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# Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry



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# TITLE PAGE

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# Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry


## Objective

We studied the characteristics of STEMI patients after expansion of a STEMI registry as part of the STEMI network program in the metropolitan city and the surrounding area covering ~ 26 million inhabitants.

## Design

Retrospective cohort study

## Setting

Emergency department of 56 health centers

## Participants

3015 patients with acute coronary syndrome, of which 1024 patients had STEMI

## Main outcome measure

Characteristics of reperfusion therapy

## Results

The majority of STEMI patients (81%; N=826) were admitted to 6 academic PCI centers. PCI centers received patients predominantly (56%; N=514) from a transfer process. The proportion of patients receiving acute reperfusion therapy was higher


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than non-reperfused patients (54% vs. 46%, p<0.001), and primary PCI was the most common method of reperfusion (86%). The mean door-to-device (DTD) time was 102 ± 68 minutes. In-hospital mortality of non-reperfused patients was higher than patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%, p<0.001). Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers who underwent primary PCI had shorter mean DTD time (96 ± 44 minutes vs. 140 ± 151 minutes, p<0.001), higher use of manual thrombectomy (60.2% vs.13.8%, p<0.001) and drug-eluting stent implantation (87% vs. 69%, p=0.001), but had similar use of radial approach and intra-aortic balloon pump (55.7% vs. 67.2%, and 2.2% vs. 3.4%, respectively). In patients transferred for primary PCI, TIMI risk score ≥ 4 on presentation was associated with a prolonged door-in to door-out (DI-DO) time (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02).

Conclusions

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. In developing countries, focusing the pre-hospital care in the network should be a major focus of care to improve the DI-DO time along with improvement of DTD time at PCI centers.

Keywords: STEMI, system of care, registry, developing country, metropolitan

Strengths and limitations of this study

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1. We were able to include 56 health centers that participate in this study and enroll 3015 patients with acute coronary syndrome, of which 1024 patients had STEMI.
2. This study describes detailed reperfusion characteristic in the 56 health centers located in the metropolitan area of a developing country.
3. This study is part of the performance measures of the STEMI care (Jakarta Cardiovascular Care Unit Network System) and the results are used to improve the care of STEMI patients in the metropolitan area.
4. This study focuses the pre-hospital care of STEMI patients, by means of the door-in to door-out time (DI-DO); Improvement of the time metrics (DI-DO) may improve the reperfusion time for STEMI patients in the metropolitan city of a developing country.
5. An important limitation of the study is data coverage. The coverage of the health centers participating in the registry is 26% of all centers in the metropolitan area, but major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well.

## Introduction

The main goal of a clinical registry of ST-segment elevation myocardial infarction (STEMI) patients is to narrow the gap between evidence and clinical practice, by providing important data to cardiologists and health care authorities. The registry data consist of acute management of STEMI, demographic profile, risk prediction tool, timing and type of reperfusion treatment, and outcomes (1-2). The



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registry records the full spectrum of patients with STEMI, and usually used as a source of data for measuring the performance of an existing STEMI network. The performance measures provide feedback to clinicians and are used to improve the quality of STEMI care and outcomes (3).

During the last decade, the results from several established large health database/registries in developed countries such as GRACE (2), FAST-MI (4), NCDR (3,5), NRMI (6), and Vienna STEMI (7) gave important contribution in optimizing the care of acute coronary syndrome (ACS) patients. All the established registries may reflect the true characteristics of the ACS patients in each region because other hospitals in the region are actively involved in data collection. The findings from the registries may optimize the care of ACS patients not only in the region where the registry is being conducted, but the data may also inform the treatment of ACS patients worldwide; thus the findings from these registries are often adopted into the European (8) and American guidelines recommendations (9).

In contrast to those registries in developed countries, there are still limited numbers of ACS registries in developing countries (10). The present study was done to analyze the characteristics of STEMI patients in a large metropolitan catchment area of a developing country where a STEMI registry, the Jakarta Acute Coronary syndrome (JAC) registry, has been applied extensively as part of the regional STEMI network program in the metropolitan city and the surrounding area that consist of ~ 26 million inhabitants. The results of the present study are expected to give insights to improve the STEMI care in the country.

## Methods

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JAC registry

The JAC registry is an on-going, observational registry collecting data on demographic, characteristics, management, and outcomes of patients with ACS that began as an initiative only in the emergency department (ED) of a tertiary academic hospital located in a metropolitan city (Jakarta, Indonesia) (11). Since October 2014, the JAC registry has gradually been applied in other hospitals in the metropolitan and the surrounding areas.

At the time of the present analysis, 56 centers were actively participating in the JAC registry. All consecutive ACS patients admitted to each center are recorded into a standardized registry form. Data quality is maintained through a careful evaluation by the cardiologist or physician at the participating center. After verification, the data are sent electronically to the data analytic center at the National Cardiovascular Center Harapan Kita, on a regular basis. At the data analytic center, the data are controlled by a monthly data monitoring by the primary investigator of the JAC registry (SD). Using the JAC registry database, we analyzed the characteristics of ACS patients (N=3015), of which 1024 were STEMI patients.

