Performance of Primary Angioplasty for STEMI during the COVID-19 Outbreak

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Abstract

There has been concern whether the declining cases of ST-segment elevation myocardial infarction (STEMI) during the coronavirus disease 2019 (COVID-19) outbreak associate with primary angioplasty performance.

We assessed the performance of primary angioplasty in a tertiary care hospital in Jakarta, Indonesia, by comparing the door-to-device (DTD) time and thrombolysis in myocardial infarction (TIMI) flow after angioplasty between two periods of admission: during the outbreak of COVID-19 (March 1 to May 31, 2020) and before the outbreak (March 1, to May 31, 2019).

Overall, there was a relative reduction of 44% for STEMI admission during the outbreak ($n = 116$) compared with before the outbreak ($N = 208$). Compared with before the outbreak period ($n = 141$), STEMI patients who admitted during the outbreak and received primary angioplasty ($n = 70$) had similar median symptom onset-to-angioplasty center admission (360 minutes for each group), similar to radial access uptake (90 vs. 89.4%, $p = 0.88$) and left anterior descending infarct-related artery (54.3 vs. 58.9%, $p = 0.52$). The median DTD time and total ischemia time were longer (104 vs. 81 minutes, $p < 0.001$, and 475.5 vs. 449 minutes, $p = 0.43$, respectively). However, the final achievement of TIMI 3 flow was similar (87.1 vs. 87.2%), and so was the in-hospital mortality (5.7 vs. 7.8%).

During the COVID-19 outbreak, we found a longer DTD time for primary angioplasty, but the achievement of final TIMI 3 flow and in-hospital mortality were similar as compared with before the outbreak. Thus, primary angioplasty should remain the standard of care for STEMI during the COVID-19 outbreak.

Keywords
► primary angioplasty
► performance measures
► COVID-19 outbreak

During the coronavirus disease 2019 (COVID-19) outbreak, the hospital admissions for acute coronary syndrome (ACS) including ST-segment elevation myocardial infarction (STEMI) have significantly declined.[1,2] Whether the declining cases of STEMI during the COVID-19 outbreak associate with the performance of primary percutaneous coronary intervention (PCI) for STEMI has not much been studied. The aim of the present analysis is to investigate the performance of primary PCI for STEMI during the early months of the COVID-19 outbreak in Jakarta, Indonesia, which at the time of analysis, Jakarta, is the epicenter of the COVID-19 outbreak in the country.

Methods

Study Design, Population, and Settings

We performed a retrospectively analysis of the Jakarta Acute Coronary Syndrome (JAC) registry, which is an observational, prospective registry, collecting data on consecutive patients with ACS (STEMI, non-STEMI, and unstable angina pectoris) who are admitted to the emergency department (ED) of a receiving primary PCI hospital. The hospital is a tertiary care academic cardiovascular center, which is located at Jakarta, Indonesia, and is hosting the STEMI network in the metropolitan area. Details of the JAC registry have been previously described.[3,4] Data collection and accuracy were evaluated on a regular basis, and all authors wrote the manuscript and aware for the completeness and data accuracy, and analyses. The study approved by the institutional review board of the National Cardiovascular Center Harapan Kita, Jakarta. In this registry, the informed consent was waived, and data were analyzed anonymously.

In this study, we included all consecutive patients with STEMI who were admitted to the hospital during the COVID-19 outbreak (March 1, 2020 to May 31, 2020) and before the outbreak (March 1, 2019 to May 31, 2019).

We compared the clinical and angiographic characteristics of patients with STEMI between the two periods. The comparison period (March 1, 2019 to May 31, 2019) was selected to appropriately describe the profile of the real-world STEMI patients admitted to the hospital within the similar observation period used during the COVID-19 outbreak.

