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Primary Preventable Cause of Door-in to Door-out Time Delay in ST-elavation Miyocard Infarction: Physician Decision Time

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Abstract

Aim: Door-in to door-out (DIDO) time is defined as the process of primary percutaneous coronary intervention after the first medical contact. In patients with ST-segment elevation myocardial infarction, this period commonly causes delays in the patient's treatment. Our aim is to determine the preventable component among the components that make up the DIDO time.

Materials and Methods: The study included 86 patients with ST-segment elevation myocardial infarction who were referred from non-percutaneous coronary intervention-capable hospitals to our percutaneous coronary intervention center. In this study, the DIDO time for transferred patients was divided into three determining components: the door-to-electrocardiography time, physician decision time (PDT), and time to referral.

Results: The DIDO time was >30 min in 91.9% of 86 patients referred for primary percutaneous coronary intervention from non- percutaneous coronary intervention-capable hospitals. The mean DIDO time was 85 (3-233) minutes. The main component prolonging the DIDO time in all groups was the "PDT", defined for the first time in this study, with a median of 49 (1-186) minutes.

Conclusion: Thanks to the data we have uncovered, a time recommendation should be developed for each stage of the transfer comprising the DIDO components. Developing standard recommendations can help define and reinforce time standards to ultimately reduce DIDO times and improve patient care.

Keywords: Acute myocardial infarction, door-in to door-out, emergency department, primary percutaneous coronary intervention, interhospital transfer

Introduction

In patients with acute ST-segment elevation myocardial infarction (STEMI), prolonged time from symptom onset to wire crossing of the responsible artery has been associated with mortality. Myocardial ischemia time is an important determinant of infarct size in patients with STEMI. Rapid identification and early treatment of acute STEMI are critical for reducing morbidity and mortality (1,2).

Guidelines recommend diagnosis within 10 min of first medical contact (FMC) in patients with suspected STEMI and initiation of primary percutaneous coronary intervention (PPCI) by transferring the patient to the PPCI center within 120 min. The recommended door-to-balloon time (D2B) of a maximum of 120 min and the door-in to door-out (DIDO) time of 30 min (time to discharge from the referral hospital for transfer to a PCI center) are often prolonged due to multiple factors (3-8).

Delays from symptom onset to the PPCI procedure are caused by two main factors: patient and system. Patient-related delay defines the time from the onset of symptoms to FMC, and system-related delay defines the time from diagnosis to treatment with reperfusion therapy (9). DIDO time is one of the critical steps of system-related delays; however, data on the components affecting this time are limited. This study aimed to reveal the median time of the components affecting DIDO time in patients referred to the PCI center after FMC.

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Materials and Methods

Study Design: This was a prospective observational study conducted at the Emergency Medicine Department of Zonguldak Bülent Ecevit University Faculty of Medicine.

Patients: This study included STEMI patients who were referred from non-PCI-capable hospitals to our PCI center hospital between 01.09.2019 and 31.10.2019. Patients whose duration could not be determined because of incomplete files were excluded from the study. The distances from non-PCI-capable hospitals to our hospital ranged between 6.8 and 39.8 miles, and the Google Maps estimated driving times were 19-62 minutes.

Study Protocol*:* Demographic data of all patients, referral center information, the times of referral stages that may have caused a system-related delay, whether troponin results were awaited, time of admission to the PCI center, and time of initiation of PPCI were recorded on the case forms.

FMC PPCI initiation times were divided into three categories as <90 minutes, 90-120 minutes, and >120 min.

DIDO time**;** was considered the duration from arrival to discharge at the first hospital to transfer from that hospital to the percutaneous coronary intervention hospital.

The components determining the duration of DIDO time after the FMC were classified into three categories (Figure 1).

1. Door-to-electrocardiography (ECG) time: The time from hospital admission to ECG.

2. Physician decision time (PDT): The time elapsed from the time written in the referral request form until ECG is performed (physician is the emergency department physician who meets the patient in the emergency department).

3. Time taken to start the referral: Time elapsed from the time written in the referral request form to the ambulance receiving the case.

The centers where STEMI patients first applied were divided into 3 categories.

