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Original Article

Time to Treatment Delay and Clinical Indicators in Patients with ST-Segment Elevation Myocardial Infarction: A Descriptive Cross-sectional Study

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Abstract

Introduction: ST-segment elevation myocardial infarction (STEMI) continues to be a significant global health issue, necessitating ongoing monitoring of care processes to enhance quality. This study aimed to examine time to treatment delay and clinical indicators in patients with STEMI undergoing primary percutaneous coronary intervention (PPCI).

Methods: This descriptive cross-sectional study was conducted with the recruitment of 313 patients with STEMI treated with PPCI Tabriz (Iran) in 2023. Data were analyzed using descriptive statistics, the Mann-Whitney U test, the Kruskal-Wallis test, the chi-square test, and regression analysis in SPSS v.13 software.

Results: Most of the patients were men and half of them were 60 years old or younger. The median door-to-balloon time [IQR] was 80 [49-140] minutes. The pre-PCI center delay time and treatment delay time were 191 and 310 minutes, respectively. There was a statistically significant association between the patient's place of residence, the admission type in the PCI center, and the pre-PCI center delay time. In addition, there was a statistically significant association between treatment delay time, left ventricular ejection fraction (LVEF), baseline troponin I level, angioplasty outcome, and receiving acute coronary syndrome (ACS) drugs at the pre-PCI center.

Conclusion: The longer pre-PCI center delay time resulted in a longer total treatment delay. To reduce delays, it is proposed to improve the logistics surrounding these procedures for patients with STEMI and to provide appropriate education about the STEMI management program to all stockholders.

Introduction

ST-segment elevation myocardial infarction (STEMI) is the most severe manifestation of acute coronary syndrome (ACS) and a life-threatening condition, accounting for approximately 25–40% of acute myocardial infarction (MI) cases.[1] The standard treatment is to restore blood flow promptly to prevent myocardial necrosis, reduce heart failure, and ultimately increase patient survival. The prognosis depends on the area affected and the speed of reopening of the blocked artery. Therefore, the timing of diagnosis and initiation of treatment plays an important role in preventing complications and mortality, including mechanical or primary percutaneous coronary intervention (PPCI) and fibrinolytic therapy. Research and guidelines recommend PPCI as a standard treatment for STEMI, provided facilities and equipment are available on time.[2-4] In parallel with the increase in the number of PPCI in developing countries from 24% in 2007 to 35% in 2013, a significant decrease in STEMI mortality from 11.7% to 7.5% was observed.[5] Based on the findings of a study conducted in South Africa, the mortality rate in STEMI patients was higher due to the increasing number of ACSs and the lack of hospitals that had PPCI units and appropriate specialists.[6] According to guidelines for developing countries, the door-to-balloon time for patients presenting with STEMI to a PPCI-capable hospital should be 60–90 minutes or less.[7]

In Iran, cardiovascular diseases are one of the leading causes of death, and the Ministry of Health has established a committee to facilitate rapid access to PPCI and standardize STEMI treatment services according to a national program such as Code 247. Significant efforts have been made to improve time management and quality of care as part of this program implementation guidelines. These include the use of telecardiology devices in emergency medical services (EMS) ambulances and PCI-capable hospitals, specialized dispatching, timely cardiology visits, and training of treatment team personnel, including nurses and other stockholders.[2,8] However, based on the resources available to researchers, studies on

time interval components and clinical outcomes related to the quality of care and treatment of patients with STEMI are limited in this country.

In a study in Mazandaran, 59% of patients with acute MI presented to the hospital within the first three hours of symptom onset, and the average time to admission was approximately four hours.[9] There is a gap and need to increase patients' awareness of heart disease, its symptoms, and its risks through public education so that patients can make timely decisions and seek medical care without delay.[10] Another study reported that a history of hypertension, sex, education level, the way the patient comes to the emergency room, and low-intensity chest pain were important factors in delaying the presentation of patients with acute MI.[11] Results from a study in Sanandaj, Iran, showed that electrocardiography took an average of 4 minutes, diagnosis of acute MI took 19 minutes, and door-to-balloon treatment took an average of 108 minutes, which is higher than standard values.[12] Another study in Qazvin found that the implementation of Code 247 guidelines in the hospital's emergency department and the training of medical and nursing staff significantly reduced door-to-balloon time for patients with STEMI from 87 to 63 minutes.[7] The results of a secondary analysis study conducted on registered data in Tehran demonstrated that only 20.5% of patients had symptom-to-door times of less than or equal to 90 minutes. Furthermore, 24.5% of the patients had symptom-to-balloon times of less than or equal to 180 minutes. Prolonged symptom-to-balloon times were associated with serious cardiac complications in the hospital.[13]