The JAC registry is the main data source for measuring the performance of the regional STEMI network, namely Jakarta Cardiovascular Care Unit (CCU) Network System. Several performance measures have been undertaken, and the results were used to improve the system of care for acute myocardial infarction (AMI) in the region (11-14).

Jakarta CCU Network System

Since 2010, the “get with the guidelines” project for STEMI in Jakarta was translated by building a STEMI network (Jakarta CCU Network System). The

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metropolitan city (Jakarta) has ~ 11 million inhabitants (13,14). In the surrounding area of Jakarta, there are many hospitals that by administration do not belong to Jakarta province, but geographically, many hospitals are located near the metropolitan city. Therefore, in daily practice, many STEMI patients at the surrounding area of Jakarta are transferred to PCI centers at the metropolitan city for reperfusion therapy. In total, there are ~ 26 million inhabitants in the five districts of the catchment area (Jakarta, Bogor, Depok, Tangerang, Bekasi) (Figure 1).

The network has provided several STEMI algorithms, including the pre-hospital triage and checklist for fibrinolytic therapy. An ECG transmission scheme is mandatory using several transmission methods (13,14). This study is part of the regular analysis of the performance measures for the regional STEMI network.

Management protocol

The acute management of STEMI patients was in accordance with the European Society of Cardiology guidelines (8) and applied at all participating centers. For patients undergoing primary PCI, 600 mg of clopidogrel or 180 mg ticagrelor was given either in the pre-hospital or in-hospital setting. Before primary PCI, all patients received an intravenous bolus of unfractionated heparin in the cath-lab (50 IU/kg if receiving glycoprotein IIb/IIIa inhibitor [GPI] or 100 IU/kg if not receiving GPI).

The choice of vascular access, thrombus aspiration, direct stenting, balloon predilation, and use of intra-aortic balloon pump during primary PCI were at the operator's discretion.

Pre-hospital care of STEMI patients

The STEMI algorithm was used as the main protocol for treating STEMI patients in the region (11,14) including a pre-hospital triage form (13). The main

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metrics to evaluate the pre-hospital care of STEMI patients transferred for primary PCI is the door-in to door-out (DI-DO) time.

Study outcome and definition

The primary outcome of the study was the proportion of patients receiving acute reperfusion therapy (primary PCI or fibrinolytic therapy). Other outcomes were in-hospital mortality and DI-DO time. PCI center was defined as receiving centers for primary PCI. Academic center was defined as university teaching hospital for medical students engaged in research, or clinical or related service (15). DI-DO time (in minutes) was defined as the time spent by a STEMI patient at the primary care (pre-hospital setting) before being transferred to a PCI center, measured by time difference between admission and referral time from the referral center (16). Killip classification (17) and thrombolysis in myocardial infarction (TIMI) risk score (18) were evaluated at presentation.

Statistical methods

Categorical data are expressed as percentage and continuous data are expressed as mean ± standard deviation. For continuous data that are not distributed normally, the data are expressed as median (range). We compared the demographic and clinical characteristics of STEMI patients between PCI and non-PCI centers. The primary PCI procedural data were compared between academic and non-academic PCI centers. The characteristics of non-reperfused patients were also described. Continuous variables were compared with Student's *t*-test or Mann Whitney *U*-test and Chi-square test or Fisher`s exact test were used to compare categorical variables

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as appropriate. Multivariate predictor of prolonged DI-DO time was analyzed using logistic regression analyses in STEMI patients transferred for primary PCI. The cut-off for a prolonged DI-DO time in this study was >180 minutes.

All statistical tests were two-tailed and a p-value <0.05 was considered significant. Statistical analyses were performed with SPSS for Windows version 17.0 (SPSS Inc, Chicago, Illinois, USA).

## Results

### Study sample

Between October 2014 and July 2015, a total of 1024 STEMI patients were admitted to the emergency departments of the participating health centers, 917 (89%) were admitted to PCI centers, and the remaining (11%) admitted to non-PCI center. Of these, the majority of STEMI patients (81%; N=826) were admitted to six academic PCI centers.

### Clinical characteristics

Both STEMI patients at PCI Centers (86%) and non-PCI centers (85%) were dominantly male. PCI centers received patients predominantly (56%; N=514) from a transfer process, while patients at non-PCI centers were dominantly patients who presented directly/self presentation (80%; N=86). Smoking was a common risk factor in the overall STEMI population (61%; N=628). Patients at non-PCI centers had more Killip class 1 but fewer TIMI score ≥4 as compared with patients admitted to PCI centers (Table 1).

### Characteristics of reperfusion therapy

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The proportion of patients receiving acute reperfusion therapy (fibrinolytic therapy or primary PCI) was higher than non-reperfused patients [54%; (N=551) vs. 46%; (N=473), p<0.001], and primary PCI was the most commonly method of reperfusion (86%). As expected, the utilization of thrombolysis therapy was significantly higher at non-PCI centers than in PCI centers (17.7% vs. 6.4%, p<0.001) (Table 1).

Characteristics of non-reperfused patients

Non-reperfused STEMI patients admitted to PCI centers were commonly coming through a transfer process (52%), while most patients at non-PCI centers (79%) were self-presenters. The majority of non-reperfused patients arrived at the ED more than 12 hours after symptom onset (N=291; 61%) (Table 2).

