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Predicting treatment outcomes by door-to-device time and baseline characteristics in STEMI patients undergoing PPCI: a cross-sectional study in southern Iran

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Abstract

BACKGROUND: Primary percutaneous coronary intervention (PPCI) is considered the gold standard for ST-elevation myocardial infarction (STEMI) treatment. While door-to-device (DTD) time critically influences outcomes, its combined impact with baseline characteristics requires further investigation.

METHODS: In this descriptive cross-sectional analytical study, 163 patients with STEMI undergoing PPCI were recruited through convenience sampling at two hospitals affiliated with Ahvaz Jundishapur University of Medical Sciences between November 2024 and May 2025. Data were collected via hospital records and a researcher-designed checklist covering demographic and clinical variables. Statistical analyses were performed using SPSS version 26.

RESULTS: The mean age of participants was 57.55 ± 13.19 years, and 85.9% were male. The mean DTD time was 108.08 minutes. Longer DTD time was significantly associated with prolonged CCU stay ($r = 0.335$, $p < 0.001$) and lower left ventricular ejection fraction (LVEF) ($r = -0.232$, $p = 0.003$). Although DTD time did not differ significantly between survivors and non-survivors ($p = 0.573$), it varied significantly across different degrees of myocardial injury ($p = 0.027$). Multivariate regression analysis showed that male gender ($\beta = -8.007$, $p = 0.002$), increased DTD time ($\beta = -0.043$, $p = 0.005$), and myocardial injury ($\beta = -14.904$, $p = 0.016$) were significantly associated with reduced LVEF. Increased DTD time ($\beta = 0.014$, $p < 0.001$) and decreased LVEF ($\beta = -0.061$, $p = 0.003$) were significantly associated with longer CCU stays.

CONCLUSION: While baseline characteristics showed minimal impact, DTD time significantly predicted worse outcomes, including prolonged CCU stays, reduced LVEF, and myocardial injury. These findings emphasize the critical importance of reducing DTD time (<60 minutes) through optimized emergency protocols to improve STEMI management outcomes.

Keywords: ST Segment Elevation Myocardial Infarction (STEMI); Primary Percutaneous Coronary Intervention (PPCI); Door-to-Device Time (DTD Time); Baseline Characteristics; Treatment Outcomes; Iran

Introduction

Cardiovascular diseases (CVDs) are among the leading causes of death and disability worldwide and contribute significantly to rising healthcare costs[1,2]. Coronary artery disease (CAD) is the most common type of CVD, presenting as Acute Coronary Syndrome (ACS), which can manifest in various forms, including unstable angina, Non–ST Elevation Myocardial Infarction (NSTEMI), and ST Elevation Myocardial Infarction (STEMI)[3]. Among these, STEMI is the most severe form of ACS, responsible for approximately 50–70% of cases of heart failure[4]. Each year, acute myocardial infarction accounts for the deaths of over one million individuals in the United States[5]. In Iran, the incidence of myocardial infarction has been reported to be approximately 5–15% higher than the global average[4]. Timely and effective treatment of patients with STEMI is essential to rapidly restore myocardial perfusion. Primary Percutaneous Coronary Intervention (PPCI) is the preferred reperfusion strategy due to its lower complication rates and superior treatment outcomes[6–8]. Numerous studies have demonstrated that patients undergoing PPCI experience more favorable outcomes compared to those treated with fibrinolysis therapy[8-10].

Despite the high efficacy of PPCI in coronary reperfusion, identifying and controlling factors affecting the success of this method, as well as patient treatment outcomes, are of particular importance. One of the most critical factors is the Door-To-Device (DTD) time. Various clinical guidelines recommend a DTD time of less than 90 minutes to reduce the likelihood of complications and mortality in patients[4,11,12]. In a study conducted in Ahvaz, only 36% of STEMI patients experienced a DTD time of less than 90 minutes[4]. Given the significance of this parameter, shortening the DTD time has been recommended as an effective strategy to improve patient treatment outcomes[3,13].

In addition to DTD time, factors such as age, gender, comorbidities (e.g., diabetes and a history of myocardial injury), smoking, and Glomerular Filtration Rate (GFR) can also influence treatment outcomes after primary angioplasty[14-16]. A systematic review in Iran showed that diabetes, a history of myocardial infarction (MI), advanced age, reduced Left Ventricular Ejection Fraction (LVEF), and involvement of the main coronary artery were associated with an increased risk of major cardiovascular and cerebrovascular complications after PPCI in elderly patients; whereas successful PPCI and high GFR were associated with a reduction in these complications[14]. Additionally, the results of a study by Stanislav Simic et al. (2020) demonstrated that the presence of conditions such as diabetes in STEMI patients can lead to poorer prognoses, including higher mortality and recurrence of cardiovascular events[16].