Examining and considering regional differences is vital for health system managers and policymakers, therefore there is a gap in existing knowledge about care processes and outcomes for STEMI patients in other regions of Iran. In addition, some important temporal factors and clinical indicators throughout the care process that may influence patient management and outcomes have not been fully described. There is a need for studies to address these knowledge gaps by examining a broader range and more details on time intervals and clinical parameters associated with STEMI management. In doing so, it will provide deeper insight into the local patient care pathway and identify potential areas for improvement. Focusing on a setting that has not been studied also contributes to a new understanding of best practices for optimizing the quality of care. Therefore, the present study aimed to investigate all components of time to treatment delay and its association with the clinical indicators of patients treated with PPCI for STEMI who were admitted to the emergency department of the Madani Hospital in Tabriz.

Materials and Methods

Design and Samples

The present study is a descriptive cross-sectional study conducted in 2023 a referral and PCI-capable hospital – in Tabriz, Iran. The sampling process began on October 23, 2023, and ended on April 5, 2024. During this period, all eligible patients were screened and included in the study until the estimated sample size was reached. Taking into account door-to-balloon time with a mean = 80 minutes and standard deviation = 10 obtained for the pilot study, precision (5% mean), $\alpha = 5\%$, and $\beta = 2\%$ the sample size was calculated as 284 using the G-Power software, and 313 people were ultimately recruited to take into account a potential withdrawal of 10%. Inclusion criteria included (*a*) STEMI diagnosis based on an initial 12-lead ECG interpreted and confirmed by a cardiologist with a decision for PPCI. STEMI patients were defined as patients with symptoms suggestive of ACS, significant ST-segment elevation of at least 0.1 mV in 2 or more contiguous leads (at least 0.2 mV in V1-V3). (*b*) Absence of background medical conditions that have a significant impact on mortality, including acute heart failure, congenital heart disease, end-stage renal disease, or advanced cancer, based on medical history. (*c*) Come to the emergency department of this hospital maximum 24 hours after the onset of acute chest pain. Exclusion criteria included (*a*) patient refusal to continue PCI treatment after transfer to the catheterization laboratory. (*b*) Cancellation of PPCI for other reasons after transfer of the patient to the catheterization laboratory. (*c*) Incomplete data collection of over 10% of questionnaire items.

Data Collection Tools

Demographic and Clinical Characteristics

The following demographic variables were collected using a standardized form: gender (male/female), age (years), marital status (single, married, divorced, and widowed), education level (illiterate, elementary school, and university), insurance status (yes/no), place of residence (urban/rural), income-cost ratio (equal, more than, and less than), admission type (directly to the PCI center, referred via the pre-hospital EMS system, and referred from other hospitals), admission shift (day/night), knowledge of the pre-hospital EMS system program for STEMI (yes/no), and length of hospital stay (days).

Data Collection Tools for Time and Clinical Measures

A separate form was used to record time and clinical indicators. Based on the context and objectives of the study, the time intervals include the time from the onset of chest pain to arrival at the triage unit of the emergency department of this hospital (delay time before the PCI center), the time from the door to the balloon or device, and the treatment delay time. Treatment delay time is defined as the time between the onset of symptoms and the balloon time.

According to the National STEMI Management Program guidelines (2) or Code 247, clinical indicators measured in this study included baseline troponin I level, the extent of coronary artery involvement (single

or multi-vessel disease), angioplasty outcome (successful vs failed) based on the catheterization report, in-hospital morbidity (stroke, recurrent MI, and major bleeding), left ventricular ejection fraction (LVEF) before discharge, and in-hospital mortality (yes/no).