Angiographic and procedural characteristics

Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers and underwent primary PCI had higher use of manual thrombectomy and drug-eluting stent implantation (60% vs.14%, p<0.001 and 87% vs. 69%, p=0.001, respectively), but had similar use of trans-radial approach and intra-aortic balloon pump (56% vs. 67%, and 2.2% vs 3.4%, respectively). The mean DTD time was 102 ± 68 minutes. At academic centers, the mean DTD time was shorter than at non-academic centers (96 ± 44.3 vs. 140 ± 151 minutes). The left anterior descending was the most common infarct-related artery (53%) (Table 3).

In-hospital mortality

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In-hospital mortality of non-reperfused STEMI patients was significantly higher than STEMI patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%, p<0.001) (Table 4). The in-hospital mortality between academic and non-academic centers was similar (3.1% vs. 3.4%) (Table 3).

Predictor of a prolonged DI-DO time in STEMI patients transferred for primary PCI

The mean DI-DO time in this study was 186 ± 111 minutes. After adjustment with several clinical variables (female sex, older age, diabetes mellitus, hypertension, Killip classification and TIMI risk score), TIMI risk score ≥ 4 on presentation was associated with a prolonged DI-DO time (>180 minutes) (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02) (Figure 1).

**Discussion**

The JAC registry was created to improve the quality of care for ACS patients (particularly STEMI) by providing information on acute management of STEMI, risk prediction tool, timing and type of reperfusion treatment. The results from the registry analysis will be translated into clinical practice by giving knowledge on how to improve patient care and outcomes. Since its inception in 2007, the JAC registry has contributed to the improvement of STEMI care in the region (12-14). Recently, the JAC registry has been expanded to 56 health centers and like other registries (4-7), this report is used as performance measures for the STEMI care that included several insights to improve the STEMI care in the region which are described below. The challenges found in implementing the regional registry and the concept for future network in the region are also discussed.

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**Changes in acute reperfusion therapy**

The number of STEMI patients who received reperfusion therapy was higher than non-reperfused patients (54% vs. 46%) and primary PCI was commonly used (86%). An earlier report showed that the number of non-reperfused STEMI patients was higher than patients receiving acute reperfusion therapy (59% vs. 41%) (11). The current finding suggests that implementation of the regional STEMI network has contributed to improvement of daily management of STEMI patient in the region, as shown by the higher proportion of patients receiving acute reperfusion therapy.

Our previous report (14) demonstrated the need to apply the registry extensively in the region as part of the STEMI network program. The wide adoption of the registry may partly explain the changes of reperfusion strategy in the region. Each participating center may evaluate the characteristics of patients admitted to the center, that in turn, it may increase the awareness of the emergency medical team to treat STEMI patients properly based on standard protocols. The increasing awareness of treating STEMI was also found in non-PCI centers as shown by higher utilization of fibrinolytic therapy than in PCI centers (Table 1).

The main reason for STEMI patients not receiving acute reperfusion therapy in this study was mainly due to high proportion of STEMI patients (61%) who were admitted to the hospital late after symptom onset (>12 h). A large proportion of non-reperfused patients (79%) were admitted directly to a non-PCI center (self presenters) (Table 2). These findings suggest that the awareness of the STEMI care in the community should also be raised. Such a program may include a public campaign to educate the public about the signs and symptoms of myocardial infarction, emphasis on early recognition and treatment, and national emergency call center campaign

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(119). These efforts are expected to give knowledge to the community to come earlier to the hospital if a heart attack is suspected.

**Academic versus non-academic PCI center for STEMI care**

The majority of STEMI patients (81%) admitted to six academic PCI centers. PCI centers had more high-risk STEMI patients (killip class 2-4 and TIMI score ≥4) compared with patients at non-PCI centers. The uptake of trans-radial access for primary PCI is well accepted in the region, as shown by the majority of patients had trans-radial PCI at both academic and non-academic centers. The use of supporting device like IABP was similar. However, in academic center, the DTD time was shorter than non-academic centers. The reason is likely to be associated with the highly involvement of clinical trials for STEMI patients at the academic centers or the presence of mature processes of care for STEMI patients. This may also explain the higher use of DES and manual thrombectomy in academic centers. Importantly, the in-hospital mortality between academic and non-academic centers was similar (Table 3); however, longer-term follow-up may be necessary to determine whether there are substantive differences in outcomes between academic and non-academic centers.

A post-hoc analysis of data from the FAST-MI registry showed that when managing patients with STEMI, a hospital's capability to perform PCI matters more than its status as an academic or nonacademic medical center (19). Primary PCI centers should have a comprehensive approach to treat STEMI patients that encompasses the journey from ED to the cath-lab, regardless of academic affiliation.