STEMI Network in Jakarta

The JAC registry is routinely being used as the performance measures for the regional STEMI network in the metropolitan area of Jakarta, Indonesia.[3–5] The STEMI network in Jakarta is hosted by the ED team of our hospital, offering 24/7 primary PCI service, and is the largest cardiovascular center in the region. In 2019, the hospital performs ~600 primary PCI procedures. Currently, there are ~ 100 health centers involved in the regional STEMI network in Jakarta and the surrounding area.

Primary PCI Procedure

Primary PCI procedure in our hospital has been previously described.[6] In brief, all patients were pretreated with 160 to 320 mg acetylsalicylic acid and 600 mg clopidogrel or 180 mg ticagrelor (peroral). Unfractionated heparin (100 IU/kg) was administered intravenously in the catheterization laboratory after sheath insertion. During primary PCI, an initial coronary angiogram was performed to assess the infarct-related artery (IRA), and baseline thrombolysis in myocardial infarction (TIMI) flow. After primary PCI, the final TIMI flow was evaluated using standard projection.

COVID-19 Outbreak in Jakarta

Jakarta covers 662 km^2 (256 sq mi) of land area, and ~ 11 million population reside with the population density of ~ 15,000 people/km^2.[7] The first two cases of COVID-19 in Indonesia were confirmed in Jakarta in March 2, 2020, which were increased to 2902 in April 18, 2020, and reached 3,832 cases by April 26, 2020, and making Jakarta as the epicenter of COVID-19 outbreak in the country.[8]

Data Collection and Quality Control

Data were collected from the JAC registry electronic dataset including sex and age of the patient, diagnosis, coronary artery disease risk factors, Killip classifications, TIMI risk score, source of referral, blood test results, left ventricular ejection fraction from echocardiography, final TIMI flow after primary PCI, ischemic time metrics for primary PCI, and in-hospital mortality. All data were checked for accuracy, and if the main data was incomplete, the data were checked again and then completed.

Outcome Measures

The primary outcome measure was the performance of primary PCI as defined by the door-to-device (DTD) time, and achievement of final TIMI 3 flow after PCI. Secondary outcomes included the symptom onset-to-PCI hospital admission time, total ischemic time, and in-hospital mortality.

Study Definitions

The diagnosis of STEMI was made based on the presence of ischemic symptoms (>20 minutes) and persistent ST-segment elevation in at least two contiguous leads, a new left bundle-branch block, or a true posterior myocardial infarction confirmed by posterior leads from the electrocardiography (ECG).[9]

DTD time was calculated as time period between ED admission at the PCI center and first device introduction in an attempt to reopen the occluded IRA.[9] Total ischemic time was defined as time period between start of the symptom (symptom onset) and first device introduction during primary PCI after the coronary guide wire has crossed the culprit lesion.[10] Symptom-to-PCI center admission time was defined as time from the first symptom onset to admission at the ED of the PCI center.

Statistical Analysis

Patient characteristics and the study outcomes between the two admission times (during and before the COVID-19 outbreak) were compared with the use of Mann–Whitney

U test for continuous variables and chi-squared or Fisher's exact tests for categorical variables.

All statistical analyses were performed with the use of the IBM SPSS statistical package, version 25.0 (Chicago, IL). All tests were two-tailed, and *p*-values of less than 0.05 were considered statistically significance.

Results

Study Population
Of 324 patients with acute STEMI recorded, 116 patients were admitted during the COVID-19 outbreak, and 208 patients were admitted before the COVID-19 outbreak period. Of these, 70 and 141 patients who received primary PCI were included the final analysis (►**Fig. 1**).

Patient Characteristics
Characteristics of patients who received primary PCI between the two periods are shown in ►**Table 1**. The median age was 55 years in the group of during the COVID-19 outbreak and 54 years in the group of before the outbreak; the percentage of male patients was ~90% in both groups. During the COVID-19 outbreak period, the admission of STEMI patients through interhospital transfer dropped by 74% (24 vs. 94 patients), the percentage of smoker and median creatinine level at admission were lower (35.7 vs.

