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Factors Leading to Delays in Primary Percutaneous Intervention for Patients with ST-Elevation Myocardial Infarction

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ABSTRACT

Background: Timely primary percutaneous coronary intervention remains the most effective treatment for patients experiencing ST-elevation myocardial infarction. However, delays in performing the procedure can result in increased myocardial injury and mortality. Such delays may occur during pre-hospital, in-hospital, or patient-related stages, emphasizing the need to identify the contributing factors within specific healthcare environments, particularly in regions with limited resources. **Objective:** To determine the factors leading to delays in primary percutaneous intervention for patients with ST-elevation myocardial infarction. **Study Design:** Descriptive cross-sectional study. **Duration and Place of Study:** The study was conducted from February 2025 to May 2025 in the Department of Cardiology, Lady Reading Hospital, Peshawar. **Methodology:** A total of 176 patients aged 20–75 years with electrocardiographically confirmed ST-elevation myocardial infarction were enrolled through consecutive sampling. Delay was defined as a time interval exceeding 60 minutes between diagnosis and initiation of the procedure. Factors evaluated included patient misinterpretation of cardiac pain, diagnostic delay, transportation delay, delay in providing consent, delay due to catheterization laboratory readiness, and procedure-related delay. **Results:** Patient misinterpretation of cardiac pain was the most prevalent factor (62.5%), followed by delay in providing consent (59.1%) and transportation delay (52.3%). Diagnosis delay and catheterization laboratory readiness issues were less common (5.7% each), while procedural delay occurred in 15.9% of patients. A significant correlation existed between hypertension and transportation delay ($p<0.01$). **Conclusion:** Patient-related factors, particularly misinterpretation of symptoms, delay in consent, and transportation challenges, were the predominant contributors to delayed primary percutaneous coronary intervention, whereas healthcare system factors played a minor role.

INTRODUCTION

Primary percutaneous coronary intervention (PCI) is regarded as the most effective therapeutic approach for patients diagnosed with ST-elevation myocardial infarction (STEMI).[1] However, in numerous instances, procedural delay occurs, which increases myocardial injury and elevates mortality risk.[2] This delay arises from multiple factors, some during the pre-hospital phase, some within the healthcare system, and some due to patient behavior.[3] During the pre-hospital period, the main reasons include delayed recognition of ischemic chest pain or failure to interpret the severity of cardiac symptoms.[4] Many patients initially consult primary care providers or local clinics lacking interventional cardiology facilities, resulting in unnecessary loss of time.[5] For individuals residing in peripheral regions, absence of advanced ambulance support or pre-hospital electrocardiogram (ECG) capability also contributes to prolonged transfer to the receiving hospital.[6]

System-related delays are equally critical. In many areas, the absence of a structured regional cardiac network causes poor coordination during inter-facility patient transfer.[7] Limited bed availability, catheterization laboratory overcrowding, or delayed mobilization of the interventional cardiology team are frequent causes of PCI postponement.[8] Within hospital premises, diagnostic confirmation or therapeutic decision-making may consume additional time.[8] Administrative clearance procedures, documentation delays, and inadequate on-call staff during nocturnal or holiday hours further extend total ischemic duration. Ideally, the door-to-balloon time should remain within 90 minutes after hospital arrival.[9]

Patient-related determinants are also major contributors. Many individuals delay hospital presentation due to financial limitations, anxiety, or denial of acute coronary symptoms.[10] Some rely on non-medical remedies, leading

to loss of critical myocardial salvage time.[10] Elderly patients and females often exhibit atypical presentations, resulting in diagnostic delay.[11] Cultural or familial influences, such as waiting for family consent or preferred physician availability, also prolong treatment initiation.[11] To minimize these determinants, community education on myocardial infarction manifestations, strengthening of the referral pathway, and optimization of emergency medical services are essential.[12] Integration of pre-hospital and in-hospital cardiac care systems can substantially reduce reperfusion delay and improve survival outcomes in STEMI management.[12]