Although the impact of door-to-device (DTD) time on short-term outcomes in STEMI patients undergoing PPCI has been examined in various studies, the relationship between this parameter and length of hospital stay, in-hospital mortality, left ventricular ejection fraction (LVEF), and myocardial injury along with the simultaneous analysis of demographic and comorbid variables (such as age, gender, diabetes, comorbidities, and socio-economic status) has not been comprehensively studied in the specific patient population attending teaching hospitals in Ahvaz. Additionally, identifying critical DTD thresholds specific to this region, in order to recognize modifiable factors affecting clinical delays that may influence treatment outcomes, requires further research. Therefore, this study was designed to predict treatment outcomes based on DTD time and baseline characteristics in STEMI patients undergoing PPCI in 2024 in Ahvaz (Southern Iran).

Methods

Study Design

This research was a prospective descriptive-analytical study aimed at predicting treatment outcomes based on DTD time and baseline characteristics in STEMI patients undergoing PPCI at two hospitals affiliated with Ahvaz University of Medical Sciences in 2024.

Study Population

In this study, 163 STEMI patients undergoing PPCI were selected based on inclusion criteria using convenient sampling from November 2024 to May 2025 at two hospitals affiliated with Ahvaz University of Medical Sciences (Golestan and Imam Khomeini Hospital). Inclusion criteria for this study were definitive diagnosis of STEMI based on ESC 2023 criteria, PPCI performed at the studied teaching hospitals, informed consent from the patient or legal guardian, and age above 18 years. Exclusion criteria included missing essential data in medical records, fibrinolysis performed prior to PPCI, and refusal to continue participation in the study. In this study, the sample size of 163 was calculated using Cochran's formula based on a similar study[4] (SD=9.78, μ=37.86) with a 95% confidence level and 4% precision:

$n = (1.96×9.78)^2/(0.04×37.86)^2 = 163$

Data Collection Tools and Methods

In this study, data were collected using a two-part researcher-designed checklist: (1) baseline characteristics information (age, gender, BMI, medical history including cardiovascular disease, diabetes, hypertension, hyperlipidemia, DTD time, and smoking) and (2) treatment outcomes (length of Coronary Care Unit (CCU) stay, myocardial injury, LVEF, GFR, and in-hospital mortality). The researcher visited the Cath Lab and CCU wards daily, identified eligible patients, and collected data through four complementary methods: (a) review of medical records, (b) interviews with patients or their companions, (c) direct observation, and (d) final confirmation by a cardiologist. Specific parameters such as DTD time were based on times recorded in medical records and Cath Lab reports, LVEF and myocardial injury were determined through echocardiography reports, and GFR was calculated using the CKD-EPI formula[15] based on baseline creatinine levels. The validity of the instrument was confirmed through the opinions of 10 cardiology and biostatistics specialists, and its reliability was confirmed by test-retest (ICC=0.89). All measurements were performed according to hospital standard protocols and recorded in the dedicated forms.

Data Analysis

Data were analyzed using SPSS version 26 (IBM Corp.) with statistical significance set at $p<0.05$. Normality was confirmed using Shapiro-Wilk tests ($p>0.05$ for all variables). Descriptive statistics included means±SD for normally distributed continuous variables and frequencies (%) for categorical variables. Bivariate analyses employed (1) Pearson's correlation for continuous variables, (2) independent t-tests/ANOVA for group comparisons of normally distributed data, (3) Mann-Whitney U/Kruskal-Wallis tests for non-parametric data, and (4) χ^2/Fisher's exact tests for categorical variables. Multiple linear regression analyses were performed to identify independent predictors of the study outcomes (length of CCU stay and LVEF). The sample included 163 patients with 12 independent variables per model (≈13.6 observations per predictor), meeting the commonly accepted criterion for sample adequacy. Model assumptions were verified before interpretation: all Variance Inflation Factor (VIF) values were <3 (no multicollinearity), the normality and homoscedasticity of residuals were verified through Normal P–P plots and scatterplots of standardized residuals versus predicted values, respectively, and the Durbin–Watson statistic (1.87) confirmed independent errors. These results confirmed that the regression models were statistically valid. Effect sizes were reported with 95% confidence intervals. Bonferroni correction addressed multiple comparisons where appropriate. All analyses were conducted as intention-to-treat with two-tailed significance testing.

