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Timeframe Factors of Door–to–Device Time During Pandemic Situation in a Tertiary Cardiovascular Centre in Indonesia

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has greatly affected every aspect of life, especially in the field of cardiovascular services. This creates many challenges in the treatment of highly time-sensitive and potentially lethal conditions such as ST-elevation acute myocardial infarction (STEMI). STEMI patients at high risk for COVID-19 are recommended to be evaluated with additional testing for COVID-19 and possibly require respiratory support, all of which can delay Door-to-device time (DTDT).

Objective: In this study, we sought to determine the DTDT for primary percutaneous coronary intervention (PCI) in acute STEMI, the various timeframes influencing the DTDT, and which time factor has the most significant correlation to DTDT in the COVID-19 pandemic era.

Methods: A longitudinal retrospective study was conducted at the largest tertiary referral hospital in Indonesia from March 2020 to February 2021. The following timeframes were measured during the study: Door-to-Diagnosis Time [Δt1], Diagnosis-to-Activation Time [Δt2], Informed Consent Time [Δt3], Preparation at Emergency Room (ER) Time [Δt4], Preparation at Catheterization Laboratory Time [Δt6], and PCI Initiation-to-Balloon Time [Δt7]. Spearman's correlation (ρ) was used to ascertain the correlation among time factors.

Results: 238 patients met the inclusion criteria of this study. The observed DTDT was 110 [47 – 437] minutes. Of the variables, DTDT had a strong positive correlation with preparation at the ER time (median 28,0 (1 – 344) minutes; r = 0.702; p-value < 0.0001).

Conclusion: This study sheds light on preparation at the ER time as a significant influencing factor for door-to-device time in the COVID-19 pandemic era.

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Keywords: *acute ST-elevation myocardial infraction; Coronavirus disease 2019 pandemic; Door-to-device time; Primary percutaneous coronary intervention*.

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Introduction

The global pandemic caused by the coronavirus disease 2019 (COVID-19) has greatly affected every aspect of life, especially in the field of health services. This poses various challenges to the treatments of highly time-sensitive and potentially lethal conditions such as ST elevation acute myocardial infarction (STEMI). STEMI patients who are at high risk for COVID-19 are recommended to be evaluated with additional testing for COVID-19 and may require respiratory support, all of which can delay door-to-device time (DTDT).

A previous study by Nallamothu et al. (2003) found that one of the many factors related to patient outcomes, including the death of coronary artery disease patients who experienced an episode of acute heart attack such as STEMI, is the time taken for patients to receive primary percutaneous coronary intervention (PPCI) treatment.[1] However, the current COVID-19 pandemic presents challenges for patients to get medical treatment as soon as possible. Based on prior studies conducted by Smith *et al.* (2021) in America, Lu *et al.* (2021) in China, and Erol *et al.* (2021) in Turkey, it was found that during the COVID-19 pandemic, STEMI patients had worse outcomes both in the hospital and after discharge than before the pandemic in terms of the time needed to receive treatment.[2-4] On the other hand, previous studies carried out by Kwok et al. (2020) in the UK and Sim *et al.* (2017) in Singapore proved that time delays did not have a significant impact on in-hospital patient outcomes.[5,6]

New challenges emerged during the COVID-19 pandemic, controversial results of relevant studies, and the unavailability of data regarding which time factors have the most influence on door-to-device time (DTDT) for STEMI patients undergoing PPCI during the pandemic in Indonesia motivated the authors to conduct this study. The results of this study are expected to provide information on which time factor has the most significant effect on delays in patients receiving treatment, thus being able to be used as material for improving health facility procedures during the COVID-19 pandemic and also in the future.

Methods

A longitudinal retrospective study was conducted at the largest tertiary referral hospital for cardiovascular diseases in Indonesia from March 2020 to February 2021. door-to-device time (DTDT) is described as the amount of time in minutes calculated from patient arrival (emergency room [ER] entry time) to the time the wire penetrates the lesion in STEMI patients presenting to PCI-capable health facilities. The following timeframes were measured in this study: door-to-diagnosis Time [$\Delta t1$], Diagnosis-to-Activation Time [$\Delta t2$], Informed Consent Time [$\Delta t3$], Preparation Time in the Emergency Room (ER) [$\Delta t4$], Preparation Time in the Catheterization Laboratory [$\Delta t6$], and PCI Initiation-to-Balloon Time [$\Delta t7$]. Spearman's correlation (ρ) analysis was carried out to ensure correlations between time factors.