A study identified multiple contributors to delayed primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction, including patient misinterpretation of cardiac pain in 68% of cases, diagnostic delay in 10.3%, transportation-related delay in 52.6%, delay in obtaining informed consent in 61.9%, delay due to catheterization laboratory readiness in 10.3%, and procedure-related delay in 12.4% of patients.[13] The requirement to undertake this research in Peshawar stems from the area's limited access to specialized cardiac care centers and delayed patient-referral systems in cases of ST-elevation myocardial infarction. Few hospitals have around-the-clock catheterization labs, ambulance networks with inadequate facilities to transfer quickly, and pre-hospital electrocardiograms. Additionally, patient awareness about the early recognition of symptoms and early hospital presentation is still weak. Quantification of the factors that cause delay in primary percutaneous intervention within this regional context will be required to ascertain the modifiable obstacles, achieve the best possible systems' efficacy, as well as the best outcomes in survival in myocardial infarcted patients within Peshawar.

METHODOLOGY

This descriptive cross-sectional investigation was carried out in the Department of Cardiology at Lady Reading Hospital, Peshawar, from February 2025 to May 2025. The study sought to determine the underlying factors contributing to delayed initiation of primary percutaneous coronary intervention among patients presenting with ST-elevation myocardial infarction. Prior to data collection, approval was secured from the institutional ethics review committee and subsequently verified by the research unit of the College of Physicians and Surgeons Pakistan.

A total of 176 participants were required, calculated through the World Health Organization sample size formula, considering a 95% confidence level, 4.5% margin of error, and an expected proportion of 10.3% for delays attributed to catheterization laboratory readiness.[13] Recruitment followed a non-probability consecutive sampling method, including all eligible patients presenting during the study period. Participants of either gender, aged between 20 and 75 years, who were clinically diagnosed with ST-elevation myocardial infarction were included. The diagnosis of ST-elevation myocardial infarction was based on electrocardiographic evidence of ST-segment elevation of at least 2 mm in men or 1.5 mm in women in leads V2–V3, or elevation of 1 mm in two contiguous chest or limb leads, with a configuration consistent with ischemic changes, accompanied by chest pain scoring above 3 on the visual analogue scale and persisting for more than 24 hours. Patients with non-ST-elevation myocardial infarction, a history of coronary artery bypass grafting, documented arrhythmias, or cardiac arrest were excluded from the study. All participants were briefed on the purpose and procedures of the research, and informed written consent was obtained before enrolment. Anonymity and confidentiality were ensured throughout the process.

Each patient underwent a detailed clinical review to assess multiple causes contributing to procedural delays. Delay was characterized as a total time interval exceeding 60 minutes between the onset of symptoms or the establishment of diagnosis and the commencement of primary percutaneous coronary intervention. The procedure was defined as a non-surgical, catheter-based technique employed to re-establish coronary blood flow in ischemic cardiac tissue by dilating or removing arterial blockages. Potential factors were evaluated individually: misinterpretation of cardiac pain referred to a patient's inability to identify symptoms suggestive of a cardiac event; diagnostic delay denoted the absence of an electrocardiogram within 30 minutes of the patient's initial medical consultation; transportation delay described the time lapse between patient recognition as a cardiac emergency and arrival at an intervention-capable facility; delay in providing consent indicated postponement between decision-making for intervention and patient's formal consent; delay due to catheterization laboratory readiness represented the waiting period caused by the unavailability or unprepared state of the laboratory; and procedure-related delay signified any intra-procedural hindrance occurring after the decision to perform the intervention. All assessments were conducted under the supervision of a consultant cardiologist with extensive post-fellowship clinical experience. Findings were recorded on a structured proforma designed for this study.

Data were analyzed using IBM SPSS version 23. Continuous variables were summarized as mean ± standard deviation or median with interquartile range, depending on the data distribution tested by the Shapiro–Wilk method. Categorical data were expressed as frequencies and percentages. The potential influence of modifiers was addressed through stratification. Statistical associations were evaluated using the Chi-square or Fisher's exact test, and a p-value of ≤ 0.05 was considered to indicate statistical significance.

