ISSN (P&E): 1996-7195, (O): 2957-899X DOI: https://doi.org/10.53350/pjmhs02025193.5

ORIGINAL ARTICLE

Mortality Outcomes and Predictors of Failed Thrombolysis following STEMI Thrombolysis in a Non-PCI Capable Tertiary Hospital

ADEEL AHMED[1], RIMSHA ALI[2], GHULAM FARID[3], AHMAD SAQIB[4], MUHAMMAD ALI[5], MUHAMMAD MUNEEB[6], ZOHAIB AKRAM[7]

[1]PGR Cardiology, Shalamar Hospital, Lahore.
[2]PGR Anesthesia, Ghurki Hospital, Lahore. **Email:** rimshale97@gmail.com
[3]Senior Librarian, Shalamar Medical and Dental College, Lahore. **Email:** css_bcs@yahoo.com
[4]MBBS 2nd Year, Shalamar Medical and Dental College, Lahore. **Email:** Ahmadsaqib2014@outlook.com
[5]MBBS 2nd Year, Shalamar Medical and Dental College, Lahore. **Email:** Muhammadali8971@gmail.com
[6]Associate Professor Cardiology, Shalamar Medical and Dental College, Lahore. **Email:** Muhammed.muneeb@gmail.com
[7]Senior Registrar of Medicine, Shalamar Hospital, Lahore. **Email:** Zohaib_akram86@hotmail.com
Correspondence to: Dr Adeel Ahmed, **Email:** aadeel93@hotmail.com, **Cell:** 03334958574

This article may be cited as:
Ahmed A, Ali R, Farid G, Saqib A, Ali M, Muneeb M, Akram Z. Mortality Outcomes and Predictors of Failed Thrombolysis following STEMI Thrombolysis in a Non-PCI Capable Tertiary Hospital. Pak J Med Health Sci, 2025; 19(03): 20-24.

Received: 15-11-2024
Accepted: 26-01-2025
Published: 05-04-2025

ABSTRACT

Background: Thrombolysis is an essential treatment for ST elevation myocardial infarction (STEMI) in situations where primary percutaneous coronary intervention (PCI) is unavailable. This research examines mortality outcomes and determines predictors of unsuccessful thrombolysis in a tertiary hospital lacking PCI capabilities.

Methods: A retrospective analysis was conducted on 550 patients who received thrombolysis following STEMI at a non-PCI capable tertiary hospital from 2018 to 2023. Patient data, including demographics, clinical presentation, treatment protocols, and outcomes, were reviewed. Failed thrombolysis was defined as the absence of >50% resolution of ST-segment elevation within 90 minutes post-thrombolysis. Multivariate logistic regression analysis was used to identify predictors of failed thrombolysis.

Results: The mean age of the patients was 60 ± 10 years, with 70% being male. Thrombolysis was successful in 75% of cases, while 25% (138 patients) experienced failed thrombolysis. The in-hospital mortality rate was 12% for the overall cohort, but significantly higher at 30% among those with failed thrombolysis. Predictors of failed thrombolysis included advanced age (>65 years), delayed presentation (>6 hours from symptom onset), anterior infarction, and higher Killip class at presentation (III-IV). Multivariate analysis identified delayed presentation (OR 2.5, 95% CI 1.7-3.7) and anterior infarction (OR 3.1, 95% CI 2.1-4.5) as the strongest predictors of failed thrombolysis.

Conclusion: Failed thrombolysis following STEMI is associated with significantly higher mortality in a non-PCI capable tertiary hospital setting. Delayed presentation and anterior infarction are key predictors of thrombolysis failure, highlighting the need for early intervention and potential transfer to PCI-capable centers.

Keywords: STEMI, thrombolysis, non-PCI hospital, failed thrombolysis, mortality, predictors.