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**Calling for improvement in pre-hospital care of STEMI patients**

Non-reperfused STEMI patients at PCI centers are predominantly transferred from other centers through a transfer process (Table 2). We found that in STEMI patients transferred for primary PCI, TIMI risk score ≥ 4 was the strongest predictor of a prolonged DI-DO time (>180 minutes) with adjusted OR=2.08 (Figure 1). In other words, high-risk STEMI patients were likely to stay longer at the referral center, whereas such patients should be transferred to a PCI center for a rapid reperfusion therapy. Furthermore, 52% of non-reperfused STEMI patients at PCI centers were transferred through a transfer process. The results suggest that there are opportunities to improve pre-hospital care. The delay in transferring the patient suggests that there should be increased consideration of fibrinolytic therapy at the referral hospital, then rapid transfer to a PCI center similar to the STREAM trial protocol (20). Routine educational program for health care professionals (general practitioners and nurses) who worked at the ED of referral centers is the key to improve the skill and knowledge for treating and transferring STEMI patients rapidly. The pre-hospital triage form (data sheet) should be used extensively and collected in a real time manner.

The DI-DO time is used as the clinical performance of the pre-hospital care, as part of the quality indicator of the STEMI network at Jakarta and the surrounding area. In this study, the mean DI-DO time was 186 ± 111 minutes. In the real world experience, it is difficult to achieve a targeted DI-DO time of <30 minutes, as recommended by the guideline, particularly in developing countries. A recent report from a US study showed that the achievement of a DI-DO time <30 minutes was only 9.7% of STEMI patients transferred for primary PCI (21). More studies are needed

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focusing the DI-DO time at developing countries in order to evaluate factors associated with and solutions for a prolonged DI-DO time.

**Challenges in implementing a regional STEMI registry**

Motivating physician to participate and controlling data completeness were two difficulties faced by the primary investigator when implementing the regional STEMI registry. However, routine discussions with physician at the other hospitals about the aim of the registry may eliminate such challenges. Other challenge includes convincing non-cardiac hospitals to participate and share their data. There is concern regarding data security and fear of a negative results from the analysis. These barriers should not exist since not all people have access to the database, and data were analyzed anonymously on a routine basis. Each hospital may have access to their data for an internal analysis.

**The concept of Megapolitan STEMI network**

Around 26 million inhabitants reside at Jakarta and the 4 districts surrounding the metropolitan. In total, there are 266 cardiologists and 46 PCI centers. Looking at the number of population, geographical and administration coverage, the STEMI network in the region is in transformation to a megapolitan network (Figure 2). The network service will be divided into nine zones. Each zone will develop a heart line (single call activation) located in the ED of the receiving PCI centers. The network is coordinated by the emergency medical service and it encompasses the public

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emergency system (prehospital units, primary health care-based emergency units, general hospitals and STEMI hospitals). A twelve lead ECG transmission scheme is mandatory in the protocol through several methods (14). The 24/7 STEMI hospitals at each zone will receive the ECG transmission. If a STEMI is diagnosed, the patients will be transferred to the nearest available PCI center. A pharmaco-invasive strategy is adopted in the network. The megapolitan network concept and potential time metrics identified can be seen on Figure 2 and 3.

The proliferation of PCI-capable hospitals with efficient regionalized integrated STEMI network, along with accelerating interventional cardiology education to young cardiologists is the main concept for developing the future STEMI network in order to improve outcomes for STEMI patients in the megapolitan area.

**Future health care research/registries in developing country**

In a developing country, it is more efficient to have a large electronic health database that can be used to evaluate the current theurapeutic modalities than doing experimental studies. Large health database provides opportunities for research and large data studies may greatly reduce costs without sacrificing quality. For example, in STEMI research, large database is usually used as source of data for measuring the performance of the STEMI network by analyzing the reperfusion therapy status, thus the results of the studies are used to improve the quality of care for STEMI patients.

In the future, large data set/registries will be used extensively as part of the modern health care system in developing countries and become the main data source for research that may facilitate the development and improvement of the national health care strategy. The current JAC registry has been expanded to other centers in the four districts, and will be used as the main concept for making a national ACS

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registry that is currently not available in Indonesia. The data will become the main source of data for measuring the performance of the STEMI care in the country.

**Study limitation**

The major limitation found in this study is the data coverage. Currently, only 26% of all centers in the metropolitan area are participating in the registry. However, major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well.

**Conclusion**

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. Focusing the pre-hospital care in the network is still mandatory to improve the DI-DO time along with improvement of DTD time at PCI centers. The expansion of the registry affords the opportunity to improve the care of STEMI patients in the country.

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**Figure Legends:**

Figure 1.

Multivariate predictors of a prolonged DI-DO time in STEMI patients transferred for primary PCI.

Figure 2.

The schematic diagram of the five districts (nine zones) in the Jakarta Megapolitan STEMI network.

Figure 3.

Time metrics variables identified in the Jakarta Megapolitan STEMI network. STEMI= ST-elevation myocardial infarction, PCI= percutaneous coronary intervention, IRA= infarct-related artery, DTD= door-to-device, DI-DO= door-in to door-out, FMC= first medical contact, EMS= emergency medical service.

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| | PCI Center (N=917 ) | Non-PCI Center (N=107) | P Value |
|---|---|---|---|
| Age, years | 55.93 ± 10.07 | 55.29 ± 10.31 | 0.535 |

Table 1. JAC registry database consist of 1024 STEMI patients.