RESULTS

In this study of 176 patients with ST-elevation myocardial infarction undergoing primary percutaneous intervention, the mean age was 46.55±15.82 years with a mean BMI of 27.98±2.71 kg/m^2. The cohort comprised 112 males (63.6%) and 64 females (36.4%). Regarding socioeconomic status, 94 patients (53.4%) belonged to the low socioeconomic group, 69 (39.2%) to the middle class, and 13 (7.4%) to the high socioeconomic group. Geographic distribution showed that 105 patients (59.7%) were from rural areas while 71 (40.3%) resided in urban locations. Educational assessment revealed that 97 patients (55.1%) were uneducated and 79 (44.9%) were

educated, while employment status indicated that 97 patients (55.1%) were employed and 79 (44.9%) were unemployed. Among comorbidities, 86 patients (48.9%) had hypertension while 90 (51.1%) did not, 58 patients (33.0%) had diabetes compared to 118 (67.0%) without diabetes, and 38 patients (21.6%) were smokers whereas 138 (78.4%) were non-smokers (as shown in Table 1).

Table 1

Patient Demographics

Demographics		Mean ± SD
Age (years)		46.55±15.82
BMI (kg/m^2)		27.98±2.71
Gender	Male n (%)	112 (63.6%)
	Female n (%)	64 (36.4%)
Socioeconomic Status	Low n (%)	94 (53.4%)
	Middle n (%)	69 (39.2%)
	High n (%)	13 (7.4%)
Residence	Rural n (%)	105 (59.7%)
	Urban n (%)	71 (40.3%)
Education Status	Educated n (%)	79 (44.9%)
	Uneducated n (%)	97 (55.1%)
Employment Status	Employed n (%)	97 (55.1%)
	Unemployed n (%)	79 (44.9%)
Hypertension	Yes n (%)	86 (48.9%)
	No n (%)	90 (51.1%)
Diabetes	Yes n (%)	58 (33.0%)
	No n (%)	118 (67.0%)
Smoking	Yes n (%)	38 (21.6%)
	No n (%)	138 (78.4%)

Analysis of delay factors demonstrated that patient misinterpretation of cardiac pain was the most prevalent issue, occurring in 110 patients (62.50%), followed by delay in providing consent in 104 patients (59.10%), and transportation delay in 92 patients (52.30%). Procedural-related delays were observed in 28 patients (15.90%), while diagnosis delay and delay due to catheterization laboratory readiness each affected only 10 patients (5.70%) (as shown in Table 1).

Table 2

Frequency of Factors Leading to Delays in Primary Percutaneous Intervention Among Patients with ST-Elevation Myocardial Infarction

Variable		Frequency	%age
Patient Misinterpretation of Cardiac Pain	Yes	110	62.50%
	No	66	37.50%
	Total	176	100%
Diagnosis Delay	Yes	10	5.70%
	No	166	94.30%
	Total	176	100%
Delay in Providing Consent	Yes	104	59.10%
	No	72	40.90%
	Total	176	100%
Transportation Delay	Yes	92	52.30%
	No	84	47.70%
	Total	176	100%
Delay Due to Cath Lab Readiness	Yes	10	5.70%
	No	166	94.30%
	Total	176	100%
Procedure-Related Delay	Yes	28	15.90%
	No	148	84.10%
	Total	176	100%

Correlation analysis between patient demographics and delay factors revealed minimal associations for most variables, with Pearson correlation coefficients ranging from -0.125 to 0.229. The only statistically significant correlation identified was between hypertension and transportation delay ($r=0.229$, $p<0.01$). All other correlations between age, BMI, socioeconomic status, education status, diabetes, smoking and the various delay factors (patient misinterpretation of cardiac pain, diagnosis delay, delay in providing consent, transportation delay, delay due to cath lab readiness, and procedure-related delay) showed weak, non-significant relationships (as shown in Table 3).

Table 3

Correlation Between Patient Demographics and Delay Factors in Primary Percutaneous Intervention

Variables	Age	BMI	Socioeconomic Status	Education Status	Hypertension	Diabetes	Smoking
Patient Misinterpretation of Cardiac Pain	0.002	-0.125	0.066	-0.032	0.1	-0.031	-0.021
Diagnosis Delay	-0.051	-0.006	0.118	0.075	-0.093	-0.015	-0.069
Delay in Providing Consent	-0.009	0.053	0.063	0.077	-0.088	0.018	-0.041
Transportation Delay	-0.075	-0.034	0.071	0.062	0.229**	-0.008	0.031
Delay Due to Cath Lab Readiness	-0.002	-0.035	0.015	0.025	-0.093	0.037	-0.069
Procedure-Related Delay	-0.028	-0.039	-0.032	-0.018	0.072	-0.041	-0.002