Results

Descriptive Statistics

This study was conducted on 163 patients with a mean age of 57.55±13.19 years, of whom 140 (85.9%) were male and 23 (14.11%) were female. The mean age of male patients was 56.44±13.39, and the mean age of female patients was 64.30±9.57. The average Body Mass Index (BMI) was 27.77±7.06, and the mean DTD time was 108.08±54.61 minutes. Twenty-three (14.11%) patients had a DTD time of less than 60 minutes, 44 (28.22%) had between 60 and 90 minutes, and 96 (58.89%) had more than 90 minutes. In terms of comorbidities, 67 (41.1%) patients had diabetes mellitus, 79 (48.5%) had hypertension, 55 (33.7%) had hyperlipidemia, and 52 (31.9%) had a history of cardiovascular disease. Moreover, 97 (59.5%) patients had a history of smoking. The mean length of CCU stay was 3.66±2.61 days, and the mean LVEF was 37.15±10.62. The in-hospital mortality rate was 9 (5.5%). Regarding myocardial injury degree, 3 (1.85%) patients exhibited akinesia, 119 (73.0%) had hypokinesia, and 41 (25.15%) showed no regional wall motion abnormalities. The most common type of myocardial infarction was inferior infarction in 70 (42.9%) patients, followed by anterior infarction in 64 (39.3%). The Left Anterior Descending (LAD) artery was the most frequently involved vessel, observed in 95 (58.3%) cases (Table 1).

Table 1. Baseline and Procedural Characteristics of the Study Participants (N=163)

Variables	Category	Mean ±SD / Frequency (%)
Male gender N (%)	-	140 (85.9%)
Diabetes, N (%)	-	67 (41.1%)
Smoking, N (%)	-	97 (59.5%)
Hyperlipidemia, N (%)	-	55 (33.7%)
Hypertension, N (%)	-	79 (48.5%)
Heart Disease History, N (%)	-	52 (31.9%)
Age Mean ±SD	Male	56.44±13.96 (Years)
	Female	64.30±9.57 (Years)
	Total	57.55 ±13.19 (Years)
Weight Mean ±SD	-	78.36 ±11.02 (Kg)
Height Mean ±SD	-	170.80 ±6.30 (Cm)
BMI Mean ±SD	-	27.77 ±7.06 (kg/m²)
GFR Mean ±SD	-	72.92 ±22.49 (ml/min)
DTD Time Mean ±SD	-	108.08 ±54.613 (min)
DTD Time (min) N (%)	<60	23(14.11%)
	60-90	46(28.22%)
	>90	96(58.89%)
LVEF Mean ±SD)	-	37.15 ±10.62
length of CCU stay Mean ±SD	-	3.66± (2.61 (Days)
In-hospital Mortality, N (%)	-	9 (5.5%)
Myocardial Injury, N (%)	Akinesia	3 (1.85%)
	Hypokinesia	119 (73.0%)
	No Injury	41 (25.15%)
MI Type, N (%)	Inferior	70 (42.9%)
	Extensive	18 (11%)
	Anterior	64 (39.3%)
	Anterolateral	6 (3.7%)
	Lateral	5 (3.1%)
Infract-related coronary artery, N (%)	LAD	95 (58.3%)
	RCA	50 (30.7%)
	LCX	11 (6.7%)
	OM	6 (3.7%)
	PLV	1 (0.6%)

SD= Standard Deviation

Analytical Statistics

The results of Pearson's correlation test indicated that an increase in DTD time was significantly associated with a longer length of stay in the CCU (r=0.335, p<0.001) and a decrease in LVEF (r=-0.232, p=0.003) (Figures 1 and 2). Although DTD time did not show a statistically significant difference between non-survivor patients and those who survived (p=0.573), it was significantly different among patients with