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| | | | |
|---|---|---|---|
| Male gender, N (%) | 788 (86%) | 91 (85%) | 0.80 |
| Onset of STEMI, hours | 7 (0.25 – 240) | 3 (0.50-120) | 0.004 |
| Systolic blood pressure, mmHg | 129 (53-254) | 130 (60-200) | 0.456 |
| Diastolic blood pressure, mmHg | 78 (30-182) | 80 (0-120) | 0.255 |
| Heart rate, beats per minute | 81 (20-210) | 86 (41-189) | 0.483 |
| Source of referral, N(%) | | | |
| Public health center | 6 (0.6%) | 6 (5.6%) | <0.001 |
| Inter-hospital | 514 (56%) | 10 (9.3%) | <0.001 |
| Intra-hospital | 17 (1.85%) | 2 (1.9%) | 1.0 |
| Self Walk-in | 367 (40%) | 86 (80%) | <0.001 |
| Private clinic | 13 (1.41%) | 3 (2.8%) | 0.23 |
| CAD Risk factors, N (%) | | | |
| Hypertension | 496 (54%) | 57 (53%) | 0.951 |
| Diabetes mellitus | 260 (28%) | 28 (26%) | 0.674 |
| Family history | 138 (15%) | 18 (17%) | 0.600 |
| Dyslipidemia | 278 (30%) | 25 (23%) | 0.151 |
| Smoker | 575 (63%) | 53 (49%) | 0.037 |
| Location of MI, N (%) | | | |
| Anterior | 238 (26%) | 37 (34.6%) | 0.01 |
| Killip class 1 at presentation, N (%) | 646 (70.4%) | 89 (83.2%) | 0.006 |
| TIMI Score ≥ 4 | 549 (59.8%) | 25 (23.3%) | <0.001 |
| Acute reperfusion therapy, N (%) | | | |
| Fibrinolytic Therapy | 59 (6.4%) | 19 (17.7%) | < 0.001 |
| Primary PCI | 473 (51.6%) | NA | NA |
| Non-reperfused | 385 (42%) | 88 (82.2%) | < 0.001 |

STEMI= ST-elevation myocardial infarction, CAD= coronary artery disease, MI= myocardial infarction, TIMI= thrombolysis in myocardial infarction, PCI= percutaneous coronary intervention.

Table 2. Characteristics of non-reperfused STEMI patients.

| | PCI Center (N=387) | Non-PCI Center (N=86) | P-Value |
|---|---|---|---|
| Source of referral, N (%) | | | |
| Public health center | 1 (0.2%) | 6 (6.9%) | <0.001 |
| Inter-hospital | 203 (52%) | 8 (9.3%) | <0.001 |
| Intra-hospital | 12 (3.1%) | 2 (2.3%) | 0.7 |
| Self walk-in | 163 (42%) | 68 (79%) | <0.001 |
| Private clinic | 8 (2.1%) | 2 (2.3%) | 0.88 |
| TIMI risk score ≥ 4 | 266 (69%) | 41 (48%) | <0.001 |
| Anterior wall MI, N (%) | 129 (33%) | 42 (49%) | 0.009 |
| Onset > 12 hours, N (%) | 264 (68%) | 27 (31%) | <0.001 |

TIMI= thrombolysis in myocardial infarction, MI= myocardial infarction.

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Table 3. Primary PCI characteristics at PCI centers (N=473). Characteristics of STEMI patients who underwent primary PCI.

| | Academic Center (N=415) | Non-Academic Center (N=58) | P-Value |
|---|---|---|---|
| Vascular access , N (%) | | | |
| Radial artery | 228/409 (56%) | 39/58 (67%) | 0.09 |
| Thrombectomy, N (%) | 248/413 (60%) | 8/58 (14%) | < 0.001 |
| Door-to-device time, minutes | 96 ± 44 | 140 ± 151 | <0.001 |
| Stent type | | | |
| Drug-eluting stent | 348/400 (87%) | 38/55 (69%) | 0.001 |
| Coronary artery by-pass graft | 1 (0.2%) | 0 (0) | 1.0 |
| Use of intraaortic balloon pump, N (%) | 9 (2.2%) | 2 (3.4%) | 0.63 |
| Infarct Related Artery, N (%) | | | |
| LAD | 217/409 (53%) | 30/56 (53.6%) | 0.94 |
| LCX | 24/409 (5.9%) | 4/56 (7.1%) | 0.76 |
| RCA | 168/409 (41%) | 22/56 (39.3%) | 0.79 |
| LM | 0 | 0 | NA |
| Coronary Angiography Result | | | |
| 1 VD | 177 (42.7%) | 21 (36.8%) | 0.39 |
| 2 VD | 134 (32.4%) | 16 (28%) | 0.51 |
| 3 VD | 103 (24.9%) | 20 (35.1%) | 1.0 |
| Clinical outcome, N (%) | | | |
| Cerebrovascular disease | 9 (2.2%) | 0 (0) | 0.61 |
| Mechanical complication | 4 (0.9%) | 0 (0) | 1.0 |
| In-hospital mortality, N (%) | 13 (3.1%) | 2 (3.4%) | 0.70 |

Table 4. Crude In-hospital mortality.

