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In-Hospital Outcomes of Acute ST-Segment Elevation Myocardial Infarction (STEMI) Patients Thrombolysed Versus Late for Thrombolysis

Muhammad Farooq Azam Khan[1], Mazhar Mahmood[1], Khadija Khan[1], Mashal Fatima[1], Jebran Khan[2]

[1]Rehman Medical Institute, Peshawar, Pakistan
[2]Khyber Teaching Hospital, Peshawar, Pakistan

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Correspondence to: Muhammad Farooq Azam Khan,
Rehman Medical Institute, Peshawar, Pakistan.
Email: farooq2239@gmail.com

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ABSTRACT

Background: The ST-segment elevation myocardial infarction is a severe cardiac emergency with a significant dependence on early treatment for outcomes. Thrombolysis plays a central role in circumstances where a percutaneous coronary intervention facility is not accessible. Late presentation more frequently makes a patient a non-candidate for early thrombolysis, further compromising prognosis. **Objective:** To determine and compare the in-hospital outcomes of patients with acute ST-segment elevation myocardial infarction who received thrombolysis versus those who presented late and were not thrombolysed. **Study Design:** Descriptive cross-sectional study. **Duration and Place of Study:** Conducted from October 2024 to March 2025 in the Department of Cardiology, Rehman Medical Institute Peshawar. **Methodology:** A total of 224 patients with STEMI were enrolled and divided into two groups: Group A (thrombolysed within 12 hours) and Group B (late presenters, not thrombolysed). Diagnosis was based on clinical symptoms, ECG criteria, and elevated troponin levels. In-hospital outcomes including mortality, left ventricular failure, mitral regurgitation, and ventricular septal rupture were documented. **Results:** Out of 224 patients, 122 received thrombolysis within 12 hours (thrombolysed group) and 102 presented late without thrombolysis (late presenters). The thrombolysed group had significantly lower mortality (9.8% vs. 25.5%; p=0.002), left ventricular failure (27.9% vs. 41.2%; p=0.036), ventricular septal rupture (4.9% vs. 13.7%; p=0.021), and mitral regurgitation (24.6% vs. 45.1%; p=0.001) compared to late presenters. **Conclusion:** Early thrombolysis in STEMI patients significantly improves in-hospital outcomes, emphasizing the importance of reducing delays in presentation and intervention.

INTRODUCTION

Acute ST-segment elevation myocardial infarction (STEMI) is a life-threatening presentation of coronary artery disease that is caused by sudden and total occlusion of a coronary artery resulting in extensive myocardial necrosis.[1] It is a time-sensitive emergency with high morbidity and mortality if it is not treated early. The pathophysiology occurs due to rupture of an atherosclerotic plaque with resultant thrombin formation that closes off blood flow.[2] Early recognition based on changes seen on an electrocardiogram along with cardiac biomarkers is critical for early initiation of relevant therapy since delay in reperfusion yields irreversible myocardial damage along with a heightened risk of complications.[3]

Thrombolysis remains a principal therapy for STEMI when centers for primary percutaneous coronary intervention (PCI) are not readily available or when it is delayed.[4] The aim of thrombolytic treatment is to restore coronary blood flow by dissolving the intraluminal thrombus to minimize infarct size and preserve left ventricular function.[5] Streptokinase, alteplase, or tenecteplase are given agents whose benefit is time-course related.[5] Optimal benefit occurs when thrombolysis is administered within a short time (e.g., a "golden window") of onset of symptoms (generally less than 12 hours), otherwise.[6] If administered beyond that time interval, thrombolysis is greatly reduced in effectiveness and more prone to be followed by adverse end points.[6]

In-hospital outcome in patients with STEMI highly relies on timely thrombolysis. Early thrombolysis patients exhibit a low incidence of in-hospital mortality and a reduced occurrence of complications such as LVF.[7] Early reperfusion limits myocardial damage, improves hemodynamic stability, and reduces occurrence of infarct-related mechanical complications.[8] In contrast, late-presenting patients for thrombolysis exhibit a higher occurrence of LVF due to extensive myocardial necrosis and damaged ventricular function with a resultant higher need for aggressive support measures and higher duration

of hospitalization.[9]

There is also occurrence more frequently of mechanical complications including ventricular septal rupture and mitral regurgitation in patients who undergo delayed thrombolysis.[10] Complications arise from transmural infarctions that render myocardial tissue weak and prone to septum or papillary muscle rupture.[11] Delayed reperfusion cannot salvage jeopardized myocardium so that infarct spreads uncontrolled.[11] Therefore, patients become more prone to life-threatening complications that result in higher in-hospital mortality. Therefore, early thrombolytic intervention plays an important role in a good short-term outcome of patients with STEMI, especially in health facilities with limited access to primary PCI.[12]