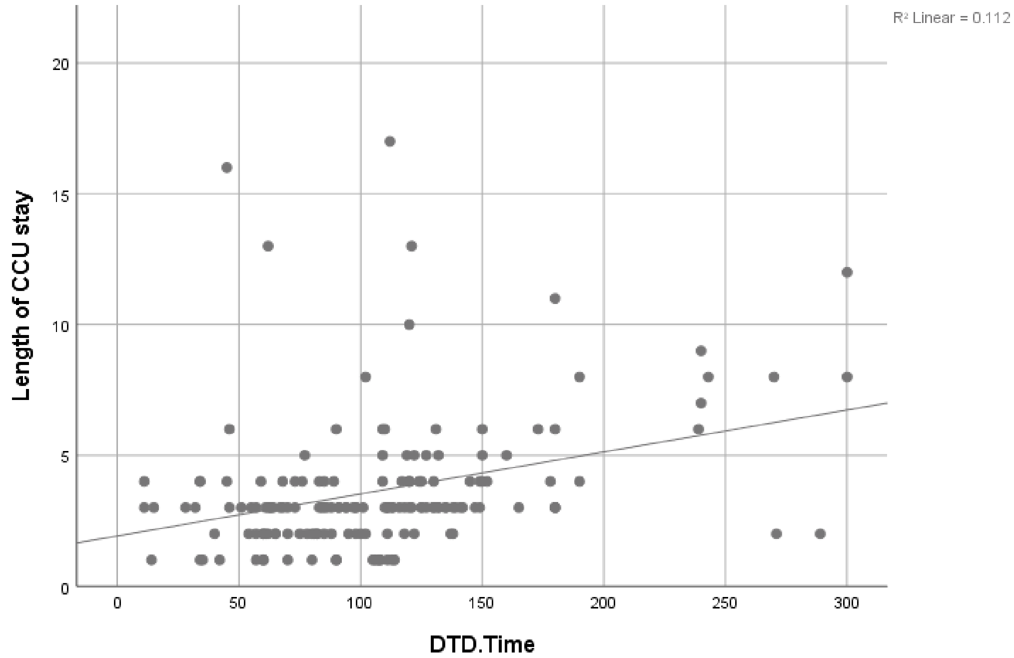

Figure 1. Simple Scatter with Fit Line of length of CCU stay by DTD.Time

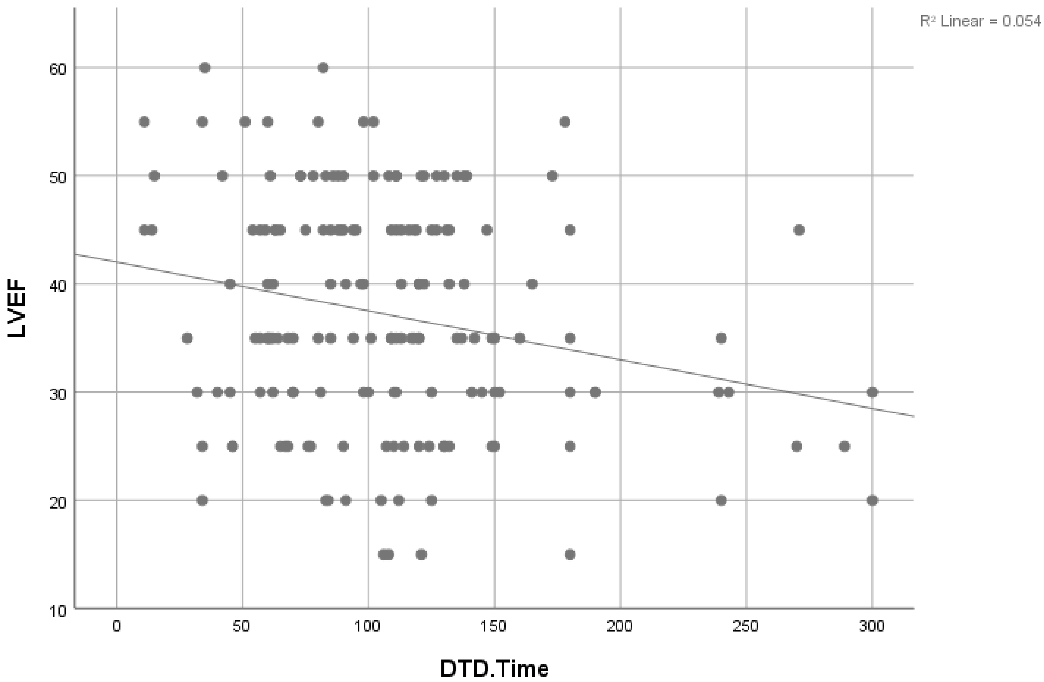

Figure 2. Simple Scatter with Fit Line of LVEF by DTD.Time

varying degrees of myocardial injury (p<0.027). Specifically, patients without myocardial injury had the shortest DTD time, while those with myocardial akinesia had the longest (Table 2).

Baseline demographic and clinical characteristics of the patients according to mortality status and the degree of myocardial injury are summarized in Table 3. No significant differences were found between survivors and non-survivors in terms of age, BMI, GFR, or any of the categorical variables (all p>0.05). Likewise, when comparing patients across myocardial injury subgroups (akinesia, hypokinesia, and no injury), no significant differences were observed in any of the evaluated parameters.

The results of the independent t-test indicated that the mean length of CCU stay and LVEF did not show significant differences between patients with and without a history of cardiovascular disease, diabetes, smoking, hyperlipidemia, and hypertension (all p>0.05). Additionally, no significant relationship was found between gender and length of CCU stay (p=0.104), but the mean LVEF was significantly higher in women than in men (p=0.004). On the other hand, Pearson's correlation test showed no significant relationship between age, BMI, and GFR with length of stay in the CCU or LVEF (all p>0.05). The only near-significant correlation was observed between BMI and LVEF (p=0.052) (Table 4).