1. City Center Level 2 Hospital: Urban Level 2 Non-PCI-capable hospitals close to the PCI center,

2. Town Level 2 Hospital: Level 2 Non-PCI-capable hospitals in towns far from the PCI center,

3. City Center Level 1 Outpatient Clinic: Neighborhood polyclinics close to the PCI center.

The FMC times of the patients were divided into three groups according to the time of admission: day, evening, and night. Patient applications between 08:00 and 17:00 were categorized as daytime, between 17:01 and 24:00 as in the evening, and between 00:01 and 07:59 as at night.

The FMC times of the patients were divided into two groups according to the days of admission: weekdays and weekends.

Ethical Approval: The research was submitted to the Clinical Research Ethics Committee at Zonguldak Bülent Ecevit University and approved under certificate number 2019-128-21/08, date: 21.08.2019.

Statistical Analysis

Descriptive statistics for categorical variables are given in percentages. Continuous variables were compared using

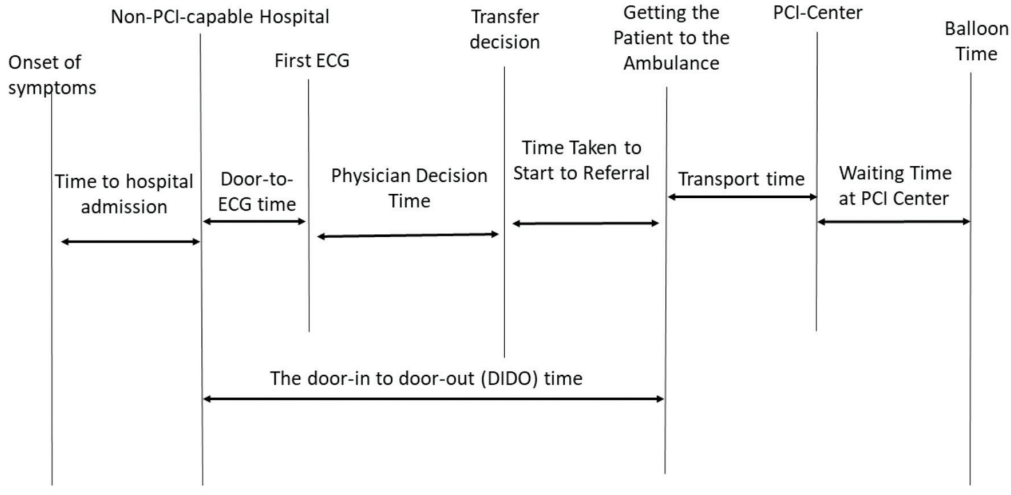

Figure 1. Components of the time from onset of STEMI patient's symptoms to initiation of the PCI procedure

PCI: Percutaneous coronary intervention, ECG: Electrocardiography, STEMI: ST-segment elevation myocardial infarction

Student's t-test or Wilcoxon test between two groups and with one-way analysis of variance between three or more groups. Categorical variables were compared using the chi-square independence test. All tests were two-tailed; $p<0.05$ was considered statistically significant. Statistical analyses were performed using Statistical Package for the Social Sciences 25.0.

Results

A total of 86 patients, 63 males and 23 females, were included in the study. The mean age was 59.05 years [stardard deviation (SD): 10.87 for men and 70.65 years (SD: 12.86) for women.

Of the 86 patients, 35 (40.7%) were admitted to a city center level 2 hospital, 46 (53%) were admitted to a Town Level 2 hospital, and 5 (5.8%) were admitted to a level 1 outpatient clinic. Of these patients, 71 (82.6%) were admitted to the emergency department by their own means, and 15 (17.4%) were admitted to the emergency department by ambulance.

Sixty-four (74.4%) patients visited the emergency department on weekdays and 22 (25.6%) on weekends.

Of the patients, 43 (50.0%) applied between 08:00 and 17:00, 31 (36.0%) between 17:01 and 24:00, and 12 (14.0%) between 24:01 and 07:59.

After the FMC, PPCI was performed within >120 min in 51 (59.3%) patients, within 90-120 min in 23 (26.7%), and within <90 minutes in 12 (14.0%) patients.