Values represent Pearson correlation coefficients (r) ** Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

The present study aimed to identify and analyze the factors contributing to delays in primary percutaneous intervention among patients presenting with ST-elevation myocardial infarction, a condition where timely intervention is critically important for optimal patient outcomes. The findings revealed that patient misinterpretation of cardiac pain was the most common cause of delay, affecting nearly two-thirds of the study population at 62.50%, which can be attributed to the variable nature of cardiac pain presentation that often mimics benign conditions such as gastritis, musculoskeletal pain, or anxiety, leading patients to dismiss or underestimate the severity of their symptoms. The second most prevalent delay factor was the delay in providing consent, observed in 59.10% of cases, which stems from the complex decision-making process that patients and their families undergo when faced with an invasive cardiac procedure, compounded by fears regarding procedural risks, financial concerns, and the need to consult multiple family members before authorization, particularly in collectivist cultural settings. Transportation delay, identified in 52.30% of patients, reflects the logistical challenges inherent in emergency cardiac care, including inadequate ambulance availability, traffic congestion, long distances from healthcare facilities, and lack of awareness about the urgency of immediate transfer. The relatively low frequency of diagnosis delay and catheterization laboratory readiness issues, each at 5.70%, suggests that healthcare system factors are less problematic than patient-related factors, indicating that once patients reach medical facilities, the diagnostic and

procedural infrastructure functions efficiently. The significant correlation between hypertension and transportation delay may be explained by the chronic nature of hypertension leading to a false sense of familiarity with cardiac symptoms, causing hypertensive patients to delay seeking immediate transport, or alternatively, hypertensive patients may have already experienced previous cardiac events making them more cautious about hospital visits due to prior negative experiences or financial burden from repeated healthcare encounters.

The findings of the present study align with and diverge from existing literature in several important aspects, providing valuable insights into the multifaceted nature of delays in primary percutaneous intervention for STEMI patients. The predominant delay factor identified in our study was patient misinterpretation of cardiac pain, affecting 62.50% of patients, which is remarkably consistent with the findings of Shaikh JK et al. [13] who reported a 68% prevalence of patient misinterpretation, and Samin A et al. [14] who found that 57.5% of patients attributed their symptoms to other diseases. This similarity across different Pakistani healthcare settings suggests a systemic issue related to inadequate public awareness about cardiac symptoms and the cultural tendency to dismiss chest pain as minor ailments. However, our finding contrasts with Zameer I et al. [15] who reported a lower prevalence of symptom misinterpretation at 28.2%, which may be attributed to differences in study methodology, patient selection criteria, or the specific definitions used to categorize delay factors. The high frequency of consent delays in our study at 59.10% closely mirrors the findings of Shaikh JK et al. [13] who reported 61.9% consent delays, suggesting that the decision-making process involving family members and concerns about procedural risks remains a significant barrier in South Asian cultural contexts where collective family decisions often take precedence over individual autonomy. This pattern differs from studies conducted in Western populations, such as Pereira H et al. [16] who did not identify consent delays as a major factor, possibly reflecting cultural differences in medical decision-making autonomy and the legal frameworks governing emergency medical procedures.

Transportation delay was identified in 52.30% of our patients, which is comparable to Shaikh JK et al. [13] who reported 52.6% transportation delays and Samin A et al. [14] who found transportation issues in 37% of cases, indicating persistent logistical challenges in emergency cardiac care access. Zameer I et al. [15] reported an even higher prevalence of transportation problems at 34.5% as a primary delay category, though their categorization methodology differed from ours. These findings collectively underscore the inadequate emergency medical services infrastructure, particularly affecting rural populations, as evidenced by our observation that 59.7% of patients resided in rural areas. This geographic disparity is further supported by Shaikh JK et al. [13] who demonstrated that rural residents had significantly higher door-to-balloon delays compared to urban dwellers, with 85.7% versus 32.5% experiencing delays respectively. The correlation between hypertension and transportation delay found in our study is a novel finding not reported in previous literature, which warrants further investigation but may reflect the complex interplay between chronic disease management, symptom perception, and healthcare-seeking behavior.