The results of multiple linear regression analysis revealed that two variables, DTD time and LVEF, were significantly associated with the

Table 2. Analysis of In-Hospital Outcomes according to Door-to-Device Time (N=163)

Variable		DTD Time (Mean Rank / r)	P-value
In-hospital Mortality	No	81.50	0.573[a]
	Yes	90.61	
Myocardial Injury degree	Akinesia	124.50	0.027[b]
	Hypokinesia	85.99	
	No Injury	67.32	
length of CCU stay		0.335	<0.001[c]
LVEF		-0.232	0.003[c]

[a] Mann-Whitney test, [b]Kruskal-Wallis Test, [c]Pearson correlation test, r=Pearson correlation

Table 3. Comparison of baseline demographic and clinical characteristics according to mortality status and myocardial injury degree (N=163)

Variable	Mortality		Myocardial Injury degree			Mortality	Myocardial Injury degree
	Yes (n=9)	No (n=154)	Akinesia (n=3)	Hypokinesia (n=119)	No Injury (n=41)	P-value	P-value
Age Mean ± SD	54.44 ±14.57	57.73 ±13.13	62.00 ±7.00	56.86 ±13.49	59.26 ±12.72	[a]0.470	[b]0.352
BMI Mean ± SD	24.49 ±4.02	27.96 ±7.15	25.29 ±6.91	28.07 ±7.86	27.06 ±3.82	[a]0.151	[b]0.919
GFR Mean ± SD	61.52 ±22.72	73.58 ±22.37	57.93 ±8.72	73.36 ±22.52	72.08 ±22.99	[a]0.118	[b]0.493
Male Gender, N (%)	8 (5.7%)	132 (94.3%)	3(2.1%)	102(72.9%)	35(25%)	[c]0.616	[c]0.996
Diabetes, N (%)	4 (6%)	63 (94%)	1(1.5%)	51(76.1%)	15(22.4%)	[c]0.989	[c]0.820
Smoking, N (%)	6(6.2%)	91(93.8%)	2(3%)	70(72.2%)	26(26.8%)	[c]0.740	[c]0.599
Hypertension, N (%)	5(6.3%)	74(93.7%)	2(2.5%)	57(72.2%)	20(25.3%)	[c]0.741	[c]0.892
History of Heart Disease N (%)	4(7.7%)	48(92.3%)	2(1.8%)	85(76.6%)	24(21.6%)	[c]0.468	[c]0.305
Hyperlipidemia, N (%)	2(3.6%)	53(96.4%)	0(0%)	39(70.9%)	16(29.1%)	[c]0.507	[c]0.382

[a] In depended t- Test, [b] ANOVA test, [c]Fisher's exact test SD= Standard Deviation

Table 4. Analysis of LVEF and CCU stay according to baseline demographic and clinical variables (N=163)

Variables		LVEF (r / Mean ± SD)	Length of CCU Stay (r / Mean ± SD)	LVEF	Length of CCU Stay
				P-value	P-value
Age		-0.031	0.002	[a]0.694	[a]0.979
BMI		0.153	0.050	[a]0.052	[a]0.529
GFR		0.006	0.010	[a]0.943	[a]0.903
Gender	Female	43.04 ± 9.62	4.48 ±2.71	[b]0.004	[b]0.104
	Male	36.18 ±10.50	3.52 ±2.58		
Diabetes	Yes	36.49 ±10.87	3.96 ±2.86	[b]0.513	[b]0.224
	No	37.60 ±10.48	3.45 ±2.42		
Smoking	Yes	37.01 ±10.54	3.51 ±2.42	[b]0.843	[b]0.372
	No	37.35 ±10.82	3.88 ±2.87		
Hypertension	Yes	38.35 ±10.99	3.46 ±1.93	[b]0.160	[b]0.344
	No	36.01 ±10.20	3.85 ±3.12		
Heart Disease History	Yes	37.40 ±12.22	3.71 ±2.96	[b]0.834	[b]0.855
	No	37.03 ±9.84	3.63 ±2.44		
Hyperlipidemia	Yes	37.55 ±11.17	3.78 ±2.78	[b]0.734	[b]0.664
	No	36.94 ±10.38	3.59 ±2.54		

[a] Pearson correlation test, [b]In depended t- Test, SD= Standard Deviation, r= Pearson correlation

length of CCU stay. Specifically, for each unit increase in DTD time, there was a corresponding average increase of 0.014 units in the length of stay (β=0.014, $p<0.001$). Conversely, each unit increase in LVEF was associated with an average decrease of 0.061 units in the length of stay (β=-0.061, p=0.003). Other independent variables, including gender, diabetes, smoking, hyperlipidemia, hypertension, heart disease, myocardial injury, age, BMI, and GFR, did not have a statistically significant impact on the length of stay (all $p>0.05$). This model explained 21.4% of the variation in length of stay ($R^2=0.214$) (Table 5).