| | Primary PCI (N=473) | Fibrinolytic therapy (N=78) | Non-reperfused patients (N=473) | P-Value |
|---|---|---|---|---|
| In-hospital mortality, N (%) | 15 (3.2%) | 3 (3.8%) | 43 (9.1%) | <0.001 |

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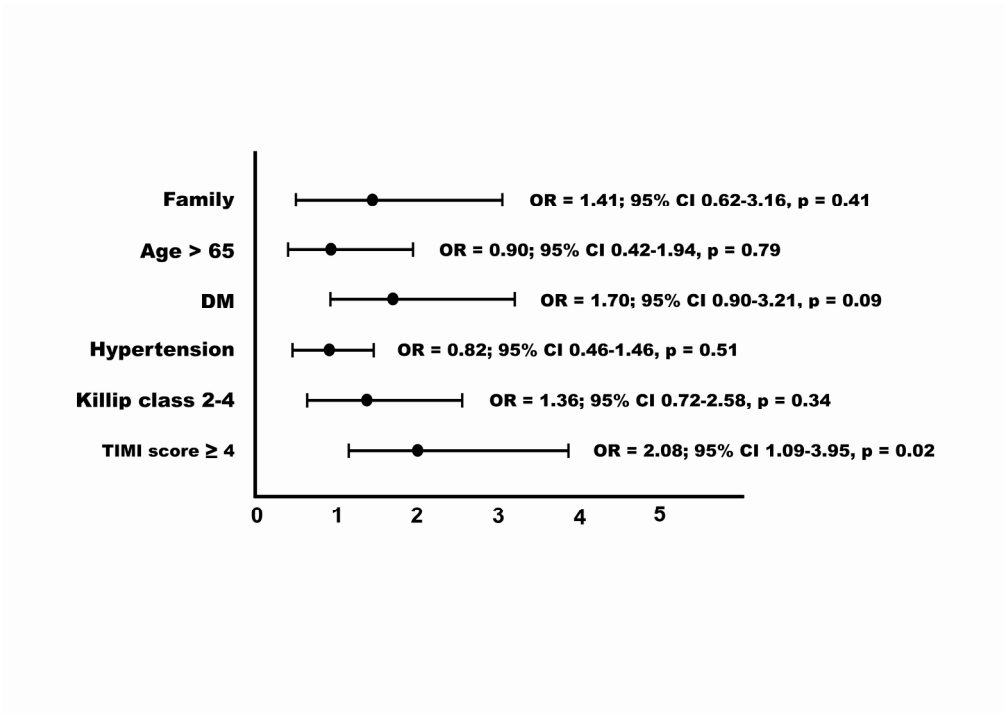


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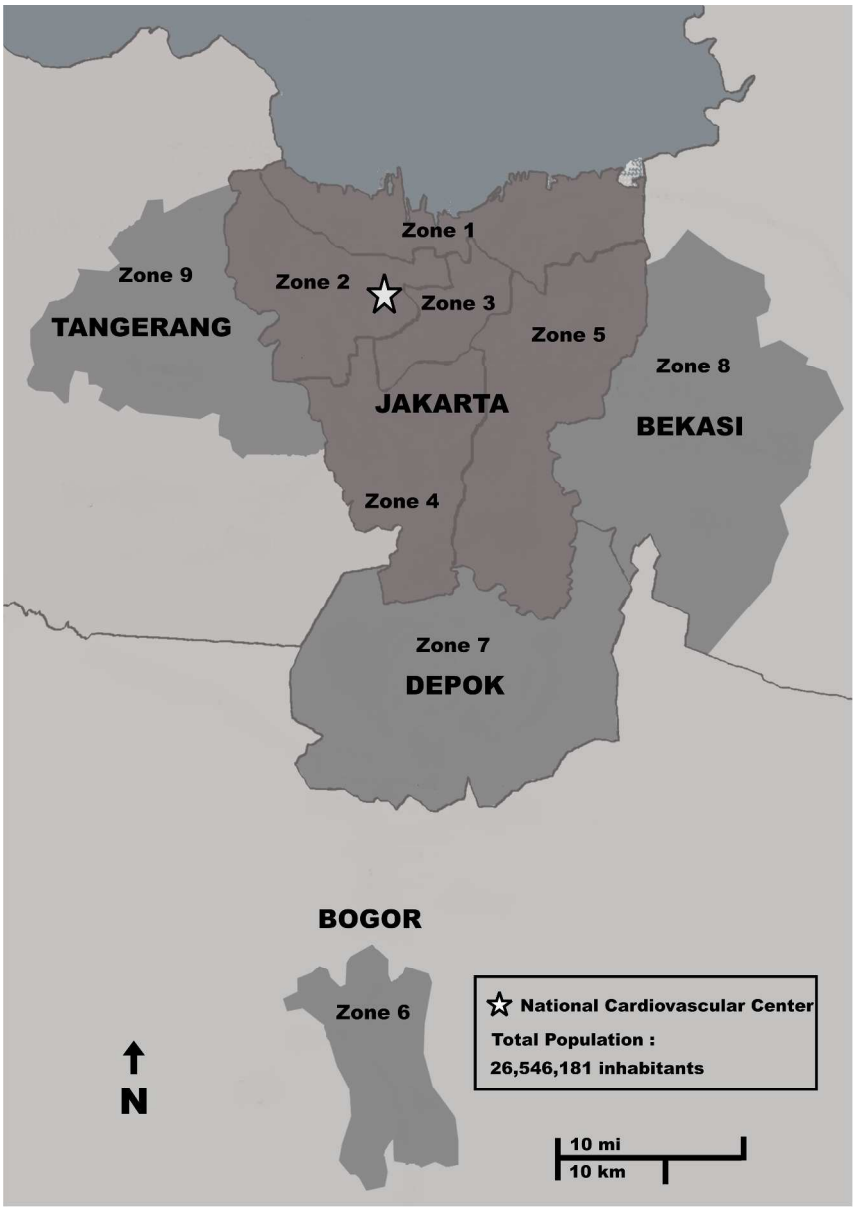