All patients were screened for comorbid conditions, triaged using the Emergency Severity Index (ESI), and their chest pain level was determined using an 11-point numerical scale (0-10). Zero means "no pain," and 10 means "the worst possible pain" (mild pain (1-3), moderate (4-6), and severe (7-10)). Hypertension is defined as systolic blood pressure ≥ 140 mm Hg and/or diastolic blood pressure ≥ 90 mm Hg and/or taking anti-hypertensive medication. Baseline troponin I levels (ng/mL) were measured in the laboratory using an enzymatic immunoassay method under standardized conditions (including identical sample handling, a single analyzer and kit lot, and a single analyzer). The expected normal value is ≤ 0.5 ng/ml and a value of ≥ 1 ng/ml indicates acute MI. LVEF was measured by a cardiologist using Samsung HS40 echocardiography and classified on a 5-point scale (not performed, normal > 55%, mild 55%-45%, moderate 45%-30%, severe < 30%) the day before discharge by a cardiologist.[14-17]

Validity and Reliability

Before using the demographic and clinical index recording form, its face validity and content validity were assessed. For this purpose, the forms were distributed to 15 faculty members of the Tabriz Nursing and Midwifery School and after obtaining their opinions, necessary corrections were made to the questionnaires. To assess the reliability of the clinical index recording form, the inter-rater agreement method was used. For this purpose, in a pilot study, the information of 20 patients with acute MI who were admitted to the emergency department and met the inclusion criteria for the study was provided to two evaluators at different times so that they could extract the desired information through observation of the data and enter it into the form. Cohen's kappa (0.86) was calculated for nominal data indices and interclass correlation coefficient (0.92) for quantitative data, obtaining an acceptable value. Calibration of the serum troponin I meter and echocardiography were performed according to the manufacturer's guidelines.

Data Collection

To gather data for the research, two nurses were selected as research assistants, in addition to the lead researcher, and were provided with the necessary training. This included training on observing and recording the research variables. They visited the selected PCI center during both day and night shifts and identified all eligible patients. They interviewed the patients, observed the care process, and reviewed their medical records to extract the desired variables and record them on the appropriate form. Time indicators were measured and recorded after adjusting the clock to Tehran time and observing the relevant events. To determine serum troponin I levels before PCI, venous blood samples were collected from patients upon admission to the emergency department and sent to the laboratory. Additionally, during the patient's hospitalization until discharge, LVEF, mortality rate, and PCI outcome were observed and recorded in the clinical indicators form.

Statistical Analysis

The collected data were analyzed using descriptive and inferential statistics using SPSS software (Version 13). Continuous data were presented as mean with standard deviation or median with interquartile range and categorical data as counts with percentages. The Kolmogorov-Smirnov test is used to test the normality of the data distribution ($P < 0.05$). The Mann-Whitney U test and the Kruskal-Wallis test were used for continuous variables and the chi-square test was used for categorical variables. Linear and multiple regression analysis was used to evaluate the association between treatment delay time and pre-discharge LVEF and other clinical measurements related to ischemia time. In all statistical analyses, $P < 0.05$ was considered the level of statistical significance.

Results

Most of the patients with STEMI were men and half of them were 60 years old or younger. The median door-to-device time [IQR] was 80 [49-140] minutes. The pre-PCI center delay time and treatment delay time were 191 [112-313] and 310 [203-476] minutes, respectively. The results of the Mann-Whitney U test and the Kruskal-Wallis test showed a statistically significant association between the patient's place of residence, the admission type in the PCI center, and the pre-PCI center delay time ($P < 0.001$). In addition, there was a statistically significant association between treatment delay time, LVEF, baseline troponin I level, angioplasty outcome, and receiving ACS drugs at the pre-PCI center ($P < 0.001$). After PCI, the average length of hospital stay for patients was 4.64 (1.01) days. Tables 1-2 show further details about patients with STEMI demographics and clinical characteristics with time and clinical indicators.

In further analysis, chi-square test results showed a statistically significant relationship between place of residence, admission type in the PCI center, receiving ACS drugs at the pre-PCI center, baseline troponin I, pre-discharge LVEF, and angioplasty outcome with treatment delay time ($P < 0.001$).

To incorporate the identified significant variables, the study first assessed the dependent variables, pre-PCI delay time and treatment delay time, for Z skewness and Z kurtosis, yielding respective values of 14.42 and 15.20 for the former, and 11.42 and 9.28 for the latter. These values exceeded recommended thresholds, indicating