Additionally, the results of multiple linear regression analysis showed that several independent variables were significantly associated with changes in LVEF. Specifically, male gender (β=-8.007, p=0.002) was associated with an average decrease of 8 units in LVEF compared to females. Moreover, each unit increase in DTD time (β=-0.043, p=0.005) was associated with an average decrease of 0.043 units in LVEF. The most significant negative effect was related to myocardial injury (β=-14.904, p=0.016) (akinesia vs. no injury), which led to an average decrease of 14.9 units in LVEF. Given the previous findings regarding the relationship between delays in DTD and myocardial injury, DTD time can still be considered a significant factor in this context. Other variables, such as diabetes, smoking, hyperlipidemia, hypertension, heart disease, age, BMI, and GFR, did not have a statistically significant effect on LVEF (all $p>0.05$). The final model explained 20.6% of the variance in LVEF ($R^2=0.206$) (Table 5).

Discussion

This study aimed to investigate the predictive factors for treatment outcomes in patients undergoing primary angioplasty, and several aspects of the results will be discussed below.

Relationship of demographic characteristics with In-hospital mortality, LVEF, length of CCU stay, and myocardial injury

The present study showed that the age of patients did not have a significant relationship with treatment outcomes, including in-hospital mortality, length of CCU stay, myocardial injury, or LVEF. This finding is in line with the results reported by Farhana Ahmed et al., who also did

Table 5. Multiple Linear Regression Analysis of Factors Associated with Length of CCU Stay and LVEF (N=163)

Parameter			B	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Length Of CCU Stay a. R Squared = .214 (Adjusted R Squared = .146)	Intercept		6.012	0.010	1.449	10.575
	Myocardial Injury	Akinesia	0.985	0.521	-2.044	4.014
		Hypokinesia	-0.667	0.153	-1.584	0.250
		No Injury	0[a]	-	-	-
	Heart Disease History	Yes	-0.243	0.578	-1.105	0.618
		No	0[a]	-	-	-
	hypertension	Yes	-0.668	0.132	-1.540	0.204
		No	0[a]	-	-	-
	Hyperlipidemia	Yes	0.371	0.430	-0.556	1.298
		No	0[a]	-	-	-
	Smoking	Yes	-0.394	0.370	-1.260	0.472
		No	0[a]	-	-	-
	Diabetes	Yes	.185	.682	-0.705	1.074
		No	0[a]	-	-	-
	Gender	male	-0.712	0.272	-1.988	0.564
		female	0[a]	-	-	-
	Age		-0.002	0.899	-0.040	0.035
	BMI		-0.002	0.959	-0.060	0.057
	DTD Time		0.014	0.000	0.007	0.022
	GFR		0.001	0.907	-0.021	0.023
	LVEF		-0.061	0.003	-0.101	-0.022
LVEF a. R Squared = .206 (Adjusted R Squared = .142)	Intercept		41.991	0.000	24.700	59.281
	Myocardial Injury	Akinesia	-14.904	0.016	-26.995	-2.813
		Hypokinesia	-3.399	0.071	-7.092	0.294
		No Injury	0[a]	-	-	-
	Heart Disease History	Yes	0.985	0.579	-2.518	4.487
		No	0[a]	-	-	-
	hypertension	Yes	2.953	0.099	-0.564	6.471
		No	0[a]	-	-	-
	Hyperlipidemia	Yes	-1.463	0.444	-5.228	2.302
		No	0[a]	-	-	-
	Smoking	Yes	1.732	0.332	-1.781	5.245
		No	0[a]	-	-	-
	Diabetes	Yes	-1.004	0.584	-4.621	2.613
		No	0[a]	-	-	-
	Gender	male	-8.007	0.002	-13.037	-2.977
		female	0[a]	-	-	-
	Age		-0.036	0.645	-0.188	0.117
	BMI		0.217	0.072	-0.019	0.453
	DTD Time		-0.043	0.005	-0.073	-0.013
	GFR		0.050	0.275	-0.040	0.139

not identify age as an independent predictor of short-term outcomes following PPCI[17]. However, these findings are inconsistent with those of Pedro Paulo Neves de Castro et al., who identified age as a significant predictor of mortality following primary angioplasty[18]. This discrepancy may be attributed to differences in sample size, with their study including a larger patient population (18,834 patients vs. 163 patients in the current study), a higher mean age (72 years vs. 57.55 years in our study), and a higher number of deaths (904 deaths vs. 9 deaths). Furthermore, in the regression analysis, age was not significantly associated with LVEF or the length of CCU stay, confirming the aforementioned descriptive findings.