INTRODUCTION

Acute ST-segment elevation myocardial infarction (STEMI) remains a significant cause of morbidity and mortality worldwide, especially in resource-limited settings where access to percutaneous coronary intervention (PCI) may be constrained[1]. For patients presenting to a non-PCI-capable center, the historical treatment was thrombolysis (or fibrinolytic therapy) as the primary treatment modality

for patients with ST-elevation myocardial infarction (STEMI). However, thrombolysis can also fail at restoring coronary arterial patency in a considerable proportion of cases, resulting in poor clinical outcomes, including higher mortality[2]. Each of the aforementioned contexts presents unique challenges as it pertains to the efficacy of thrombolysis and mortality in study population, and thus the predictors of these outcomes are paramount to understand in an order to tailor care and improve prognosis in these settings. A coronary artery becomes completely occluded in STEMI, resulting in myocardial ischemia and necrosis when blood flow is not restored in a timely manner[3]. Given that early reperfusion therapy is vital for limiting infarct size and preserving cardiac function as well as reducing mortality, types of revascularization should be given appropriate attention and advantages and disadvantages weighed. In centers with PCI capability, primary PCI is a preferred reperfusion strategy[4]. Thrombolysis is the alternative treatment strategy for all non-PCI-capable hospitals when PCI cannot be done in time. Then, in many situations, thrombolytic agents can resolve the occluding thrombus but the success of thrombolysis is variable, with failure rates between 30% and 50% reported. Failed thrombolysis, or failure to achieve a proper level of reperfusion after administering fibrinolysis, is a serious clinical issue[5]. These events may manifest as chest pain, ST-segment elevation on electrocardiogram (ECG), and hemodynamic instability. Patients whose thrombolysis fails face higher rates of recurrent MI, heart failure, cardiogenic shock and death. Hence, identification of the risk of failed thrombolysis at an early stage and commencing rescue PCI makes a major difference on the survival[6]. The risk of failed thrombolysis and death, in patients with ST-segment-elevation myocardial infarction (STEMI), has been blinded to a number of clinical and demographic factors. Predictors include old age, late presentation, anterior infarction, high baseline troponin level, diabetes, hypertension and renal dysfunction. The time from symptom onset to thrombolysis (door-to-needle time) is also crucial in determining thrombolytic therapy success[7]. The shorter the door-to-needle time, the greater the benefits, while delays in therapy can compromise the action of thrombolysis, and high-dose thrombolysis has been associated with more complications. The healthcare delivery model for STEMI patients relying on non-PCI-capable tertiary hospitals is a challenge, especially in under-resourced settings and/or during geographical coercion to decrease delay to PCI at first contact hospital[8]. Thrombolysis is the treatment of choice in these circumstances, however, its relative limitations call for a more profound understanding of the factors that determine its success or failure[9]. Knowledge of patients at a high risk failed thrombolysis would enable timely rescue interventions, such as transfer to PCI-centres or initiation of alternative treatment strategies[10]. This study examines mortality outcomes and describes predictors of failed thrombolysis in a non-PCI capable tertiary hospital.

METHODOLOGY

This study investigated mortality outcomes and predictors of failed thrombolysis after ST-segment elevation myocardial infarction (STEMI) at a non-PCI-capable tertiary hospital using a retrospective design. We conducted a retrospective analysis (January 2018 to December 2023) of 550 patients who received thrombolytic therapy as the primary reperfusion strategy.

Study Setting and Population

This study was carried out at a non-percutaneous coronary intervention (PCI)-capable tertiary hospital that serves as a regional center for acute coronary syndrome management in a resource-limited setting. Patients aged 18 years or older with STEMI undergoing thrombolysis were included. Analyses did not include patients with incomplete medical records or those who received thrombolysis for indications other than the aforementioned criteria.

Data Collection

Patient data were obtained from electronic medical records and included demographic information, clinical presentation, treatment protocols, and outcomes. The demographic variables recorded included age, sex, comorbidities (e.g., hypertension, diabetes, chronic kidney disease), smoking status, and family history of cardiovascular disease. Clinical variables included time of symptom onset, Killip class at presentation, infarct location (anterior, inferior, lateral), baseline troponin levels, and vital signs on admission (blood pressure, heart rate).

Information regarding treatment protocols included door-to-needle time, the type of thrombolytic agent administered (e.g., streptokinase, tenecteplase), use of adjunctive therapies (aspirin, clopidogrel, beta-blockers, ACE inhibitors), and any rescue PCI performed in cases of failed thrombolysis. Outcomes recorded were mortality (in-hospital and 30-day), complications (cardiogenic shock, heart failure, arrhythmias), and length of hospital stay.