door-to-diagnosis Time is defined as the number of minutes calculated from patient arrival in the ER until the diagnosis (including triage, early assessment, and ECG). Diagnosis-to-activation Time is the number of minutes from the diagnosis until the cardiac intervention on duty was informed for the Primary Percutaneous Coronary Intervention (PPCI). Informed Consent Time is the number of minutes calculated when the doctor gives information to the patient and/or their family until the informed consent of the intervention is made. Preparation at the ER Time is defined as the calculated minutes since the patient and/or their family give their consent until the patient is ready to be transferred to the Cath Lab. Patient Transfer Time is the calculated number of times needed to transfer the patient from the ER to the Cath Lab. Preparation at Cath Lab Time is defined as the number of times in minutes since the patient arrives in the Cath Lab until the PPCI is ready to begin. Percutaneous Coronary Intervention Initiation-to-balloon Time is the number of minutes calculated since the procedure begins until the device crosses the culprit lesion.

Results

Study Results

During the period of this study, 238 Two hundred and thirty-eight patients. patients met the inclusion

Table 1. Baseline characteristic.

Characteristics	Total Subjects (n = 238)
Gender	
Male	215 (90.3 %)
Female	23 (9.7 %)
Age (year)**	56.64 ± 10.6
Age Category	
Early Adulthood (26 – 35 years)	4 (1.7 %)
Late Adulthood (36 – 45 years)	36 (15.1 %)
Early Elderly (46 – 55 years)	67 (28.2 %)
Elderly (56 – 65 years)	81 (34.0 %)
Late Elderly (> 65 years)	50 (21.0 %)
Health Insurance	
National health insurance	220 (92.4 %)
Out-of-pocket	12 (5.0 %)
Others	6 (2.5 %)
Risk Factors	
Hypertension	
Yes	139 (58.4 %)
No	99 (41.6 %)
Diabetes Mellitus	
Yes	77 (32.4 %)
No	161 (67.6 %)
Dislipidemia	
Yes	71 (29.8 %)
No	167 (70.2 %)
Smoking	
Yes	107 (45.0 %)
No	131 (55.0 %)
Family History	
Yes	20 (8.4 %)
No	218 (91.6 %)
History	
Acute Myocardial Infarction (AMI)	
Yes	21 (8.8 %)
No	217 (91.2 %)
Percutaneous Coronary Intervention (PCI)	
Yes	21 (8.8 %)
No	217 (91.2%)
Coronary Artery Bypass Graft (CABG)	
Yes	0 (0 %)
No	238 (100%)
Complication	
Acute heart failure	39 (16.4 %)
Cardiogenic shock	8 (3.4 %)
Acute kidney failure	12 (5.0 %)
Others	24 (10.1 %)
No complication	155 (65.1 %)
STEMI Diagnosis	
Anterior	71 (29.8 %)
Inferior	94 (39.5 %)
Lateral	18 (7.6 %)
Anterior Extensive	46 (19,3 %)
Undetermined	9 (3.8 %)
COVID-19 Diagnosis	
COVID-19 Suspect	225 (94.6 %)
COVID-19 Confirmed	13 (5.5 %)
Angiography and Procedural Characteristics	
Angiography Diagnosis	
CAD1VD	94 (39.5 %)
CAD2VD	79 (33,2 %)
CAD3VD	65 (27,3 %)
Culprit Artery	
RCA	90 (37.8 %)
LM	1 (0.4 %)
LAD	137 (57.6 %)
LCx	10 (4.2 %)
TIMI Flow Post-Procedural Degree	
TIMI Flow 0	2 (0.8 %)
TIMI Flow 1	3 (1.3 %)
TIMI Flow 2	31 (13.0 %)
TIMI Flow 3	202 (84.9 %)

CAD1VD = coronary artery disease 1 vessel disease; CAD-2VD = coronary artery disease 2 vessel disease; CAD3VD = coronary artery disease 3 vessel disease; LAD = left anterior descending; LCx = left circumflex; LM = left main artery; RCA = right coronary artery; STEMI = ST-elevation myocardial infarction; TIMI = thrombolysis in myocardial infarction.

criteria of this study and were included in the analysis **(Figure 1)**.

Baseline Characteristics

Of all the patients involved in this study, the majority of the subjects were male (90.3%), with a mean age of 56.64 ± 10.6 years. The distribution of the baseline characteristics of the subjects is presented in **Table 1**.