65.2%, $p < 0.001$; and 0.94 vs. 1.03 mg/dl, $p = 0.006$, respectively), but the uptake of radial access and left anterior descending IRA were similar as compared with before the COVID-19 outbreak period (90 vs. 89.4%, and 54.3 vs. 58.9%, respectively).

Outcomes
Study outcomes are displayed in ►**Table 2**. Compared with the period before the COVID-19 outbreak, patients with STEMI who were admitted to the PCI hospital during the COVID-19 outbreak had longer median DTD time (104 vs. 81 minutes, $p < 0.001$), and longer total ischemia time (475.5 vs. 449 minutes, P = NS). However, the symptom onset-to-PCI center admission time was similar (360 minute for each group), and so were the achievement of TIMI 3 flow after primary PCI (87.1 vs. 87.2%), and in-hospital mortality (5.7 vs. 7.8%).

Discussion

In our analysis of data from a registry in a primary PCI hospital in Jakarta, we found that the hospital admission for patients with STEMI has dramatically declined during the COVID-19 outbreak. Importantly, the DTD was longer, but the achievement of final TIMI 3 flow and in-hospital mortality were similar compared with before the COVID-19 outbreak, and deserve further discussion.
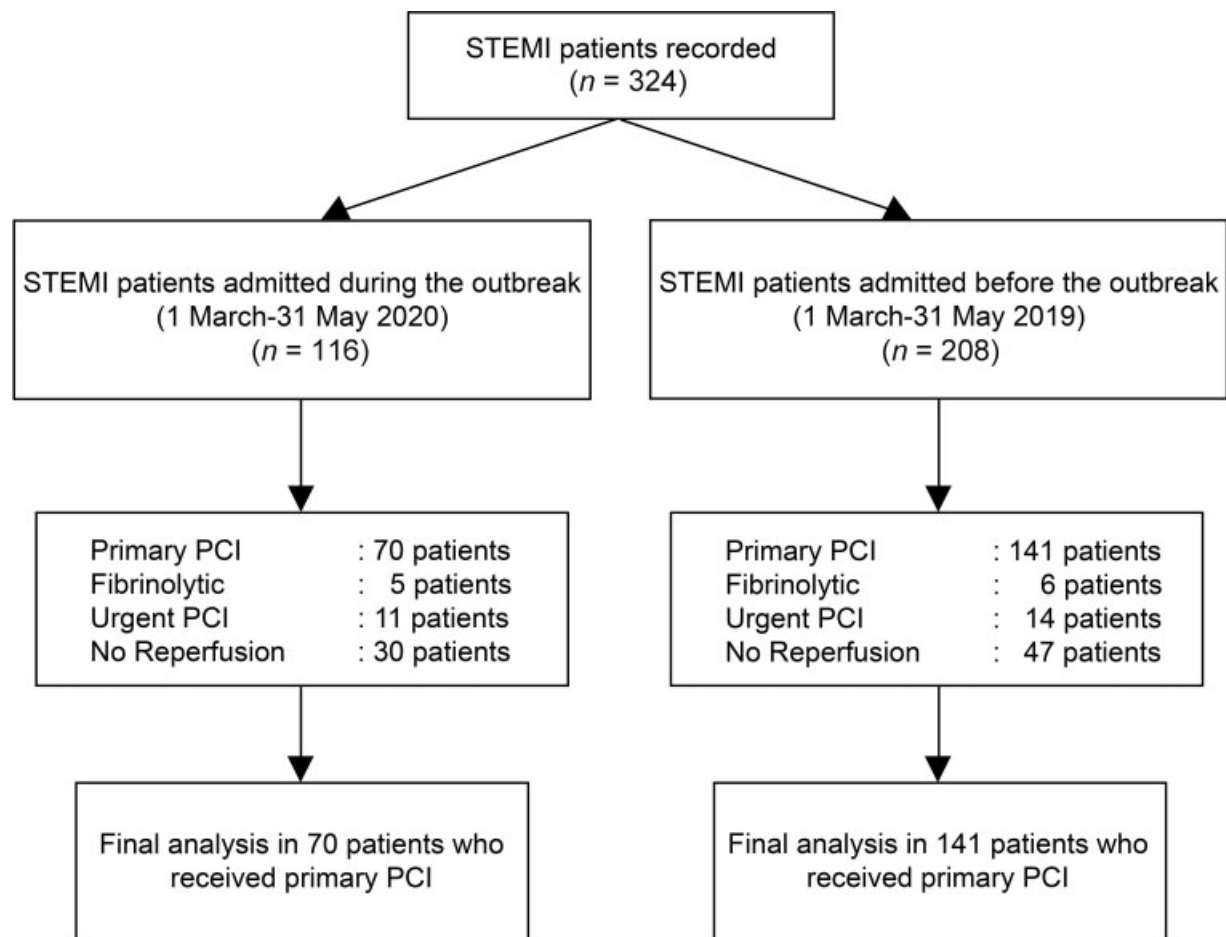