The median D2B was 166 (122-365) minutes in the group with D2B >120 minutes, 109 (91-120) minutes in the group with 90 <D2B <120 minutes, and 77 (50-90) minutes in the group with D2B <90 minutes.

The median D2B was 110 (50-365) minutes in the FMC City Center Level 2 group, 159.5 (63-343) minutes in the Town Level 2 group, and 126 (65-250) minutes in the City Center Level 1 Outpatient Clinic group.

DIDO time was >30 min in 79 (91.9%) of 86 patients referred for PPCI from non-PCI-capable hospitals. The mean DIDO time was 74.5 (3-233) minutes.

Median DIDO times were 98 (39-233) minutes in the group with a D2B >120 min, 55 (16-85) minutes in the 90-120 min group, and 42 (3-55) minutes in the <90-minute group.

Median DIDO times were 65 (15-199) minutes in the FMC City Center Level 2 group, 79.5 (3-233) minutes in the Town Level 2 group, and 70 (21-177) minutes in the City Center Level 1 Outpatient Clinic group.

In all patient groups, the main component causing prolongation of D2B was a delay in DIDO time with a median of 74.5 (3-233) minutes. The main component prolonging the DIDO time in all groups was PDT with a median of 49 (1-186) minutes. In groups with FMC-PPCI duration <90 minutes, 90-120 minutes, and >120 min, PDT was 12, 37, and 62 min, respectively. By hospital category, that is, in city center level 2, Town Level 2, and city center level 1 non-capable PCI hospitals, PDT was 40, 53, and 43 min, respectively.

Table 1 shows the relationship between the D2B and the time spent on the components that cause the prolongation of DIDO.

D2B time >120 min was more common in the group with FMC on weekdays than in the group with FMC on weekends (64.1% vs. 45.5%). In the group with FMC time between 24.01 and 07.59, D2B time >120 min was more common than in the 17:01-24:00 and 08:00-17:00 groups (83.3% vs. 61.3-51.2%) (Table 2).

Table 1. Relationship between the D2B time and the time spent on the components causing the prolongation of DIDO

		DIDO time			DIDO time (min)
		Door-to-ECG time (min)	PDT (min)	Time taken to start to referral (min)	
D2B time (min)					
<90 min	Mean	7.83	18.33	9.00	35.17
	SD	7.23	15.18	5.97	17.97
	Minimum	1	1	1	3
	Maximum	24	40	18	55
	Median	**5**	**12**	**7.5**	**42**
90-120 min	Mean	10.00	33.74	14.00	57.74
	SD	10.71	19.17	9.88	18.21
	Minimum	1	3	1	16
	Maximum	51	67	45	85
	Median	**6**	**37**	**10**	**55**

Table 1. Continued

		DIDO time			DIDO time (min)
		Door-to-ECG time (min)	PDT (min)	Time taken to start to referral (min)	
D2B time (min)					
>120 min	Mean	21.41	73.20	14.65	109.26
	SD	29.03	40.94	11.86	50.05
	Minimum	1	10	1	39
	Maximum	170	186	58	233
	Median	**13**	**62**	**10**	**98**
In all patients	Mean	16.47	54.99	13.69	85.14
	SD	23.75	40.27	10.78	50.06
	Minimum	1	1	1	3
	Maximum	170	186	58	233
	Median	**10**	**49**	**10**	**74.5**
P value*		**0.031**	**0.000**	**0.263**	**0.000**
First Applied Hospital					
City Center Level 2 Hospital	Mean	12.31	43.11	15.34	70.77
	SD	12.02	31.46	12.61	36.77
	Minimum	1	3	1	15
	Maximum	51	144	58	199
	Median	**8**	**40**	**12**	**65**
Town Level 2 Hospital	Mean	19.70	64.37	12.41	96.47
	SD	30.37	44.23	9.14	55.58
	Minimum	1	1	1	3
	Maximum	170	186	45	233
	Median	**11.50**	**53**	**10**	**79.50**
City Center Level 1 Outpatient Clinic	Mean	15.80	51.80	13.80	81.40
	SD	14.45	42.19	11.65	60.88
	Minimum	2	6	1	21
	Maximum	35	120	30	177
	Median	**10**	**43**	**13**	**70**
In all patients	Mean	16.47	54.99	13.69	85.13
	SD	23.85	40.27	10.78	50.06
	Minimum	1	1	1	3
	Maximum	170	186	58	233
	Median	**10**	**49**	**10**	**74.5**
P value*		**0.309**	**0.040**	**0.549**	**0.042**