Table 1. Demographics of patients with STEMI and pre-PCI center delay time

Variables	No. (%)	Mean rank, hour	*P*
Sex			
Male	245(78.3)	157.60	0.825[a]
Female	68(21.7)	154.85	
Age>60 years			
Yes	155 (49.5)	159.42	0.639 [a]
No	158 (50.5)	154.62	
Marital status			
Single	17 (5.4)	159.91	0.669[b]
Married	263 (84)	154.74	
Divorced	3 (1)	147.50	
Widowed	30 (9.6)	176.15	
Education level			
Illiterate	43 (13.7)	165.20	0.067 [b]
Elementary	133 (42.5)	166.64	
High school	108 (34.5)	151.92	
University	29 (9.3)	119.55	
Insurance status			
Yes	305 (97.4)	155.86	0.168 [a]
No	8 (2.6)	200.50	
Place of residence			
Urban	239 (76.4)	141.87	<0.001
Rural	74 (23.6)	203.57	
The income-to-cost ratio			
Equal	208 (66.5)	154.25	0.132[b]
More than	30 (9.6)	136.40	
Less than	75 (24)	172.58	
Admission type in PCI center			
Directly to the PCI center	80 (25.6)	159.79	<0.001[b]
Transferred by pre-hospital EMS system	129 (41.2)	122.64	
Transferred from other hospitals	104 (33.2)	197.47	
Admission shift			
Day	198 (63.3)	151.99	0.198 [a]
Night	115 (36.7)	165.63	
Aware of the pre-hospital EMS system program for STEMI			
Yes	10 (3.2)	179.80	0.418 [a]
No	303 (96.8)	156.25	
Pre-PCI center delay time min, Median [IQR]			
Total	313 (100)	191[IQR 112-313]	

STEMI: ST-segment elevation myocardial infarction; PPCI: Primary percutaneous coronary intervention; EMS: Emergency medical service; Min: minutes; IQR: Interquartile range.
[a] Mann-Whitney U test; [b] Kruskal-Wallis test.

non-normal distributions. Consequently, the variables were transformed using the natural logarithm (LN) and re-evaluated for normality, resulting in values of -1.43 and 0.85 for the first variable, and -1.21 and 0.66 for the second variable, which fell within acceptable ranges for normality.

Table 3 presents the regression analysis outcomes revealing that variables such as admission type, place of residence, receiving ACS drugs at the pre-PCI center, and baseline troponin I level exhibit statistically significant effects on the dependent variables. Upon examination of the standardized beta coefficients, it becomes apparent that the influence of admission type surpasses that of place of residence. To further explore these relationships and assess their implications across different categories, these variables were subsequently incorporated into a multiple regression model.

Table 4 presents the results of the multiple regression analysis concerning the variables categorized by classes. The findings indicate that individuals admitted through Code 247 experienced a statistically significant decrease of 0.460 units in pre-PCI center delay time compared to those referred from another center ($P<0.001$). Similarly, residents in the city exhibited a statistically significant reduction of 0.321 units in pre-PCI center delay time compared to those living in rural ($P=0.152$). Additionally, individuals received medication before hospitalization demonstrated a statistically significant decrease of 0.324 units in treatment delay time compared to those who did not ($P<0.001$). Moreover, individuals with elevated troponin levels experienced a statistically significant increase of 0.275 units in treatment delay time compared to those with normal levels ($P<0.001$).

Discussion

In this study, the pre-PCI center delay time and total treatment delay time for patients with STEMI were longer than the standard recommended times. However, the door-to-balloon time was less than 90 minutes, the recommended value for quality care in Iran. A longer treatment delay time was defined if the time between symptom onset and balloon time was more than 180 minutes.[2] Then, the longer pre-PCI center delay time resulted in a longer total treatment delay time. The shorter door-to-balloon time suggests that this referral PCI center physicians and nurses followed guidelines. Adherence to guideline-based therapy improves the quality of care. Inconsistently, the results of a study in a different context in Iran showed that the average door-to-balloon time was longer than the recommended value.[12]

The results of further data analysis showed an association between the patient's place of residence and the admission type with the pre-PCI center delay time and treatment delay time. These time delays were longer for patients who reside in rural areas and were shorter for patients who were transferred to PCI center by pre-hospital EMS system ambulance equipped with telemedicine (or Code 247). These results suggest that pre-hospital EMS managers and staff adhere to STEMI management program guidelines, and it may be a good option to reduce out-of-hospital

Table 2. Treatment delay time and clinical measures of patients with STEMI treated with PPCI