In a study, the incidence of left ventricular failure was also lower in the early thrombolysis group, reported in 37.5% of patients, whereas it occurred in 56.25% of those who were late for thrombolysis. Mechanical complications showed a similar trend; ventricular septal rupture was observed in only 3.9% of patients who underwent thrombolysis, compared to 17.2% in those who did not.[13]

Even with advancements in acute ST-segment elevation myocardial infarction (STEMI) treatment, early access to thrombolysis is scarce in most settings, particularly where resources are scarce or in rural areas. Delayed reperfusion significantly worsens patient outcome with an increased risk of mortality as well as of mechanical complications. There is a requirement to compare and analyze in-hospital parameters for patients with timely thrombolysis versus late-presenting patients, to illustrate the impact of late intervention as well as generate guidelines for early referral, diagnosis, and therapeutic enhancement in acute STEMI.

METHODOLOGY

This descriptive cross-sectional study was conducted in the Department of Cardiology at Rehman Medical Institute between October 2024 and March 2025. A total of 224 patients diagnosed with acute ST-segment elevation myocardial infarction (STEMI) were enrolled. Sample size was calculated using the WHO formula, with 95% confidence level, 80% power, and an expected difference in the frequency of left ventricular failure between those who received thrombolysis and those who did not (37.5% vs. 56.25%).[13] Participants were selected through non-probability consecutive sampling and were divided equally into two groups: Group A consisted of patients who received thrombolytic therapy within 12 hours of chest pain onset, while Group B included those who presented beyond 12 hours and did not receive thrombolytic therapy. Inclusion criteria comprised adults aged 16 to 65 years of either gender who were diagnosed with STEMI. Diagnosis required the presence of at least 20 minutes of ischemic chest pain radiating to the left shoulder or jaw, graded using the Canadian Cardiovascular Society classification and confirmed by the on-call consultant. Electrocardiography was performed using a Nihon Koden machine at 25 mm/sec and 10 mm/mV settings, and a diagnosis was confirmed when there was ST-segment elevation at the J-point in at least two contiguous leads—2 mm or more in V2–V3 for men, 1.5 mm or more for women, and 1 mm or more in other leads—persisting for more than 20 minutes. Elevated serum troponin levels were also required, with thresholds set at >17.5 pg/ml for females and >39.2 pg/ml for males, measured using the ALINITY analyzer. Patients with pericarditis, non-ST-elevation acute coronary syndromes, myocarditis, or chest pain due to conditions such as peptic ulcer disease, pulmonary embolism, or aortic dissection were excluded.

Following ethical approval from the institutional review board, written informed consent was obtained from all participants. Demographic and clinical data including age, sex, body mass index, duration of symptoms, smoking status, and comorbidities such as hypertension, diabetes mellitus, dyslipidemia, chronic obstructive pulmonary disease, obesity, previous thrombolysis, and family history of ischemic heart disease were recorded. The administration of streptokinase within 12 hours of chest pain marked the classification of a patient as thrombolysed, whereas those who presented after 12 hours and were managed without streptokinase were categorized as late presenters. Each patient's clinical course was monitored throughout their hospital stay.

At discharge, vital status was recorded. Survivors underwent transthoracic echocardiography using the GE VIVID T8 system, performed by a cardiologist with at least five years of post-fellowship experience. Left ventricular failure was considered present if ejection fraction was below 50%. Ventricular septal rupture was identified when color Doppler imaging revealed abnormal blood flow across the interventricular septum. Mitral regurgitation was diagnosed in cases where vena contracta width exceeded 0.7 cm with a central jet occupying more than 40% of the left atrium, accompanied by systolic reversal in pulmonary veins or evidence of a flail mitral leaflet with ruptured chordae. All findings were documented on a structured data collection form by the principal investigator.

Data were analyzed using IBM SPSS version 23. The Shapiro–Wilk test was applied to evaluate normality for continuous variables including age, body mass index, and symptom duration. These were expressed as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables such as gender, survival status, and presence of complications were presented as frequencies and percentages. Post-stratification analysis was carried out using the chi-square test, with a p-value of ≤0.05 considered statistically significant.

RESULTS

The study analyzed 224 STEMI patients with a mean age of 52.32±7.60 years, BMI of 27.51±1.93 kg/m^2, and symptom duration of 11.66±6.06 hours (Table I). The cohort was predominantly male (167, 74.6%), with 43 patients (19.2%) having previous thrombolysis history and 119 patients (53.1%) having a family history of ischemic heart disease. Treatment categorization revealed 122 patients (54.5%) received thrombolytic therapy while 102 patients (45.5%) were late for thrombolytic intervention (Table 1). Comorbidity analysis demonstrated high prevalence of cardiovascular risk factors including hypertension in 121 patients (54.0%), diabetes mellitus in 115 patients (51.3%), dyslipidemia in 102 patients (45.5%), obesity in

91 patients (40.6%), smoking in 83 patients (37.1%), and COPD in 34 patients (15.2%) (Table 2).