As seen in the table, 81 (34,0%) subjects were in their elderly (aged 56 – 65 years) and mostly were male (90,3%). Most of the subjects were patients with hypertension (58,4%), but the risk factors for diabetes mellitus, dyslipidemia, and family history were not dominant in this study. In addition to risk factors, data on complications, such as acute heart failure (16,4%), cardiogenic shock (3,4%), acute kidney failure (5.0%), and other complications (10.1%), were obtained. A total of 155 subjects (65.1 %) did not have any complications.

The median DTDT during the period of this study was 110.0 (47 – 437) minutes, with the percentage of patients whose DTDT was not achieved or extended (>90 minutes) being 65.5% **(Table 2)**.

Figure 2 (a) shows that most of the subjects (82.4%) reached the target time for informed consent compared to 17.6% of the subjects who did not reach the target. There was a statistically significant mean difference between informed consent time of 30 minutes and >30 minutes [9 (0-30) minutes vs. 49 (31-210) minutes, $Z = -10{,}183$, $p < 0.0001$]. Meanwhile, it can be seen in

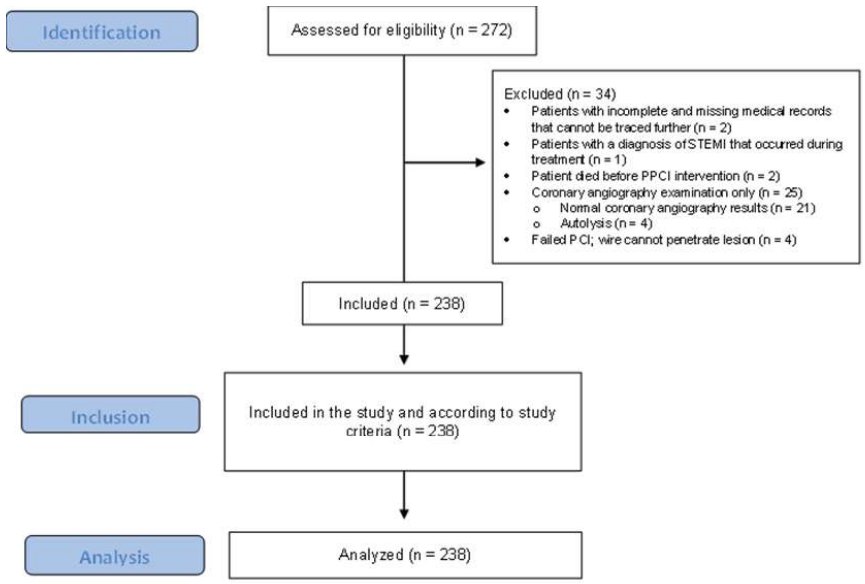

Figure 1. Door-to-Device-Time (DTDT) Timeframe of Primary Percutaneous Coronary Intervention (PPCI) in acute