Fig. 1 Patients included in the analysis. STEMI, ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention.

Table 1 Characteristics of patients with acute STEMI treated by primary PCI (*n*= 211)

Variables	Missing data, *n* (%)	During the outbreak (*n* = 70)	Before the outbreak (*n* = 141)	*p*-Value
Age, y	0	55 (46–60)	54 (48–59)	0.43
Male, *n* (%)	0	64 (91.4)	131 (92.9)	0.70
Off-hour admission, *n* (%)	0	31 (44.3)	70 (49.6)	0.46
Anterior MI, *n* (%)	0	37 (52.9)	82 (58.2)	0.46
Symptom onset, *n* (%)				
≤ 2 h	0	2 (2.9)	9 (6.4)	0.34
> 2–6 h	0	36 (51.4)	71 (50.4)	0.88
6–12 h	0	28 (40)	56 (39.7)	0.96
> 12 h	0	4 (5.7)	5 (3.5)	0.48
Cardiovascular risk factors, *n* (%)				
Smoker	0	25 (35.7)	92 (65.2)	<0.001
Hypertension	0	34 (48.6)	84 (59.6)	0.13
Diabetes mellitus	0	19 (27.1)	55 (39)	0.08
Dyslipidemia	0	11 (15.7)	23 (16.3)	0.91
Family history	0	8 (11.4)	12 (8.5)	0.49
Source of referral, *n* (%)				
Interhospital referral	0	24 (34.3)	94 (66.7)	< 0.001
Killip classification, *n* (%)				
I	0	62 (88.6)	116 (82.3)	0.23
II	0	4 (5.7)	15 (10.6)	0.23
III	0	2 (2.9)	4 (2.8)	1.0
IV	0	2 (2.9)	6 (4.3)	1.0
TIMI risk score >4, *n* (%)	0	21 (30)	44 (31.2)	0.85
Antiplatelet therapy within 24 h, *n* (%)				
Salicylic acid	0	69 (98.6)	140 (99.3)	1.0
Clopidogrel	0	56 (80)	110 (78)	0.74
Blood tests				
Hemoglobin (g/dL)	0	14.7 (12.975–15.625)	14.6 (13.3–15.45)	0.84
Leukocyte (/μL)	0	13,102.5 (10,880–15,402)	13,300 (10,780–16,080)	0.69
Initial troponin T (ng/L)	15 (7.109)	323.5 (106–1241)	273 (66.5–840)	0.84
Creatinine level (mg/dL)	0	0.94 (0.825–1.1)	1.03 (0.85–1.245)	0.006
Admission blood glucose, (mg/dL)	1 (0.4734)	133 (120.75–55.75)	147 (122.5–214.5)	0.005
Echocardiography variables				
LVEF (%)	21 (9.952)	45 (35–54)	45 (36–51)	0.76
Primary PCI procedural characteristics				
Balloon predilatation, *n* (%)	0	69 (98.6)	130 (92.2)	0.06
Use of drug-eluting stent, *n* (%)	0	67 (95.7)	134 (95)	1.0
Transradial access, *n* (%)	0	63 (90)	126 (89.4)	0.88
Infarct-related artery, *n* (%)				
Left main	0	1 (1.4)	0	0.33
Left anterior descending	0	38 (54.3)	83 (58.9)	0.52
Left circumflex	0	2 (2.9)	4 (2.8)	1.0
Right coronary artery	0	29 (41.4)	54 (38.3)	0.66