Table 1
Patient Demographics

Demographics		Mean ± SD
Age (years)		52.32±7.60
BMI (kg/m^2)		27.51±1.93
Duration (hrs)		11.66±6.06
Gender	Male n (%)	167 (74.6%)
	Female n (%)	57 (25.4%)
Previous Thrombolysis	Yes n (%)	43 (19.2%)
	No n (%)	181 (80.8%)
Family History of IHD	Yes n (%)	119 (53.1%)
	No n (%)	105 (46.9%)
Treatment Category	Thrombolytic n (%)	122 (54.5%)
	Late for Thrombolytic n (%)	102 (45.5%)

Table 2
Frequency of Comorbidities

Comorbidities		Frequency	%age
Diabetes Mellitus	Yes	115	51.30%
	No	109	48.70%
Hypertension	Yes	121	54.00%
	No	103	46.00%
Smoking	Yes	83	37.10%
	No	141	62.90%
Obesity	Yes	91	40.60%
	No	133	59.40%
Dyslipidemia	Yes	102	45.50%
	No	122	54.50%
COPD	Yes	34	15.20%
	No	190	84.80%

Overall in-hospital outcomes showed mortality in 38 patients (17.0%), left ventricular failure in 76 patients (33.9%), mitral regurgitation in 76 patients (33.9%), and ventricular septal rupture in 20 patients (8.9%) (Table 3).

Table 3
Frequency of In-Hospital Outcomes

In-Hospital Outcomes		Frequency	%age
Mortality	Yes	38	17.00%
	No	186	83.00%
Left Ventricular Failure (LVF)	Yes	76	33.90%
	No	148	66.10%
Ventricular Septal Rupture (VSR)	Yes	20	8.90%
	No	204	91.10%
Mitral Regurgitation (MR)	Yes	76	33.90%
	No	148	66.10%

Comparative analysis between treatment groups revealed significantly superior outcomes in the thrombolytic group versus the late-for-thrombolytic group: mortality was markedly lower (12 patients, 9.8% vs 26 patients, 25.5%; p=0.002), left ventricular failure occurred less frequently (34 patients, 27.9% vs 42 patients, 41.2%; p=0.036), ventricular septal rupture was substantially reduced (6 patients, 4.9% vs 14 patients, 13.7%; p=0.021), and mitral regurgitation was significantly less common (30 patients, 24.6% vs 46 patients, 45.1%; p=0.001), with all comparisons achieving statistical significance (Table 4).

Table 4
Comparison of In-Hospital Outcomes between the two groups (n=224)

Outcomes		Thrombolytic n=122	Late for Thrombolytic n=102	P value
		n (%)	n (%)	
Mortality	Yes	12 (9.8%)	26 (25.5%)	0.002
	No	110 (90.2%)	76 (74.5%)	
	Total	122 (100%)	102 (100%)	
Left Ventricular Failure (LVF)	Yes	34 (27.9%)	42 (41.2%)	0.036
	No	88 (72.1%)	60 (58.8%)	
	Total	122 (100%)	102 (100%)	
Ventricular Septal Rupture (VSR)	Yes	6 (4.9%)	14 (13.7%)	0.021
	No	116 (95.1%)	88 (86.3%)	
	Total	122 (100%)	102 (100%)	
Mitral Regurgitation (MR)	Yes	30 (24.6%)	46 (45.1%)	0.001
	No	92 (75.4%)	56 (54.9%)	
	Total	122 (100%)	102 (100%)	

DISCUSSION

The research revealed that early thrombolysis significantly reduced mortality and major complications such as left ventricular failure, mitral regurgitation, and ventricular septal rupture. Such variances can be medically explained with the beneficial effect of early reperfusion in salvaging ischemic but viable myocardium. Thrombolytic agents dissolve the occluding thrombus with a restitution of coronary flow and an infarct size restriction with a time window of therapy, typically within 12 hours of onset of symptoms.

Reduced mortality in thrombolysed subjects can be explained with sparse myocardial damage and preserved ventricular function, reducing fatal arrhythmial as well as susceptibility to cardiogenic shock. Few instances of left ventricular failure in such individuals are equally consistent with early reperfusion with intact contractile myocardial mass, thereby preserving adequate ejection function. Correspondingly, mitral regurgitation, more frequently due to papillary muscle dysfunction or rupture, occurs more frequently with widespread myocardial necrosis—something more likely with delayed reperfusion. Ventricular septal rupture, a mechanical complication of gruesome proportions, occurs due to full-thickness myocardial infarction; early thrombolysis reduces transmural necrosis, thereby reducing septal wall disruption susceptibility. Collectively, these findings emphasize clinical and physiological importance of early thrombolysis therapy in altering natural history of STEMI.