Variables	No. (%)	Mean rank, hour	*P* value
Admission type in PCI center			
Directly to the PCI center	80 (25.6)	158.03	
Transferred by pre-hospital EMS system	129 (41.2)	127.41	<0.001[b]
Transferred from other hospitals	104 (33.2)	192.91	
Place of residence			
Urban	239 (76.4)	141.99	<0.001[a]
Rural	74 (23.6)	2003.18	
Triage level (ESI)			
1	16 (5.1)	153.47	
2	295 (94.2)	157.70	0.488[b]
3	2 (0.6)	81.50	
Receiving ACS drugs at the pre-PCI center			
Yes	76 (24.3)	115.72	<0.001[a]
No	237 (75.7)	170.24	
Comorbid conditions			
No	128 (41.2)	154.86	
Hypertension and/or diabetes	140 (45)	160.36	0.780[b]
Previous MI	20 (6.4)	140.15	
Other	23 (7.4)	149.59	
Chest pain severity			
Mild	19 (6.1)	151.84	
Moderate	175 (55.9)	155.56	0.891[b]
Sever	119 (38)	159.94	
Baseline troponin I level			
Elevated	238 (76)	168.50	<0.001[a]
Normal	75 (24)	120.52	
The extent of coronary artery involvement			
Single	126 (40.3)	159.34	0.708[a]
Multi-vessel disease	187 (59.7)	155.43	
Angioplasty outcome			
Successful	289 (92.3)	152.49	<0.001[a]
Failed	24 (7.7)	211.25	
In-hospital morbidity			
No	305 (97.4)	155.21	
Recurrent myocardial infarction	6 (2)	200.08	0.169[b]
Major bleeding	2 (0.6)	287	
LVEF			
Normal	42 (13.4)	114.87	
Mild	140 (44.7)	153.87	<0.001[b]
Moderate	98 (31.3)	169.08	
Sever	33 (10.5)	188.03	
In-hospital mortality			
Yes	2 (0.6)	197.25	0.528[a]
No	311 (99.4)	156.74	
Duration of hospital stay > 3 days			
Yes	287 (91.7)	155.29	0.267[a]
No	26 (8.3)	175.85	
Treatment delay min, Median [IQR]			
Total	313(100)	310[IQR 203-476]	

LVEF: Left ventricular ejection fraction; STEMI: ST-segment elevation myocardial infarction; EMS: Emergency medical service; ACS: Acute coronary syndrome; PPCI: Primary percutaneous coronary intervention; ESI: Emergency severity index.
[a] Mann-Whitney U test; [b] Kruskal-Wallis test.

Table 3. Linear regression coefficients for predictors of pre-PCI center delay time and treatment delay time

Variable	β	Beta*	t	*P* value
Admission type[J]	0.234	0.237	3.75	<0.001
Place of residence[J]	0.311	0.156	2.46	0.014
Receiving ACS drugs at the pre-PCI center[K]	0.282	0.191	3.22	0.001
Baseline troponin I level[K]	0.019	0.160	2.88	0.004
Angioplasty outcome[K]	0.257	0.108	1.91	0.056
LVEF[K]	0.036	0.048	0.78	0.432

LVEF: Left ventricular ejection fraction; ACS: Acute coronary syndrome; PCI: percutaneous coronary intervention.
*Standardized coefficient; J: Ln Pre-PCI center delay time as a dependent variable; K: Ln treatment delay time.

Table 4. Results of multiple regression analysis: Effect of independent variables categories on pre-PCI center delay time and treatment delay time

Variable	β (95% CI)	*P* value
Admission type[J]		
Transferred by pre-hospital EMS system	-0.460 (- 0.706, - 0.214)	<0.001
Directly to the PCI center	-0.188 (-0.444, 0.69)	0.152
Transferred from other hospitals	Reference category	
Place of residence[J]		
Urban	-0.321 (-0.572, -0.71)	0.012
Rural	Reference category	
Receiving ACS drugs at the pre-PCI center[K]		
Yes	-0.324 (-0.483, -0.166)	<0.001
No	Reference category	
Baseline troponin I level[K]		
Elevated	0.275 (0.116, 0.435)	<0.001
Normal	Reference category	

EMS: Emergency medical services; ACS: Acute coronary syndrome; PCI: percutaneous coronary intervention.
J: Ln Pre-PCI center delay time as a dependent variable; K: Ln treatment delay time.

time delays as a problematic component of time delays.[9,11] Pre-hospital EMS teams could be deployed in rural areas to conduct early ECGs and initiate on-site treatment. Establishing telemedicine capabilities for remote ECG interpretations and consultations may also help initiate timely reperfusion therapies. Upgrading ambulances

with basic life support and monitoring equipment tailored for STEMI patients can minimize on-scene and transport times.