(*Continued*)

Table 1 (Continued)

Variables	Missing data, n (%)	During the outbreak (n = 70)	Before the outbreak (n = 141)	p-Value
Coronary artery involvement, n (%)				
Single vessel disease	0	32 (45.7)	55 (39)	0.35
Two vessel disease	0	21 (30)	35 (24.8)	0.42
Three vessel disease	0	17 (24.3)	51 (36.2)	0.08
Left main disease	0	2 (2.9)	8 (5.7)	0.5
Medication at discharged, n (%)				
Salicylic acid	0	65 (92.9)	130 (92.2)	0.86
Clopidogrel	0	46 (65.7)	103 (73)	0.27
ACE/ARB inhibitors	0	58 (82.9)	122 (86.5)	0.47
Beta blocker	0	59 (84.3)	119 (84.4)	0.98
Simvastatin	0	65 (92.9)	130 (92.2)	0.86
Length of stay, d	0	5 (4–7)	5 (4–6)	0.55

Abbreviations: ACE, angiotensin converting enzyme; ARB, angiotensin receptor blocker; LVEF, left ventricular ejection fraction; MI denotes myocardial infarction; NA, not analyzed; PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction.

The results of this study suggest that it is still feasible to perform primary PCI during the COVID-19 pandemic with expected delays in reperfusion time that partly due to the COVID-19 screening at the ED. However, the delays should not reduce the utilization of primary PCI, indicating that during the COVID-19 pandemic, primary PCI should continue to be the standard of care for patients with definite STEMI, particularly when patients are presenting to a primary PCI center. However, during the COVID-19 pandemic, all primary PCI procedures should be performed in the way of safest environment, indicating that all patients with STEMI should be treated as possible COVID-19 at presentation.

A recent protocol from China[11] suggests use of fibrinolytic therapy as the initial treatment for patients with acute STEMI within 12 hours of symptom onset during the pandemic. However, the protocol should not be generalized to all STEMI care during the pandemic since the success rate of fibrinolytic therapy in restoring the flow of the IRA is lower than primary PCI, and this was associated with a worse clinical outcome in patients who receive fibrinolytic therapy as compared with primary PCI.[12] However, in some cases of highly expected delays for primary PCI due to COVID-19 assessment or establishing the STEMI diagnosis, it is reasonable to initiate fibrinolytic therapy, particularly for those patients who first presented to a non-PCI center with possible prolonged door-in to door-out time. In our study, fibrinolytic therapy was successfully initiated in four patients during the study period. Fibrinolytic therapy was indicated due to the expected delay for primary PCI related to the COVID-19 assessment at the ED, and was administered during the early weeks of the COVID-19 outbreak.

In our study, the DTD time was longer during the COVID-19 outbreak that related to the COVID-19 screening at the ED including the epidemiology screening, chest X-ray, severe acute respiratory syndrome coronavirus 2 antibody evaluation, and additional blood test measurement (lymphocyte and C-reactive protein). The COVID-19 screening at the ED should be effective and efficient, and this can be achieved by