*ANOVA test.
D2B: Door to balloon time, DIDO: Door-in to door-out, PDT: Physician Decision Time, ECG: Electrocardiogram, PCI: Percutaneous coronary intervention, FMC: First medical contact, PPCI: Primary percutaneous coronary intervention, min: Minute, SD: Standard deviation

Table 2. Relationship between D2B times by day and time of first medical contact

		D2B time			p value*
		<90 min N (%)	90-120 min N (%)	>120 min N (%)	
First medical contact days	Weekdays	10 (15.6)	13 (20.3)	41 (64.1)	0.07
	Weekends	2 (9.1)	10 (45.5)	10 (45.5)	
First medical contact hours	08:00-17:00	6 (14.0)	15 (34.9)	22 (51.2)	0.188
	17:01-24:00	6 (19.4)	6 (19.4)	19 (61.3)	
	24:01-07:59	0 (0.0)	2 (16.7)	10 (83.3)	

*Chi-square, Fisher's exact test.
D2B: Door to balloon time, min: Minute

The median DIDO time was 75 (3-203) and 57.5 (28-233) minutes in the groups with FMC on weekdays and weekends, respectively. In both groups, the main component prolonging DIDO time was PDT with 52 (1-186) and 40 (5-75) minutes, respectively.

In the groups with FMC times of 08:00-17:00, 17:01-24:00, and 24:01-07:59, the median DIDO time was 75 (3-199), 60 (16-233), and 89 (53-233) min, respectively. In all three groups, the main component prolonging DIDO time was PDT with 49 (1-144), 35 (6-175), and 72 (37-186) min, respectively. The longest PDT time occurred in patients admitted between 24:01-07:59 h, with 72 min.

Table 3 shows the relationship between whether the FMC is on a weekday or on a weekend, while of day the application is made, and the processes until the start of the procedure.

Troponin level was awaited to make a diagnosis in 57.8% of STEMI patients admitted to the Town Level 2 hospital and in 37.1% of the patients admitted to the City Center Level 2 hospital. On the other hand, 66.7% of the patients with D2B time >120 min waited for the troponin result to be diagnosed (Table 4).

Table 3. Relationship between first medical contact days and hours with time spent in DIDO components

		DIDO time			DIDO time (min)
		Door-to-ECG time (min)	PDT (min)	Time taken to start the referral	
First medical contact days					
Weekdays	Mean	15.33	57.52	13.23	86.08
	SD	18.51	40.82	11.17	47.77
	Minimum	1	1	1	3
	Maximum	124	186	58	203
	Median	**10**	**52**	**10**	**75**
Weekends	Mean	19.77	47.64	15	82.41
	SD	35.48	38.56	9.70	57.32
	Minimum	1	5	4	28
	Maximum	170	175	45	233
	Median	**9.5**	**40**	**13**	**57.5**
P value*		**0.485**	**0.280**	**0.558**	**0.687**
First medical contact hours					
08:00-17:00	Mean	13.3	52.26	14.14	79.70
	SD	12.1	36.34	11.47	42.89
	Minimum	1	1	1	3
	Maximum	51	144	45	199
	Median	**10**	**49**	**10**	**75**
17:01-24:00	Mean	21.94	45.71	13.10	80.74
	SD	35.97	37.96	10.66	54.86
	Minimum	1	6	1	16
	Maximum	170	175	58	233
	Median	**10**	**35**	**10**	**60**
24:01-07:59	Mean	13.67	88.75	13.58	116
	SD	13.26	45.20	9.17	54.06
	Minimum	1	37	2	53
	Maximum	45	186	32	233
	Median	**10**	**72**	**11**	**89.0**
P value**		**0.259**	**0.005**	**0.867**	**0.077**

*Independent sample t-test.
**ANOVA.
DIDO: Door-in to door-out, min: Minute, SD: Standard deviation

Table 4. The centers where the patients applied, the time taken to perform PPCI, and the number of patients whose troponin result is awaited for diagnosis