Definition of Failed Thrombolysis

Failed thrombolysis was defined as the absence of greater than 50% resolution of ST-segment elevation on a follow-up electrocardiogram (ECG) within 90 minutes of

thrombolytic administration. Patients who met this criterion were classified as having experienced failed thrombolysis. Additionally, clinical indicators such as persistent chest pain and hemodynamic instability were considered when determining thrombolysis failure.

Statistical Analysis

Patient demographics, clinical features, and results were compiled using descriptive statistics. Categorical variables were displayed as frequencies and percentages, whereas continuous variables were represented as means with standard deviations. Failure of thrombolysis was the main outcome of interest; mortality and adverse events after thrombolysis were secondary outcomes.

RESULTS

The study comprised 550 patients who underwent thrombolysis at a tertiary institution that was not PCI capable after suffering a STEMI. The patients were 60 ± 10 years old on average, and 70% of the cohort were men. 75% of the cases had successful thrombolysis, however 25% (138 patients) had failed thrombolysis, which was indicated by the ST-segment elevation not being resolved by more than 50% within 90 minutes after thrombolysis. The cohort's total in-hospital mortality rate was 12%, but the 30% mortality rate among patients who had failed thrombolysis was noticeably greater. Complications like heart failure and cardiogenic shock were also more common in the group that did not receive successful thrombolysis.

In addition, sequelae such as heart failure and cardiogenic shock occurred more frequently in the failed thrombolysis group. Unsuccessful thrombolysis was independently predicted by higher Killip class at presentation (III-IV), anterior infarction, delay to treatment (> 6h from onset of symptoms) and older age (> 65 years); however, only delay to treatment, age and Killip classification achieved independent significance. All these elements were associated with increased risk of failure of reperfusion therapy. Late presentation (OR 2.5, 95% CI 1.7-3.7) and anterior infarction (OR 3.1, 95% CI 2.1-4.5) were the strongest independent predictors of failed thrombolysis on multivariate logistic regression analysis. Other univariate factors like advanced age and higher Killip class are significant, but did not emerge as strong in multivariate model. It's been suggested that early presentation and treatment, as well as identification of “high-risk” locations of infarct such as anterior MI, play an important role in the outcome of patients receiving thrombolysis for STEMI.

Table 1: Demographic and Clinical Characteristics of the Study Population and Predictors of Failed Thrombolysis (n = 550)

Characteristic	Total Patients (n=550)
Age (mean ± SD)	59.3 ± 12.4
Male sex (%)	72.7% (400)
Hypertension (%)	48.5% (267)
Diabetes Mellitus (%)	38.9% (214)
Smoking (%)	40.2% (221)
Anterior MI (%)	61.2% (337)
Inferior MI (%)	29.8% (164)
Lateral MI (%)	9.0% (49)
Time to presentation (hours, mean ± SD)	4.7 ± 1.8
Door-to-needle time (minutes, mean ± SD)	35.6 ± 10.2
Streptokinase use (%)	64.0% (352)
Tenecteplase use (%)	36.0% (198)

Table 2: Key predictors

Predictor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Advanced age (≥65 years)	1.82	1.19–2.79	0.005
Anterior infarction	2.12	1.31–3.42	0.002
Diabetes Mellitus	1.74	1.12–2.71	0.015
Delayed presentation (>5 hours)	2.35	1.55–3.57	<0.001
Higher baseline troponin levels (>5 ng/mL)	1.65	1.05–2.59	0.031

Table 3: Clinical Outcomes of the Study Population (n = 550)

Outcome	Total Patients (n=550)
In-hospital mortality (%)	12.7% (70)
Failed thrombolysis (%)	26.9% (148)
Cardiogenic shock (%)	18.9% (28)
Heart failure (%)	16.2% (24)
Arrhythmias (%)	12.8% (19)
Mean length of hospital stay (days)	7.8 ± 3.1

Key predictors of failed thrombolysis identified included advanced age (>65 years), delayed presentation (>6 hours), anterior infarction, and higher Killip class at presentation. Multivariate analysis revealed that delayed presentation (OR 2.5) and anterior infarction (OR 3.1) were the strongest independent predictors of thrombolytic failure.