Our study demonstrated that STEMI patients who received timely thrombolysis experienced significantly better in-hospital outcomes compared to those who were late for thrombolysis. Specifically, early thrombolysis was associated with reduced mortality (9.8% vs 25.5%; p=0.002), left ventricular failure (27.9% vs 41.2%; p=0.036), mitral regurgitation (24.6% vs 45.1%; p=0.001), and ventricular septal rupture (4.9% vs 13.7%; p=0.021). These findings are in agreement with Afilalo J, et al. [14] who reported that prolonged symptom-to-door time significantly lowered post-MI LVEF, which supports the idea that delays in treatment allow for more extensive myocardial necrosis, leading to increased mechanical and functional complications. In both studies, early

intervention played a critical role in preserving ventricular function and reducing adverse events.

Similar trends were reported by Tariq MN, et al. [15] who found that early coronary intervention after fibrinolysis (≤24 hours) significantly reduced in-hospital reinfarction and mortality compared to delayed intervention. Their mortality rate in the early group (2%) is even lower than ours (9.8%), likely reflecting not only early reperfusion but also the added benefit of PCI post-thrombolysis. In contrast, patients with delayed PCI (>24 h) had a mortality rate of 10%, which closely mirrors the 25.5% mortality observed in our late-thrombolysis group, highlighting the critical impact of timely reperfusion. Both studies consistently demonstrate that delayed intervention—whether in the form of late thrombolysis or late PCI—is associated with poorer outcomes, possibly due to irreversible myocardial damage and progression to complications like pump failure and structural defects.

The results of our study also align with those of Kavyashree SM, et al. [16] who found that thrombolysis within 3 hours of symptom onset yielded the highest success rates and lowest complication rates. In their cohort, patients lysed within 3 hours had significantly fewer adverse events (11.1%) compared to those lysed after 6 hours (51.9%). This supports our findings that early thrombolysis reduces the incidence of complications such as LV failure and mitral regurgitation. The difference in absolute complication rates may be explained by the variation in definitions of adverse outcomes and the timing of thrombolysis; however, both studies strongly support the "golden window" principle of reperfusion therapy.

Conversely, our findings also resonate with the study by Ullah N, et al. [17] which focused solely on patients who were late for thrombolysis (>12 hours). They reported high rates of cardiogenic shock (21.9%) and left ventricular thrombus formation (6.7%), with an overall mortality of 8.57%. While their mortality appears slightly lower than our late group (25.5%), this discrepancy could be due to differences in baseline characteristics or sample size. Nonetheless, the high burden of mechanical and hemodynamic complications in delayed presenters is a common finding in both studies and underscores the progressive pathophysiological deterioration in untreated infarcts.

Overall, our research findings are in agreement with available literature on the importance of early thrombolysis for STEMI. Heterogeneity of mortality as well as complication rates across studies can be a function of patient population, kind as well as timing of reperfusion therapy, availability of PCI, as well as healthcare infrastructure. Nevertheless, universal to all studies is that early identification as well as treatment of STEMI substantially optimizes in-hospital outcomes by minimizing irreversible myocardial injury as well as its aftermath.

The ongoing association of early intervention with fewer complications from our research, as well as others, further emphasizes expedited acute myocardial infarction transport, recognition, and treatment. Increased education of the population, bettered prehospital response systems, and decreased treatment delay remain crucial for STEMI care outcomes' enhancement, particularly in resource-limited settings.

Nonetheless, this investigation comes with some limitations that must be highlighted. It was only carried out from a single tertiary referral center, thus potentially narrowing the generalizability of outcomes in other parts of the country with varying access or infrastructure for healthcare. In addition, sample size although sufficient for an initial comparison, would be unable to adequately reflect rare complication rates or permit extensive subgroup analysis. Also, outcomes after discharge for a long duration were not evaluated, thus limiting the focus of interpretation only to in-hospital occurrences. Multicenter studies for the future with larger populations with long-term follow-up are encouraged for validating as well as broadening on these outcomes.

CONCLUSION

The study concluded that early thrombolysis of acute ST-segment elevation myocardial infarction resulted in significantly favorable in-hospital outcomes compared with late-presenting thrombolysis groups. Early treatment significantly reduces mortality risk in addition to major cardiac morbidity and highlights its significant importance in rapid diagnosis with urgent implementation of reperfusion therapy. Our findings indicate the importance of increasing early detection of STEMI cases with improved treatment access for clinical outcomes improvement.

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