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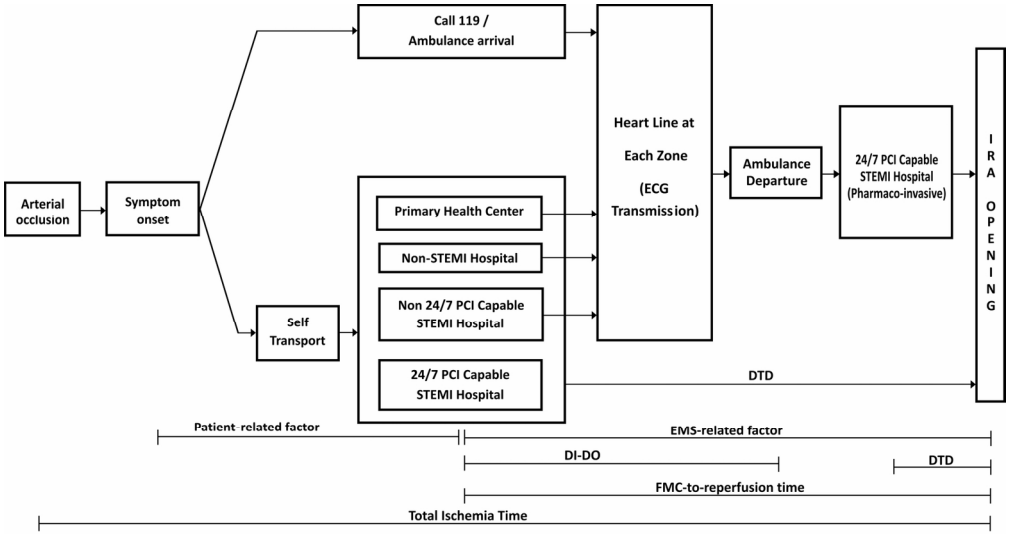


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# Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry



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# TITLE PAGE

Full Title: Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry

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Objective

We studied the characteristics of STEMI patients after expansion of a STEMI registry as part of the STEMI network program in the metropolitan city and the surrounding area covering ~ 26 million inhabitants.

Design

Retrospective cohort study

Setting

Emergency department of 56 health centers

Participants

3015 patients with acute coronary syndrome, of which 1024 patients had STEMI

Main outcome measure

Characteristics of reperfusion therapy

Results

The majority of STEMI patients (81%; N=826) were admitted to 6 academic PCI centers. PCI centers received patients predominantly (56%; N=514) from a transfer process. The proportion of patients receiving acute reperfusion therapy was higher than non-reperfused patients (54% vs. 46%, p<0.001), and primary PCI was the most common method of reperfusion (86%). The mean door-to-device (DTD) time was 102 ± 68 minutes. In-hospital mortality of non-reperfused patients was higher than patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%,

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p<0.001). Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers who underwent primary PCI had shorter mean DTD time (96 ± 44 minutes vs. 140 ± 151 minutes, p<0.001), higher use of manual thrombectomy (60.2% vs.13.8%, p<0.001) and drug-eluting stent implantation (87% vs. 69%, p=0.001), but had similar use of radial approach and intra-aortic balloon pump (55.7% vs. 67.2%, and 2.2% vs. 3.4%, respectively). In patients transferred for primary PCI, TIMI risk score ≥ 4 on presentation was associated with a prolonged door-in to door-out (DI-DO) time (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02).

Conclusions

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. In developing countries, focusing the pre-hospital care in the network should be a major focus of care to improve the DI-DO time along with improvement of DTD time at PCI centers.

Keywords: STEMI, system of care, registry, developing country, metropolitan

Strengths and limitations of this study

1. We were able to include 56 health centers that participate in this study and enroll 3015 patients with acute coronary syndrome, of which 1024 patients had STEMI.
2. This study describes detailed reperfusion characteristic in the 56 health centers located in the metropolitan area of a developing country.

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3. This study is part of the performance measures of the STEMI care (Jakarta Cardiovascular Care Unit Network System) and the results are used to improve the care of STEMI patients in the metropolitan area.
4. This study focuses the pre-hospital care of STEMI patients, by means of the door-in to door-out time (DI-DO); Improvement of the time metrics (DI-DO) may improve the reperfusion time for STEMI patients in the metropolitan city of a developing country.
5. An important limitation of the study is data coverage. The coverage of the health centers participating in the registry is 26% of all centers in the metropolitan area, but major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well.