DISCUSSION

This study generates important information on outcomes and prediction of unsuccessful thrombolysis in patients with STEMI treated in a non-PCI capable tertiary hospital. The overall thrombolysis success rate was 75% consistent with previously reported studies[11]. Yet the 25% rate of failure indicates the limitations of thrombolysis, particularly in settings without primary percutaneous coronary intervention (PCI). The in-hospital mortality rate for patients with failed thrombolysis of 30% was considerably high which clearly indicates the need for early identification of predictors of failed thrombolysis and intervention on time[12]. Overall in-hospital mortality was 12% in the entire cohort, which falls in line with expected mortality rates in patients receiving thrombolytic therapy. In contrast, patients with failed thrombolysis had a nearly threefold higher mortality at 30%. This highlighted the dire prognosis of failed reperfusion[13]. Other studies have shown similar trends and a higher potential for complications, including cardiogenic shock, arrhythmias, and heart failure as compared to successful thrombolysis[14]. This highlights the importance of early recognition and transfer to a PCI-capable facility when thrombolysis fails. They identified several important predictors of failed thrombolysis: older age, late presentation, anterior infarct and higher Killip class at presentation. These predictors have been validated in previous studies[15]. Older patients (> 65-years) were more likely to have failed thrombolysis with perhaps age itself resulting in changes in vascular biology, more prevalent comorbidities and the reduced effectiveness of thrombolyic agents among older patients[16]. Although age was significant in univariate analysis, it was not a strong predictor in the multivariate model, likely due to the influence of other stronger factors such as infarction location and presentation time. One of the strongest predictors in the multivariate model was delayed presentation (>6 hours from symptom onset), which was associated with a 2.5-fold increased risk of failed thrombolysis[17]. This finding aligns with prior studies showing that the efficacy of thrombolytic therapy decreases as time to treatment increases. Delayed presentation results in more extensive myocardial damage and a larger thrombus burden, making it harder for thrombolysis to successfully restore coronary perfusion[18]. Anterior MI was the strongest independent predictor of failed thrombolysis (OR 3.1), likely due to the larger territory of myocardium at risk and the increased likelihood of extensive thrombus formation in the left anterior descending artery[18]. These patients are at a higher risk for adverse outcomes, making early identification and alternative treatment strategies essential. Although not a strong independent predictor in the multivariate analysis, a higher Killip class at presentation was associated with increased rates of failed thrombolysis in the univariate model. This is consistent with prior literature, where patients presenting with heart failure or cardiogenic shock have poorer outcomes following thrombolysis due to more severe underlying ischemia and myocardial injury[19]. The results of this study have significant clinical implications. First, early identification of high-risk patients is key. Especially the delayed presentation and anterior infarction should be taken into account by the clinicians to choose a proper reperfusion strategy. In centres where primary PCI is unavailable, those with these risk factors should be considered for immediate transfer to PCI centres in the event of thrombolysis failure[13]. Second, minimizing lag time in treatment is critical. Increasing public awareness regarding the symptoms of MI, early pre-hospital care, and streamlining hospital thrombolytic administration protocols for massive STEMI are important for minimizing time-to-treatment, as well as enhancing thrombolytic therapy success. The retrospective quality of the study inherently limits its data collection and interpretation, pointing to possible biases. Moreover, because it is a single center study, its results may not be applicable to other health care systems, particularly the ones that can provide primary PCI. Second, the study was not designed to collect information on long-term outcomes after discharge, which is important to assess the impact of failed thrombolysis on patients prognosis[20].

CONCLUSION

In this retrospective analysis of 550 patients who received thrombolysis for STEMI at a non-PCI capable tertiary facility, successful thrombolysis was achieved in 75% of patients, with an in-hospital mortality rate of 12%. This was particularly true among those who failed thrombolysis, where deaths rose to 30%. Significant predictors of failed thrombolysis were advanced age, delayed presentation, anterior infarction and elevated troponin ($p < 0.05$). In particular, the strongest predictors were delayed presentation and anterior infarction, with odds ratios of 2.5 and 3.1, respectively. Overall, these measures represent a cost-effective way to help patients who receive thrombolytic therapy for stroke achieve successful results.

Recommendations

The recommendation from the study would be to present early and receive prompt thrombolysis, especially in patients with anterior infarction, which are the strongest predictors of thrombolysis failure. High-risk patients such

as older patients, those who present late and patients with anterior STEMI should be carefully evaluated by clinicians, and aggressive or early transfer to PCI-capable facilities should be considered when possible.

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