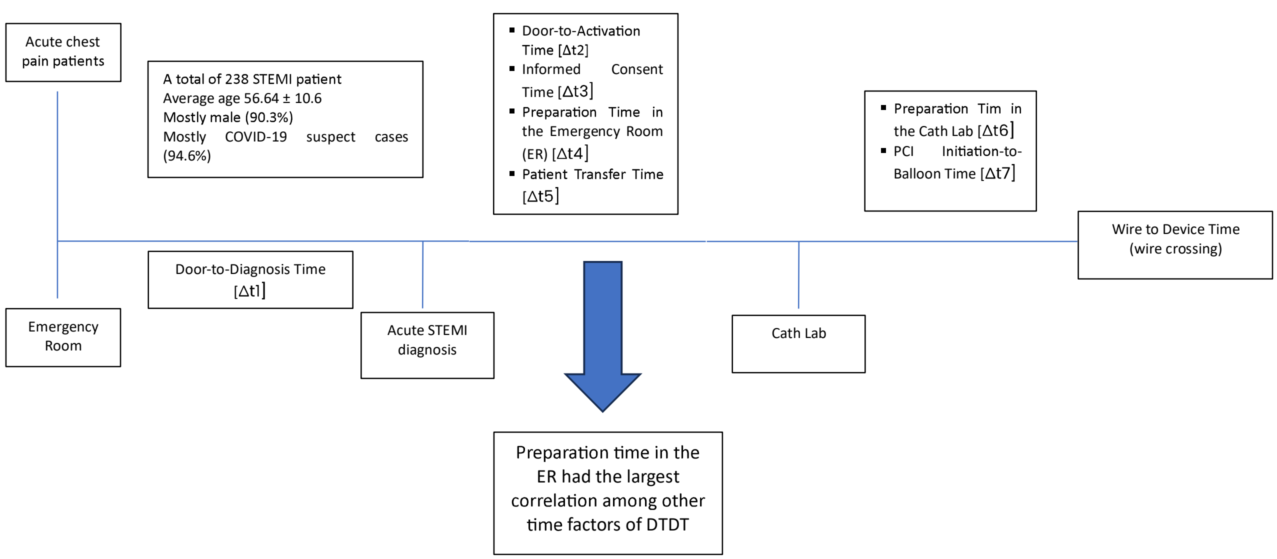

Figure 2. Box-and-whiskers plots (a) informed consent time (Δt3); (b) preparation at emergency room time (Δt4).

Figure 2 (b) that most subjects (83.2%) did not achieve the target preparation time in the ER of 10 minutes, whereas 16.8% of the subjects achieved the target. There was a statistically significant mean difference between preparation time in the ER of 10 minutes and >10 minutes [6 (1-10) minutes vs. 355 (11-344) minutes, Z = -9977, $p < 0.0001$].

The results of the correlation analysis are described in **Table 3** below. The time factor Δt4 (Preparation Time in the ER) was proven to have a strong correlation with DTDT during the COVID-19 pandemic [median 28.0 (1 – 344) minutes; r = 0.702; $p < 0.0001$].

From the analysis presented in **Table 3**, Preparation Time in the ER had the largest correlation coefficient value among other time factors of DTDT. This time factor was found to have a statistically significant correlation or relationship with DTDT and the

Table 2. Door-to-device time Factors Parameters.

Variable	Result (n 238)*#
Door-to-device time (min)	110.0 (47 – 437)
Category of DTDT:	
≤90 minutes	82 (34.5 %)
>90 minutes	156 (65.5 %)
Door-to-Diagnosis Time [Δt1] (min)	10.0 (2 – 124)
Category of Δt1:	
≤10 minutes	124 (52.1 %)
>10 minutes	114 (47.9 %)
Diagnosis-to-Activation Time [Δt2] (min)	5.0 (1 – 113)
Category of Δt2:	
≤5 minutes	164 (68.9 %)
>5 minutes	74 (31.1 %)
Informed Consent Time [Δt3] (min)	10.0 (0 – 210)
Category of Δt3:	
≤30 minutes	196 (82.4 %)
>30 minutes	42 (17.6 %)
Preparation at ER Time [Δt4] (min)	28.0 (1 – 344)
Category of Δt4:	
≤10 minutes	40 (16.8 %)
>10 minutes	198 (83.2 %)
Patient Transfer Time [Δt5] (min)	5.0 (1 – 35)
Category of Δt5:	
≤5 minutes	136 (57.1 %)
>5 minutes	102 (42.9 %)
Preparation at Cathlab Time [Δt6] (min)	11.0 (2 – 63)
Category of Δt6:	
≤15 minutes	189 (79.4 %)
>15 minutes	49 (20.6 %)
PCI Initiation-to-Balloon Time [Δt7] (min)	21.0 (7 – 127)
Category of Δt7:	
≤15 minutes	62 (26.1 %)
>15 minutes	176 (73.9 %)

DTDT = Door-to-device time

strongest correlation among all variables [r = 0.702, p < 0.0001]. The coefficient of determination value [r2 = 0.4928] states the proportion of DTDT diversity that is explainable by a linear relationship between the variability of this time factor.

Figure 3 displays a scatter plot of the linear relationship between Preparation Time in the ER and DTDT, which shows that the distribution of points follows a linear pattern with a positive slope, meaning that there was a consistent relationship between this time factor and DTDT.

Discussion

The majority of subjects in this study were male (90.3%), with a mean age of 56.64 ± 10.6 years. A total of 81 (34.0%) subjects were in the category of elderly (aged 56 – 65 years). This is in line with previous studies, e.g., a study conducted by McCabe *et al.* (2012), where the majority of STEMI patients observed in their study were also men with a mean age of 58-61 years.[7]

Impact of the COVID-19 Pandemic on Door-to-device Time

The median DTDT during the period of this study was 110 (47 – 437) minutes. This is not following the time recommended by the American College of Cardiology/American Heart Association and the European Society of Cardiology, namely the DTDT of less than or equal to 90 minutes for patients diagnosed with STEMI undergoing primary percutaneous coronary intervention.[9,10]