The relatively low frequency of diagnosis delay and catheterization laboratory readiness issues in our study, each at 5.70%, contrasts sharply with several other investigations and suggests efficient healthcare system functioning once patients reach medical facilities. Samin A et al. [14] reported a much higher misdiagnosis rate of 50%, while Awan MS et al. [17] found that 16.9% of cases involved ECG misinterpretation as NSTEMI and 19.7% had absent initial ECGs. The discrepancy between our findings and these studies may reflect differences in institutional protocols, physician training levels, availability of diagnostic equipment, or the specific tertiary care setting of our study where experienced cardiologists and well-equipped catheterization laboratories are more readily available. Similarly, our low procedural-related delay rate of 15.90% suggests effective catheterization laboratory operations, which aligns with the broader finding that system-level delays are less problematic than patient-level delays in well-resourced tertiary centers.

Our demographic findings show a mean age of 46.55±15.82 years, which is notably younger than populations studied by Gooshvar M et al. [18] with a mean age of 63.68±10.20 years, Pereira H et al. [16] at 61 years, and Samin A et al. [14] at 61.6±1.07 years, but similar to Shaikh JK et al. [13] at 52.70±6.25 years and Kalwar MH et al. [19] at 53.37±10.65 years. This younger age profile in South Asian populations, particularly in Pakistan, reflects the earlier onset of coronary artery disease in this region, likely attributable to higher prevalence of risk factors such as diabetes, metabolic syndrome, genetic predisposition, and lifestyle factors including dietary patterns and physical inactivity. Our male predominance of 63.6% is consistent with most studies including Ranasinghe G et al. [20] at 85.2% males, Samin A et al. [14] at 61.7% males, and Shaikh JK et al. [13] at 91.75% males, though our female representation is higher than some studies, potentially reflecting increasing recognition of cardiac disease in women or differences in healthcare access patterns in our study population.

The socioeconomic distribution in our study, with 53.4% from low socioeconomic status, parallels the findings of Kalwar MH et al. [19] who demonstrated that delayed treatment groups had worse socioeconomic status at 65% compared to 20% in timely treatment groups. This relationship was further corroborated by Gooshvar M et al. [18] who found that higher socioeconomic status was protective against delays with an odds ratio of 0.68, and Shaikh JK et al. [13] who reported that low socioeconomic status was associated with 66% delay rate versus 20% in high socioeconomic groups. These consistent findings across multiple studies highlight the critical role of economic barriers, including inability to afford immediate transportation, concerns about treatment costs, and limited health literacy, in delaying time-sensitive cardiac interventions. The predominance of rural residence in our population at 59.7% reflects similar patterns observed in other South Asian studies and explains the high transportation delay rates, as rural populations face

greater distances to specialized cardiac centers, limited ambulance services, and poor road infrastructure, challenges that are compounded by lower health literacy and delayed symptom recognition as demonstrated by Samin A et al. [14] who found rural residence correlated with misdiagnosis.

The present study has several limitations that warrant consideration when interpreting the findings. First, this was a single-center study conducted at a tertiary care hospital, which may limit the generalizability of our results to other healthcare settings, particularly smaller hospitals or primary care facilities with different resource availability and patient populations. The cross-sectional design restricts our ability to establish causal relationships between the identified factors and delays in primary percutaneous intervention. Additionally, the study relied on patient recall for documenting certain delay factors, which may have introduced recall bias, particularly regarding the exact timing of symptom onset and reasons for delayed presentation. The sample size of 176 patients, while adequate for initial analysis, may have limited statistical power to detect weaker associations between demographic variables and delay factors. Furthermore, we did not collect detailed information on other potentially relevant variables such as distance from the hospital, ambulance availability in different regions, or specific socio-cultural beliefs that might influence healthcare-seeking behavior. The lack of follow-up data prevents us from assessing the long-term clinical outcomes associated with these delays, which would provide valuable insights into the prognostic significance of different delay factors.

CONCLUSION

Our study has concluded that patient-related factors, particularly misinterpretation of cardiac symptoms, consent delays, and transportation difficulties, constitute the primary barriers to timely primary percutaneous intervention in patients with ST-elevation myocardial infarction, while healthcare system factors such as diagnostic delays and catheterization laboratory readiness play a minimal role in our tertiary care setting.

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