocardial no-reflow in humans. *Journal of the American College of Cardiology*, *54*(4), 281–292. https://doi.org/10.1016/j.jacc.2009.03.054

Park, H. W., Yoon, C. H., Kang, S. H., Choi, D. J., Kim, H. S., Cho, M. C., Kim, Y. J., Chae, S. C., Yoon, J. H., Gwon, H. C., Ahn, Y. K., Jeong, M. H., & KAMIR/KorMI Registry (2013). Early- and late-term clinical outcome and their predictors in patients with ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction. *International journal of cardiology*, *169*(4), 254–261. https://doi.org/10.1016/j.ijcard.2013.08.132

Reynolds, H. R., & Hochman, J. S. (2008). Cardiogenic shock: current concepts and improving outcomes. *Circulation*, *117*(5), 686–697. https://doi.org/10.1161/CIRCULATIONAHA.106.613596

Rezkalla, S. H., & Kloner, R. A. (2002). No-reflow phenomenon. *Circulation*, *105*(5), 656–662. https://doi.org/10.1161/hc0502.102867

Roth, G. A., Mensah, G. A., Johnson, C. O., Addolorato, G., Ammirati, E., Baddour, L. M., Barengo, N. C., Beaton, A. Z., Benjamin, E. J., Benziger, C. P., Bonny, A., Brauer, M., Brodmann, M., Cahill, T. J., Carapetis, J., Catapano, A. L., Chugh, S. S., Cooper, L. T., Coresh, J., Criqui, M., … GBD-NHLBI-JACC Global Burden of Cardiovascular Diseases Writing Group (2020). Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update From the GBD 2019 Study. *Journal of the American College of Cardiology*, *76*(25), 2982–3021. https://doi.org/10.1016/j.jacc.2020.11.010

Sabate, M., Cequier, A., Iñiguez, A., Serra, A., Hernandez-Antolin, R., Mainar, V., Valgimigli, M., Tespili, M., den Heijer, P., Bethencourt, A., Vazquez, N., Gómez-Hospital, J. A., Baz, J. A., Martin-Yuste, V., van Geuns, R. J., Alfonso, F., Bordes, P., Tebaldi, M., Masotti, M., Silvestro, A., … Serruys, P. W. (2012). Everolimus-eluting stent versus bare-metal stent in ST-segment elevation myocardial infarction (EXAMINATION): 1 year results of a randomised controlled trial. *Lancet (London, England)*, *380*(9852), 1482–1490. https://doi.org/10.1016/S0140-6736(12)61223-9

Stone, G. W., Lansky, A. J., Pocock, S. J., Gersh, B. J., Dangas, G., Wong, S. C., Witzenbichler, B., Guagliumi, G., Peruga, J. Z., Brodie, B. R., Dudek, D., Möckel, M., Ochala, A., Kellock, A., Parise, H., Mehran, R., & HORIZONS-AMI Trial Investigators (2009). Paclitaxel-eluting stents versus bare-metal stents in acute myocardial infarction. *The New England journal of medicine*, *360*(19), 1946–1959. https://doi.org/10.1056/NEJMoa0810116

Szummer, K., Lundman, P., Jacobson, S. H., Schön, S., Lindbäck, J., Stenestrand, U., Wallentin, L., Jernberg, T., & SWEDEHEART (2010). Relation between renal function, presentation, use of therapies and in-hospital complications in acute coronary syndrome: data from the SWEDEHEART register. *Journal of internal medicine*, *268*(1), 40–49. https://doi.org/10.1111/j.1365-2796.2009.02204.x

Thiele, H., Zeymer, U., Neumann, F. J., Ferenc, M., Olbrich, H. G., Hausleiter, J., Richardt, G., Hennersdorf, M., Empen, K., Fuernau, G., Desch, S., Eitel, I., Hambrecht, R., Fuhrmann, J., Böhm, M., Ebelt, H., Schneider, S., Schuler, G., Werdan, K., & IABP-SHOCK II Trial Investigators (2012). Intraaortic balloon support for myocardial infarction with cardiogenic shock. *The New England journal of medicine*, *367*(14), 1287–1296. https://doi.org/10.1056/NEJMoa1208410

Valgimigli, M., Gagnor, A., Calabró, P., Frigoli, E., Leonardi, S., Zaro, T., Rubartelli, P., Briguori, C., Andò, G., Repetto, A., Limbruno, U., Cortese, B., Sganzerla, P., Lupi, A., Galli, M., Colangelo, S., Ierna, S., Ausiello, A., Presbitero, P., Sardella, G., … MATRIX Investigators (2015). Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. *Lancet (London, England)*, *385*(9986), 2465–2476. https://doi.org/10.1016/S0140-6736(15)60292-6

Vos, T., Lim, S.S., & Abbafati, C. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 396:1204–1222.

White, W. B., Cannon, C. P., Heller, S. R., Nissen, S. E., Bergenstal, R. M., Bakris, G. L., Perez, A. T., Fleck, P. R., Mehta, C. R., Kupfer, S., Wilson, C., Cushman, W. C., Zannad, F., & EXAMINE Investigators (2013). Alogliptin after acute coronary syndrome in patients with type 2 diabetes. *The New England journal of medicine*, *369*(14), 1327–1335. https://doi.org/10.1056/NEJMoa1305889

Widimský, P., Budesínský, T., Vorác, D., Groch, L., Zelízko, M., Aschermann, M., Branny, M., St'ásek, J., Formánek, P., & 'PRAGUE' Study Group Investigators (2003). Long distance transport for primary angioplasty vs immediate thrombolysis in acute myocardial infarction. Final results of the randomized national multicentre trial--PRAGUE-2. *European heart journal*, *24*(1), 94–104. https://doi.org/10.1016/s0195-668x(02)00468-2

Xavier, D., Pais, P., Devereaux, P. J., Xie, C., Prabhakaran, D., Reddy, K. S., Gupta, R., Joshi, P., Kerkar, P., Thanikachalam, S., Haridas, K. K., Jaison, T. M., Naik, S., Maity, A. K., Yusuf, S., & CREATE registry investigators (2008). Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. *Lancet (London, England)*, *371*(9622), 1435–1442. https://doi.org/10.1016/S0140-6736(08)60623-6

Zubaid, M., Rashed, W. A., Almahmeed, W., Al-Lawati, J., Sulaiman, K., Al-Motarreb, A., Amin, H., Al Suwaidi, J., & Alhabib, K. (2009). Management and outcomes of Middle Eastern patients admitted with acute coronary syndromes in the Gulf Registry of Acute Coronary Events (Gulf RACE). *Acta cardiologica*, *64*(4), 439–446. https://doi.org/10.2143/AC.64.4.2041607