In terms of demographic variables, the only significant difference observed was in gender, specifically in LVEF, which was higher in women than in men. Multivariate regression analysis also supported this finding, showing that male gender was associated with a decrease in LVEF compared to women. Simon Stewart et al. attributed this finding to structural differences in the heart (smaller ventricles and thinner walls in women) and the protective effects of estrogen[19]. No significant gender differences were observed in other outcomes, such as length of CCU stay and mortality, which is consistent with the findings of Firman Sugiharto et al.[20] However, some studies, such as those by Mohamad Alkhouli[21] and Yolanka Castro-Dominguez[22], have reported higher mortality rates in women.

No significant relationship was found between BMI and treatment outcomes, which is consistent with the findings of Ahmadreza Assareh et al.[4] Furthermore, multivariate regression analysis revealed that BMI had no significant effect on either LVEF or the length of stay in the CCU. These results are in contrast to those reported by Firman Sugiharto et al., who found that a BMI greater than 24.22 was associated with prolonged CCU stay[20]. Such discrepancies may be explained by several factors, including differences in patient demographics, variations in outcome definitions, shorter follow-up duration in the present study (in-hospital outcomes vs. one-year follow-up), and potential underestimation of comorbid conditions.

Relationship of clinical characteristics with in-hospital mortality, LVEF, length of CCU stay, and myocardial injury

The present study showed that a history of heart disease did not have a significant relationship with treatment outcomes, including in-hospital mortality, length of CCU stay, myocardial injury, and LVEF. Regression analysis also confirmed these findings, showing that a history of heart disease did not have a statistically significant effect on LVEF or length of CCU stay. This finding contradicts the results of Talakoob et al.[23] and Pedro Paulo Neves de Castro et al.[24], who linked a history of heart surgery and heart failure to more complications. This difference may be due to the smaller sample size, short follow-up period, and appropriate therapeutic and care interventions during the patients' hospitalization in the current study.

Regarding a history of diabetes, the findings indicated no significant relationship with treatment outcomes. Regression analysis also showed that diabetes was not significantly associated with LVEF or length of CCU stay. This contrasts with the studies of Pedro Paulo Neves de Castro et al.[24] and Viktor Klancik et al.[25], who reported diabetes as an important risk factor for mortality and heart complications. This difference is likely related to the limited sample size, the low number of deaths, and the short follow-up period in the current study.

The present study found no significant relationship between a history of hypertension and clinical outcomes. This result is consistent with findings by Lidia Sawicz[26] and Turgay Isik et al.[27], who reported that hypertension typically exerts its impact in combination with other risk factors and is not considered a strong independent predictor on its own. Similarly, the study showed no significant relationship between estimated glomerular filtration rate (GFR) and clinical outcomes. In regression analysis, GFR was not significantly associated with either LVEF or the length of hospital stay. This contrasts with the findings of Turgay Isik et al.[27] and Nahid Salehi et al.[28], who reported that reduced GFR is associated with poorer outcomes. One possible explanation for this discrepancy may be that the mean GFR in the current study population was within or close to the normal range.

The present study also found no significant relationship between smoking history and treatment outcomes, including in-hospital mortality, length of CCU stay, myocardial injury, and LVEF. This finding was confirmed by regression analysis, which showed no statistically significant effect of smoking on either the length of CCU stay or LVEF. These results are in line with studies by Turgay Isik[27] and Pedro Paulo Neves de Castro[24], who reported shorter hospital stays and lower short-term mortality rates among smokers. However, these studies also cautioned that long-term smoking is associated with serious health complications. Similarly, no significant relationship was found between hyperlipidemia and treatment outcomes in the current study. In multivariate regression analysis, hyperlipidemia showed no statistically significant effect on LVEF or length of CCU stay. This result is consistent with findings from studies by Lidija Savic[26] and Viktor Klancik[25].

Overall, the findings suggest that certain traditional risk factors such as a history of hypertension, diabetes, smoking, and hyperlipidemia may not significantly influence short-term treatment outcomes. However, this does not imply that these factors are clinically unimportant. Their effects may become more pronounced over the long term or when interacting with other risk factors.