Table 2 Study outcomes

	During the outbreak (n = 70)	Before the outbreak (n = 141)	p-Value
Symptom onset-to-PCI hospital admission, min	360 (240–540)	360 (270–480)	0.84
Door-to-device time, min	104 (79.50–149.25)	81 (67–111)	<0.001
Total ischemic time, min	475.5 (354–679.5)	449 (356.5–585.5)	0.43
Final TIMI flow, n (%)			
0	1 (1.4)	1 (0.7)	1.0
1	0 (0)	1 (0.7)	1.0
2	8 (11.4)	16 (11.3)	0.98
3	61 (87.1)	123 (87.2)	0.98
In-hospital mortality, n (%)	4 (5.7)	11 (7.8)	0.77

a good collaboration between the staff at the ED, imaging, laboratory department, and the interventional cardiologists on duty. In certain circumstances, there will be longer time needed to assess the COVID-19 possible such as in patients with unclear STEMI diagnosis that potentially increases the delay in transferring the patient to the catheterization laboratory that also leads to a longer DTD time. Early activation of the catheterization laboratory is also crucial in maintaining the recommended DTD time during the pandemic to prepare the safest environment during the interventional procedures. In our center, all staff involved in the interventional procedure followed the use of standard personal protective equipment including use of gown, N95, face shield, and covered shoes. We also used a dedicated catheterization laboratory room to perform primary PCI cases during the study period. It is also suggested to avoid unnecessary X-ray projections during coronary angiography of primary PCI to minimize the total procedural time. In addition, the number of interventional cardiologists in the hospital should be appropriate to allow the operator working within shift and avoid excessive exposure to the primary PCI procedures. Currently, there are 15 interventional cardiologists who are responsible for primary PCI in the hospital that work within a daily shift and to ensure adequate time for recovery, and perhaps related to the high achievement of TIMI 3 flow after PCI during the COVID-19 outbreak in ~90% of cases, and this was similar to the achievement of before the outbreak (►Table 2).

During the COVID-19 outbreak, the utilization of primary PCI in our hospital was lower than before the outbreak (51.4 vs. 74%), and this was partly associated with an overall 41% drop of the STEMI admissions in the hospital, whereas admission through interhospital hospital reduced by 74% (►Table 1). Other possible reasons for the lower uptake of primary PCI in the hospital during the COVID-19 outbreak were related to patients who had complete resolution of ST-segment elevation at presentation, thus treated conservatively. Several speculations were described to explain the dramatic reduction in admission of STEMI patients from interhospital transfer in the region during the COVID-19 outbreak such as people are afraid of getting infected by COVID-19 when visiting the EDs of the primary hospitals, and the strict regulations to stay and work from home, social distancing, large scale social restriction, and self-isolation may partly prevent patients going to hospital to seek help for their health conditions.

A recent recommendation emphasizes the use of primary PCI in definite STEMI patients, and primary PCI should be the standard of care for STEMI patients during the COVID-19 pandemic with some important caveats, and all patients presenting with a suspected STEMI should be considered as COVID-19 positive,[13] which is a reasonable guide for our daily clinical practice during this pandemic.

All health-care providers should prepare for the unexpected arrival of the delayed presentation of patients with ACS during the pandemic, which are probably associated with severe complications such as acute heart failure, arrhythmia, and mechanical complications. Furthermore, it also important

that all hospitals should prepare for the possible increase in hospital visits by patients with cardiovascular disease soon after the COVID-19 outbreak has been controlled.

Finally, the regional systems of care for STEMI patients should be able to provide a simple and efficient protocol to transfer patients from non-PCI hospitals to a primary PCI hospital within the reasonable time delay, and if possible introduce the fibrinolytic therapy protocol immediately after admission at the non-PCI centers in patients with STEMI who presented early after symptom onset, before transferring the patient to a PCI center.

Study Limitation

This study has several limitations. First, this was a single-center study with relatively small sample size. Second, we did not record the time delay at the first hospital before the transfer process in patients who admitted from interhospital transfer process. Finally, we did not evaluate other system-related delay at our hospital including the time from ECG recording to STEMI diagnosis, and from STEMI diagnosis to catheterization arrival.

Conclusion

During the COVID-19 outbreak, we found a longer DTD time for primary angioplasty, but the achievement of final TIMI 3 flow and in-hospital mortality were similar as compared with before the COVID-19 outbreak. Thus, primary angioplasty should remain the standard of care for STEMI during the COVID-19 outbreak, and it should be performed with several precautions and within the safest environment.

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