In the literature, mixed results were found on the impact of COVID-19 on DTDT. A study by Hammad et al. (2021) reported 143 cases of STEMI in 18 hospitals in Ohio from January to April 2020 and found that mean DTDT did not differ between the pre- and post-COVID-19 cohorts (59 minutes [44–84] versus 58 minutes [42–102]; p=0.84).[11] Similarly, a study conducted by Tan et al. (2020) in California found that during the early months of the pandemic, hospitals did not experience any delays in treating STEMI patients.[12]

Unlike other studies carried out around the world, only a study done by Lee et al. (2020) in South Korea reported that STEMI patients in this country had better DTDT during the COVID-19 outbreak.[13] In the study, data on COVID-19 patients obtained from a 560-bed hospital located in the Seoul metropolitan area were analysed over a 20-week period, starting from January 26, 2020. The study revealed that all patients with acute myocardial infarction who underwent PCI during the COVID-19 pandemic had a longer DTDT (34.3 ± 11.3 min vs. 22.7 ± 8.3 min; p<0.001), compared with pre-COVID-19 patients. With regard to the volume of patient visits to the hospital, the study found fewer ERs and increased availability of procedure rooms during the COVID-19 pandemic. These findings suggest that the

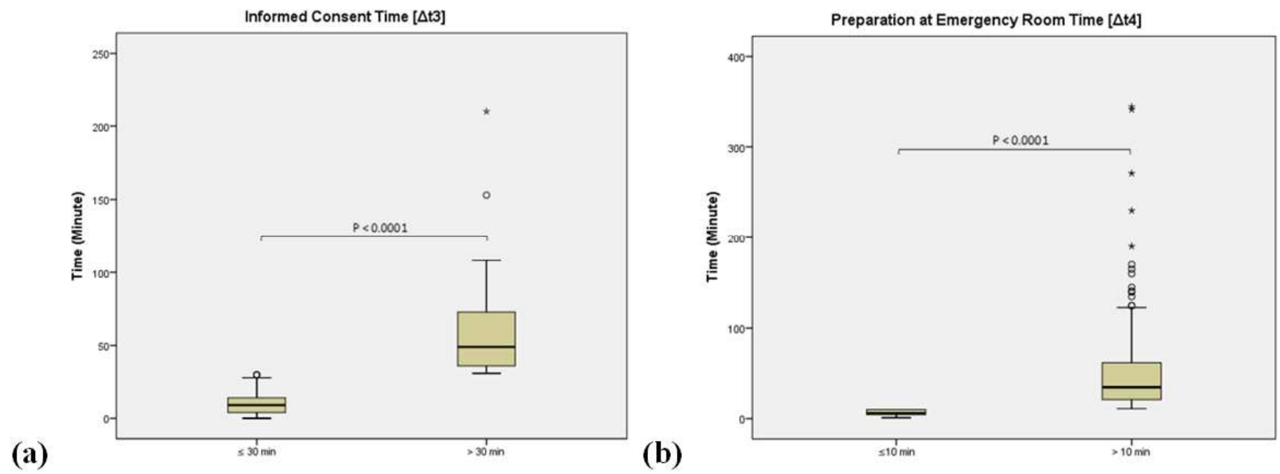

Figure 3. Scatter plot demonstrating the correlation between Preparation at the ER Time and Door-to-device time. Black circles are individual subjects. X and Y axes are log scale.

hospital's personnel and resources can handle clinical cases well even under conditions of potential spread of infection. Another supportive variable to these findings is the compartmentalization of the treatment areas. The resources of their hospital were allocated between COVID-19 and non-COVID-19 patients in a ratio of 2:8. In their hospital, COVID-19 patients were treated exclusively in a 112-bed building (20% of the total 560 beds), which is completely separate from non-infected admissions. In addition, this hospital provided an intermediate zone in its system to ensure safety and protection during the COVID-19 pandemic in South Korea. This zone accommodated patients requiring immediate hospitalization while awaiting confirmation of their COVID-19 test results, which is subdivided into two zones for separate monitoring of patients with overt respiratory infection symptoms (BZ1) and those without (BZ2). During the period of the study, 9% and 37.5% of patients were hospitalized in zones BZ1 and BZ2, respectively.[13]