Relationship of DTD Time with In-hospital mortality, LVEF, length of CCU stay, and myocardial injury

The present study found no significant relationship between DTD time and in-hospital mortality, a finding consistent with the results reported by Assareh et al.[4] This result was further supported by multivariate regression analysis, which did not identify DTD time as a predictor of mortality. In contrast, the study by Kitcha Champasri et al.[29] reported a 50% increase in mortality when DTD time exceeded 90 minutes. This discrepancy may be due to the lower overall mortality rate (5.5%) in the current study, which could have limited the statistical power to detect a significant effect.

The findings of the present study indicated that an increase in DTD time was associated with a longer length of stay in the coronary care unit (CCU). Regression analysis confirmed that prolonged DTD time was an independent predictor of extended CCU hospitalization. This result is consistent with the pathophysiological mechanism of prolonged ischemic injury and with studies such as that of Sharkawi et al.[30], which reported longer hospital stays in patients with higher DTD times. Extended DTD time may increase the need for intensive care due to complications such as heart failure and arrhythmias[31,32].

In line with these findings, the current study also revealed a significant inverse relationship between DTD time and LVEF. Multiple regression analysis supported this result, identifying prolonged DTD time as an independent factor associated with reduced LVEF. These results are consistent with studies by Mershed Alsamara et al.[33] and Rezvab Tudor Dadu et al.[34], which emphasized that shorter DTD times are associated with better preservation of ventricular function. A decrease in LVEF due to delayed reperfusion may predispose patients to adverse outcomes such as heart failure and prolonged hospitalization.

Consistent with these results, regression analysis also demonstrated that reduced LVEF was independently associated with longer CCU stays. In other words, patients with impaired ventricular function required more extended periods of intensive care. In addition to DTD time, myocardial injury particularly akinesia was identified as a stronger independent predictor of reduced LVEF. Notably, the mean DTD time was significantly higher among patients with myocardial injury (especially those with akinesia) compared to those without myocardial injury. This finding is consistent with studies by Mitsuaki Sawano et al.[35] and Nasir Khan et al.[36], which reported that DTD times under 90 minutes were associated with smaller infarct size and fewer cardiac complications.

In summary, although DTD time was not significantly related to short-term mortality in this study, its negative impact on length of stay, cardiac function (LVEF), and myocardial injury was highly significant. These results underline the strategic importance of reducing DTD time to less than 90 minutes and ideally to less than 60 minutes.

Limitations

This study faced several limitations. First, the relatively small sample size particularly the low number of in-hospital deaths (n=9) may have reduced the statistical power to detect significant associations, especially regarding mortality outcomes. A post hoc power analysis indicated insufficient power to identify statistically meaningful differences in mortality between patient subgroups. Second, the short follow-up period (limited to hospitalization) did not allow for the assessment of long-term outcomes such as recurrent events or post-discharge mortality. Third, although door-to-device time was the central focus of this study, prehospital delay times (e.g., symptom onset to hospital arrival) were not included due to limitations in accurate time documentation and variability in referral pathways. Fourth, although LVEF was examined, Killip class was not consistently recorded in patient files, preventing its inclusion in the analysis despite its prognostic relevance. Fifth, potential confounding factors including the type and timing of medications administered, the severity of comorbidities, and the precision of clinical time recordings (e.g., DTD time) were not fully controlled. Additionally, this study did not assess certain potentially influential variables, such as patients' physical activity level, nutritional status, and psychological stress. Finally, the observational and cross-sectional design inherently limits the ability to draw causal inferences from the associations observed.

Conclusion

The present study demonstrated that, within the studied population, traditional demographic factors such as age, sex, and BMI did not have a significant impact on short-term outcomes following PPCI. Similarly, pre-existing conditions including cardiovascular disease, diabetes, hypertension, hyperlipidemia, and smoking history were not significantly associated with short-term treatment outcomes. These findings may be attributed to the limited sample size, short follow-up duration, adequate risk factor control, and the effectiveness of therapeutic interventions. In contrast, DTD time emerged as a strong and significant predictor, showing a direct association with longer CCU stay, reduced LVEF, and increased incidence of myocardial injury. Furthermore, myocardial injury was associated with lower LVEF, and lower LVEF, in turn, correlated with prolonged CCU hospitalization. These results underscore the critical importance of minimizing DTD time to less than 90 minutes preferably under 60 minutes as a key determinant in improving outcomes for patients with STEMI. While further prospective studies with larger sample sizes and extended follow-up periods are recommended to better understand the role of traditional risk factors, it is essential to emphasize that optimizing emergency medical systems and implementing standardized protocols to reduce DTD time should be prioritized in healthcare planning.

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Conflict of interests

The authors declare no conflict of interest.

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Manuscript Drafting: MA, SV, MAh, SG, AK
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