	Troponin result		p value*
	Awaited N (%)	No awaited N (%)	
First Applied Hospital			
City Center Level 2 Hospital	22 (62.9)	13 (37.1)	
Town Level 2 Hospital	19 (41.3)	27 (58.7)	
City Center Level 1 Outpatient Clinic	3 (60)	2 (40)	
In all patients	44 (51.2)	42 (48.8)	
FMC-PPCI time (min)			
<90 min	11 (91.7)	1 (8.3)	
90-120 min	16 (69.6)	7 (30.4)	0.148
>120 min	17 (33.3)	34 (66.7)	
In all patients	44 (51.2)	42 (48.8)	

*Chi-square, Fisher's exact test.
PCI: Percutaneous coronary intervention, FMC: First medical contact, PPCI: Primary percutaneous coronary intervention, min: Minute

Discussion

All over the world, FMC of STEMI patients frequently occurs in non-PCI-capable hospitals, necessitating their transfer to a PCI-capable hospital (10-13). For STEMI patients requiring interhospital transfer for PPCI, the recommended D2B time is a maximum of 120 min. However, in most patients, this transfer occurs over the recommended times. The most important component of these system-related delays is the DIDO time (6).

However, only 8.1% of our patients could meet a DIDO time of 30 min as recommended in the guidelines. In the literature, the rates of compliance with the DIDO time are between 20.1% and 2.1% (3,14-16).

Despite many studies on variables that may affect the DIDO time, such as whether ECG is taken before the hospital, the patient's age, ethnicity, comorbidities, the vehicle chosen for transfer, longer symptom duration, and distance between centers, there is not enough data on the components that make up the DIDO time (3,11,14,17). In addition, no suggestions have been made regarding the duration of the components that make up the DIDO time. Identifying the components that constitute the DIDO time and providing reasonable suggestions during these components may help shorten this period.

Our study revealed that the most important preventable parameter in prolonging the DIDO time was PDT, which was defined for the first time in this study, and its median value was 49 (1-186) minutes. This finding adds new data consistent with the existing literature on referral hospital-related DIDO time delay (2,14).

Delays in the referral decision of physicians may be caused by delays in evaluating the ECG taken by the nurse, being unsure of the diagnosis of STEMI, not being able to convince the PCI center physician without a troponin result, the need for cardiologist approval for the referral decision, overcrowding in the emergency room, etc. Additional detailed studies are needed to uncover the causes of PDT prolongation, which is one of the most important components of DIDO time in STEMI patients.

Other data revealed in this study is that DIDO time was longer during weekdays and working hours. However, existing literature suggests that this period is longer, especially for those who apply on weekends and outside working hours (5). We think this may be due to various reasons, such as the intervention of the procedures in the decision-making mechanisms on weekdays and during working hours, the concern to follow the specialist's tendency, and the PCI center serving patients with other appointments. However, more detailed studies are required to clarify this issue.

Developing standard time recommendations for each procedure from the moment a patient with suspected STEMI presents to a non-PCI-capable hospital until the patient reaches the catheterization laboratory may prompt hospitals and teams to act more carefully.

Study Limitations

Because this study considered the documented times, it was not possible to deduce whether these periods were extended due to procedural reasons. Even so, since these are the written documents that will initiate the process, recorded deadlines were accepted as realistic timings.

This small, single-center, observational study only provides limited generalizability; therefore, multicenter studies are needed.

Conclusion

Our study found that the most important preventable step of delayed DIDO time was PDT, with a median of 49 (1-186) minutes. We believe that a time recommendation should be developed for each stage of the transfer, making up the DIDO components. Developing standard recommendations can help define and reinforce time standards to ultimately reduce DIDO times and improve patient care.

Ethics

Ethics Committee Approval: The research was submitted to the Clinical Research Ethics Committee at Zonguldak Bülent Ecevit University and approved under certificate number 2019-128-21/08, date: 21.08.2019.

Informed Consent: Consent form was filled out by all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices - Concept - Design - Data Collection or Processing - Analysis or Interpretation - Literature Search - Writing: H.H., A.C.H.

Conflict of Interest: No conflict of interest was declared by the authors.

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