In line with the results of these studies, Dharma et al. (2021) also reported in their study at the largest tertiary referral center for cardiovascular diseases that the percentage of DTDT reaching 90 minutes for STEMI patients undergoing primary PCI before the pandemic (2019) was 68.70%, with the median DTDT being 81 (67 – 111) minutes. Meanwhile, only 34.5% of patients achieved the 90-minute DTDT during the pandemic [81 vs. 110 minutes; p < 0.001]. This suggests that there was a significant prolongation of DTDT during the COVID-19 pandemic.[14] A similar finding was reported by De Luca et al (2020) in a study in 77 PCI centers, located in 18 countries, that despite the significant reduction in PPCI, there was a significant increase in door-to-balloon and total ischemic time in STEMI patients in the pandemic situation. This longer door-to-balloon time can certainly be explained by organization delay because of the specific COVID-19 protocols for screening patients and preparing equipment and personnel in the catheterization laboratory.[1]

Impact of the Prolongation of DTDT During the COVID-19 Pandemic

The various reports above have proven the prolongation of DTDT during the COVID-19 pandemic, even though the importance of optimal management (angioplasty) in STEMI patients and reduction of DTDT has been well established long ago. A study by Berger et al. (1999) showed that patients who underwent PCI in 60 minutes or less had the lowest 30-day mortality rate; the mortality rate rises with an increase in the time delay between diagnosis and balloon inflation.[15] In connection with this study, De Luca et al. (2004) observed 1791 STEMI patients over the same time frame and concluded that for every minute of delay in ischemic time until adequate reperfusion therapy, 1-year mortality increased significantly.[16] However, a study by Dharma et al. (2021) during the COVID-19 pandemic showed a delay of DTDT for primary angioplasty, although the achievement of TIMI flow

Table 3. Correlation of the Time Factors to Door-to-device time During the COVID-19 .

Time Factors to DTDT	Median**	P-value	Spearman's Correlation Coefficienzt (ρ)*#
Door-to-Diagnosis Time [Δt1]	10.0 (2 – 124)	0.0001	0.291
Diagnosis-to-Activation Time [Δt2]	5.0 (1 – 113)	0.0001	0.291
Informed Consent Time [Δt3]	10.0 (0 – 210)	0.0001	0.373
Preparation at ER Time [Δt4]	28.0 (1 – 344)	0.0001	0.702
Patient Transfer Time [Δt5]	5.0 (1 – 35)	0.905	0.008
Preparation at Cathlab Time [Δt6]	11.0 (2 – 63)	0.006	0.177
PCI Initiation-to-Balloon Time [Δt7]	21.0 (7 – 127)	0.0001	0.357

DTDT = Door-to-device time; ER = Emergency Room; Cathlab = Catheterization Laboratory
The data are presented on numerical data scale; time units in minutes.
*) Pearson's correlation if the data are normally distributed.
#) If the data are not normally distributed, then the Spearman's correlation test is performed.
**) Numerical data are reported in mean ± SD, if normally distributed; in median (min-max), if not normally distributed

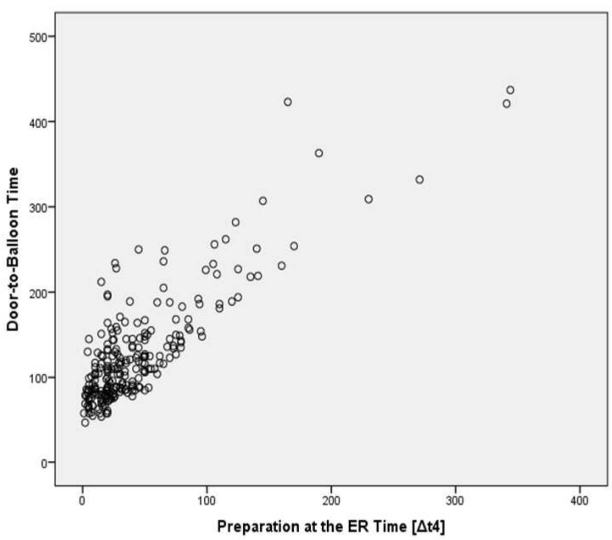

Figure 4. Scatter plot demonstrating the correlation between Preparation at the ER Time and Door-to-device time. Black circles are individual subjects. X and Y axes are log scale.

3 after intervention and the intra-hospital mortality rate was not significantly different from before the COVID-19 pandemic. Furthermore, their study also recommended that primary angioplasty should remain the standard for the management of STEMI during the COVID-19 pandemic and should be performed with several precautions in the safest environment for both patients and healthcare workers.[14]

Relationship of Timeframes to Overall Door-to-device Time

The present study found that preparation time in the ER had a statistically significant correlation or relationship with DTDT and the strongest relationship between variables among other time factor variables [r = 0.702, p < 0.0001]. Approximately 49.28% of the variation in the length of DTDT during the COVID-19 pandemic was affected by the preparation time in the ER, whereas the remaining 50.72% was influenced by the other variables [r2 = 0.4928; p = 0.0001].