The results of a study from Saudi Arabia consistently reported that pre-hospital delay times were shorter in patients transported by pre-hospital EMS ambulance.[10] However, in this study, most patients reported that they were unaware of the EMS system's national program for STEMI treatment. In one study, patients reported that ignorance of coronary artery disease and self-medication were the most common causes of delays in emergency arrival.[18] Patients with chest pain should contact the pre-hospital emergency system for urgent help or go to a hospital emergency preferably directly to a PCI-capable center on time.[19] In this regard, public education campaigns through mass media, social networks, and local clinics can boost awareness of STEMI symptoms and emphasize the need to immediately call EMS.

Patients who were transferred to the PCI center from other non-PCI-capable hospitals experienced longer delays. These results suggest a need for further research about the inter-hospital patient transfer process and facilities, greater adherence to guidelines by all non-PCI-capable hospital emergencies, and appropriate education for managers, physicians, and nurses. In this regard, standardizing transfer protocols through collaborative agreements between PCI and non-PCI centers, clarifying responsibilities, communication processes, and dedicated transfer routes/vehicles can simplify the process. Implementing regional STEMI networks where PCI-capable centers accept transfers 24 hours a day may shorten pre-PCI delay times, appropriate STEMI management, timely PCI, and improve patient care. In this context, it is of course worth noting that there are still some limitations in developing countries, including transport delays, a limited number of primary PCI centers, the lack of well-established a communication network between centers, and financial problems.[20]

Treatment delay time is a measure and estimate of total myocardial ischemia time. The results of this study showed that prolonged treatment time is associated with decreased LVEF, increased baseline troponin I, and increased angioplasty failure. These results highlight the importance of shortening treatment time and timely PPCI for maintaining normal myocardial function in patients with STEMI and preventing adverse effects. Consistent with these findings, in a study conducted by Nozari et al the symptom-to-balloon time was longer and associated with more frequent in-hospital serious adverse cardio-cerebrovascular events.[13] The results of one-year follow-up in patients with STEMI who underwent PPCI showed that longer ischemia duration was significantly associated with a combination of death, re-hospitalization, and revascularization.[21] Healthcare providers should also consider that while reducing time delays in the treatment of STEMI is crucial, it represents only one part of a very complex medical care chain. Because of other effective factors, shorter time delays may not necessarily produce better results. They should treat sicker patients and patients with high-risk features, including acute heart failure, congenital heart disease, end-stage renal disease, or advanced cancer, by introducing them to the best available treatment options on time.[22]

This region of Iran still does not have a uniformly organized national cardiology data registry like other societies. It was then impossible to access and evaluate more detailed time interval components and outcomes in other non-PCI-capable hospitals. In our opinion, this deserves to be one of the highest priorities of all healthcare providers in this country. In the present study, based on the objectives, we recruited patients with STEMI who were undergoing PPCI, and patients with a history of PCI and a history of thrombolytic drug use were not included in the study. Therefore, this issue needs to be considered when generalizing research results as well as when designing and conducting future studies.

Conclusion

In this study the longer pre-PCI center delay time resulted in a longer total treatment delay time than recommended standards. Efforts should be made to timely PPCI and improve the quality of care. In this regard, it is suggested to improve the logistics surrounding these procedures for patients with STEMI, especially those who reside in

Research Highlights

What is the current knowledge?

- STEMI is an important cause of morbidity and mortality worldwide.
- The most effective way of reducing morbidity and mortality from STEMI is by PPCI at the earliest possible time.
- Care processes must be monitored regularly to identify areas for quality improvement in STEMI care.

What is new here?

- This study showed that there were substantial delays with a median door-to-balloon time of 80 minutes, a pre-PCI center delay of 191 minutes, and a total treatment delay of 310 minutes.
- Significant associations were identified between the patient's residential location, admission type, and pre-PCI delay times, as well as between treatment delay times and clinical measures such as left LVEF, troponin I levels, angioplasty outcomes, and pre-PCI medication administration.
- To reduce delays, the authors suggest improving logistics and providing appropriate education about STEMI management to all stakeholders.

rural and distant areas. In addition, consideration should be given to providing all stockholders with adequate education about the STEMI management program.

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Author's Contribution

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Competing Interests

The authors declare no conflicts of interest.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

This study was approved by the Regional Research Ethics Committee at the Tabriz University of Medical Sciences (Code: IR. TBZMED. REC.1401.956). Also, to collect the data, the necessary coordination with the relevant officials was made. While providing the necessary explanations to patients, their informed consent to participate in the study was obtained. The principle of data confidentiality was respected by the researchers. The research reported in this paper adhered to STROBE guidelines (https://www.equator-network.org/reporting-guidelines/strobe/).

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