Regarding this finding, a study conducted by McCabe et al. (2012) in America revealed that the incidence in the ER had a significant relationship with DTDT, compared to that of the catheterization lab.[7] In their study, there were only three times factors of DTDT, namely Door-to-Activation Time, Activation-to-Laboratory Time, and Laboratory-to-Balloon Time. The median DTDT found in this study was 78 (62–106) minutes, while the medians of door-to-activation time, activation-to-laboratory time, and laboratory-to-balloon time were 19 (9-54) minutes, 33 (23-40) minutes, and 28 (22-38) minutes, respectively. Within the door-to-activation time, the median door-to-diagnosis time was 8 (3-19) minutes, which correlated strongly with the overall door-to-activation time (correlation coefficient of [r]=0.72). According to McCabe et al. (2012), Door-to-Activation Time had an incredibly strong correlation with DTDT compared to the other time factors (r =

0.907; $p < 0.05$). The problems faced in their study were also related to the time frame in the ER, that is, the time required for STEMI diagnosis and the activation time of the catheterization laboratory (Door-to-Activation Time). In their study, Door-to-Diagnosis Time and Diagnosis-to-Activation Time were also found to have a significant relationship with DTDT, but the strength of their relationship or correlation was weak ($r = 0.291$; $p < 0.0001$).[7]

Based on the univariate analysis of their study, typical angina symptoms, pre-hospital ambulance ECG, presence of hypotension or bradycardia upon patient arrival, ST-segment elevation in the inferior leads on the ECG, and increased ST-segment elevation amplitude or the number of leads with ST-segment elevation were all associated with a shorter door-to-activation time and had a statistically significant relationship with DTDT. On the other hand, the use of computed tomography (CT) scans in the ER and the characteristics of patients belonging to the Asian race were closely related to significantly longer door-to-activation times. According to them, triage time and diagnosis time (door-to-activation time) of <20 minutes were strongly associated with achieving a Door-to-device time of <90 minutes. Therefore, they recommended to achieve a door-to-activation time of less than 20 minutes.[7]

Different from the aforementioned study by McCabe et al. (2012), the Door-to-Activation Time factor was divided into more specific schemes in the present study, namely Door-to-Diagnosis Time and Diagnosis-to-Activation Time, with each target time being 10 minutes and 5 minutes. As seen in **Table 2**, most of the subjects reached the target door-to-diagnosis time (52.1%) and diagnosis-to-activation time (68.9%). This was due to the sufficient number of interventional cardiologists working in the hospital, allowing operators to work in shifts and avoiding overexposure when performing PPCI procedures during the COVID-19 pandemic. Currently, there are 15 interventional cardiologists responsible for primary PCI in our hospital who work on a daily shift schedule on standby in the hospital, so the time between diagnosis and activation can be kept to a minimum.

As for informed consent time ($\Delta t3$), most of the subjects in this study (82.4%) reached the target, while the remaining 17.6% did not. There was a statistically significant mean difference between Informed Consent Time of 30 minutes and >30 minutes [9 (0-30) minutes vs. 49 (31-210) minutes, $Z = -10{,}183$, $p < 0.0001$]. In addition, this time factor had a statistically significant relationship with DTDT but was not strongly correlated ($r = 0.373$; $p < 0.0001$). Problems that prolonged the informed consent time identified in this study were waiting times for decisions from the family, long administrative arrangements, problematic or inactive BPJS (Indonesian health insurance), absent family members, and/or patients presenting without family assistance.

Concerning the informed consent time factor, a study done by Khrisnan et al. (2021) indicated that this time factor was strongly correlated with DTDT in India ($r = 0.903$; $p < 0.01$). The prolonged informed consent time in this study was caused by the trend of spending on healthcare in India, which is out-of-pocket or on personal expenses, instead of using health insurance or national schemes. The informed consent time in their study varied widely and could not be shortened by changing protocols or guidelines. The solution may lie in addressing the issue of healthcare costs for patients and providing a universal scheme that includes PPCI measures.[17]

Factors Associated with Longer Preparation Time in the ER

According to the results of this present study, preparation time in the ER ($\Delta t4$) was the most contributing factor in the prolongation of DTDT during the COVID-19 pandemic. Therefore, factors associated with a longer preparation time in the ER were analyzed. The trend of prolonged preparation time in the ER during the COVID-19 pandemic in this study was related to screening for COVID-19 in the ER, including epidemiological screening, chest X-ray, evaluation of antibodies to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and measurement of blood tests (lymphocytes and C-reactive protein). In certain circumstances, it may take a longer time to assess the possibility of COVID-19 infection such as in patients with an unclear STEMI diagnosis. This has the potential to increase the delay in transferring patients to the catheterization laboratory, leading to a longer DTDT time. In addition, early activation of the catheterization laboratory is extremely crucial to maintain the recommended DTDT during the pandemic while preparing for the safest environment during intervention procedures. At our hospital, all staff involved in intervention procedures followed the standard use of personal protective equipment including protective gowns, N-95 masks, face shields, and covered shoes.

Apart from the COVID-19 screening process in the ER, complications often delay the preparation time in the ER for some patients. **Table 1** shows the most frequent complications in this study, i.e., acute heart failure (16.4%), cardiogenic shock (3.4%), and acute renal failure (5.0%). However, the majority of patients (155 people) had no complications (65.1%). This is in line with the findings of Rathore et al. (2009) who stated that DTDT had a significant relationship with left ventricular ejection fraction and vascular infarcts.18 However, this finding is not in accord with a study from Dhungel *et al.* (2018) which found that DTDT did not have a significant relationship with complications such as heart failure [p = 0.316] or left ventricular ejection fraction (LVEF) [p = 0.819], as well as the number of affected blood vessels [p = 0.638] and the type of artery causing the infarct [p = 0.471].19 These findings are similar to those of another study by Lubovich *et al.* (2011).[20]

Strategies for Achieving Shorter Door-to-device time During the COVID-19 Pandemic

Strategies to reduce DTDT often focus on pre-hospital management and the development of an expanding STEMI referral network.[21,22] Various strategies have been proposed to help reduce DTDT, including rapid acquisition, interpretation of the 12-lead electrocardiogram and rapid diagnosis of STEMI in the pre-hospital setting, activation of the catheterization laboratory by physicians in the emergency room, and the presence of an interventional cardiologist who specializes in the catheterization laboratory. Another strategy supported by the European Society of Cardiology (2012) guidelines for the management of acute myocardial infarction in patients with ST-segment elevation is to bypass the ER process by direct admission of STEMI patients to the catheterization laboratory for PCI.[9,10] This approach may also include directly activating the catheterization laboratory and bypassing all processes in the ER for certain patients who have a pre-hospital diagnosis of STEMI.[23,24] In this regard, a study conducted by Lubovich et al. (2011) showed that patients who bypassed all processes in the ER and went directly to the catheterization lab were significantly associated with a shorter DTDT (59 vs. 97 minutes, $p < 0.001$), but had no significant relationship with 30-day MACCE (major adverse cardiac and cerebrovascular events) as well as 30-day and 1-year mortality.[20]

Study Limitations

This study has several limitations as follows. First, this study is retrospective by using secondary data and manual time recording, which may result in biased results. Thus, time recording done electronically can minimize such bias. Second, only patients undergoing PPCI were involved in this study, therefore may lead to selection bias. Third, we didn't measure the door-to-device time in the pre-COVID-19 pandemic era so we can't compare the delay in DTD before and during the pandemic. The addition of a larger number of research subjects with broader criteria and the duration of the study period can provide more accurate results.

Conclusion

This study sheds light on preparation time in the ER as a factor that most significantly affects Door-to-device time in the treatment of STEMI patients presenting to the health facility during the COVID-19 pandemic. The active role and good cooperation between doctors and the referring hospitals with the receiving hospital team to shorten the door-in-to-door-out (DIDO) time of STEMI patients is extremely important so that patients can receive revascularization therapy earlier. In addition, COVID-19 screening in the ER must be carried out effectively and efficiently through good collaboration between the staff on duty in the ER, imaging room, and laboratories, as well as the interventional cardiologists. It is highly recommended for hospitals to consider passing the COVID-19 test and bypassing the process in the ER for urgent cases. Good communication between referring physicians and interventional specialists can allow the catheterization team to work faster, thus reducing DTDT for angioplasty. Furthermore, extensive awareness campaigns regarding the importance of coronary artery disease symptoms, accessible ECG facilities in the community, and affordable emergency revascularization therapy in hospitals can help reduce delays caused by patients in DTDT-related decision-making.

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