## Introduction

The main goal of a clinical registry of ST-segment elevation myocardial infarction (STEMI) patients is to narrow the gap between evidence and clinical practice, by providing important data to cardiologists and health care authorities. The registry data consist of acute management of STEMI, demographic profile, risk prediction tool, timing and type of reperfusion treatment, and outcomes (1-2). The registry records the full spectrum of patients with STEMI, and usually used as a source of data for measuring the performance of an existing STEMI network. The performance measures provide feedback to clinicians and are used to improve the quality of STEMI care and outcomes (3).

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During the last decade, the results from several established large health database/registries in developed countries such as GRACE (2), FAST-MI (4), NCDR (3,5), NRMI (6), and Vienna STEMI (7) gave important contribution in optimizing the care of acute coronary syndrome (ACS) patients. All the established registries may reflect the true characteristics of the ACS patients in each region because other hospitals in the region are actively involved in data collection. The findings from the registries may optimize the care of ACS patients not only in the region where the registry is being conducted, but the data may also inform the treatment of ACS patients worldwide; thus the findings from these registries are often adopted into the European (8) and American guidelines recommendations (9).

In contrast to those registries in developed countries, there are still limited numbers of ACS registries in developing countries (10). The present study was done to analyze the characteristics of STEMI patients in a large metropolitan catchment area of a developing country where a STEMI registry, the Jakarta Acute Coronary syndrome (JAC) registry, has been applied extensively as part of the regional STEMI network program in the metropolitan city and the surrounding area that consist of ~ 26 million inhabitants. The results of the present study are expected to give insights to improve the STEMI care in the country.

## Methods

JAC registry

The JAC registry is an on-going, observational registry collecting data on demographic, characteristics, management, and outcomes of patients with ACS that began as an initiative only in the emergency department (ED) of a tertiary academic

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hospital located in a metropolitan city (Jakarta, Indonesia) (11). Since October 2014, the JAC registry has gradually been applied in other hospitals in the metropolitan and the surrounding areas.

At the time of the present analysis, 56 centers were actively participating in the JAC registry. All consecutive ACS patients admitted to each center are recorded into a standardized registry form. Data quality is maintained through a careful evaluation by the cardiologist or physician at the participating center. After verification, the data are sent electronically to the data analytic center at the National Cardiovascular Center Harapan Kita, on a regular basis. At the data analytic center, the data are controlled by a monthly data monitoring by the primary investigator of the JAC registry (SD). Using the JAC registry database, we analyzed the characteristics of ACS patients (N=3015), of which 1024 were STEMI patients.

The JAC registry is the main data source for measuring the performance of the regional STEMI network, namely Jakarta Cardiovascular Care Unit (CCU) Network System. Several performance measures have been undertaken, and the results were used to improve the system of care for acute myocardial infarction (AMI) in the region (11-14).

Jakarta CCU Network System

Since 2010, the "get with the guidelines" project for STEMI in Jakarta was translated by building a STEMI network (Jakarta CCU Network System). The metropolitan city (Jakarta) has ~ 11 million inhabitants (13,14). In the surrounding area of Jakarta, there are many hospitals that by administration do not belong to Jakarta province, but geographically, many hospitals are located near the metropolitan city. Therefore, in daily practice, many STEMI patients at the surrounding area of

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Jakarta are transferred to PCI centers at the metropolitan city for reperfusion therapy. In total, there are ~ 26 million inhabitants in the five districts of the catchment area (Jakarta, Bogor, Depok, Tangerang, Bekasi) (Figure 1).

The network has provided several STEMI algorithms, including the pre-hospital triage and checklist for fibrinolytic therapy. An ECG transmission scheme is mandatory using several transmission methods (13,14). This study is part of the regular analysis of the performance measures for the regional STEMI network.

Management protocol

The acute management of STEMI patients was in accordance with the European Society of Cardiology guidelines (8) and applied at all participating centers. For patients undergoing primary PCI, 600 mg of clopidogrel or 180 mg ticagrelor was given either in the pre-hospital or in-hospital setting. Before primary PCI, all patients received an intravenous bolus of unfractionated heparin in the cath-lab (50 IU/kg if receiving glycoprotein IIb/IIIa inhibitor [GPI] or 100 IU/kg if not receiving GPI).

The choice of vascular access, thrombus aspiration, direct stenting, balloon predilation, and use of intra-aortic balloon pump during primary PCI were at the operator's discretion.

Pre-hospital care of STEMI patients

The STEMI algorithm was used as the main protocol for treating STEMI patients in the region (11,14) including a pre-hospital triage form (13). The main metrics to evaluate the pre-hospital care of STEMI patients transferred for primary PCI is the door-in to door-out (DI-DO) time.

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Study outcome and definition

The primary outcome of the study was the proportion of patients receiving acute reperfusion therapy (primary PCI or fibrinolytic therapy). Other outcomes were in-hospital mortality and DI-DO time. PCI center was defined as receiving centers for primary PCI. Academic center was defined as university teaching hospital for medical students engaged in research, or clinical or related service (15). DI-DO time (in minutes) was defined as the time spent by a STEMI patient at the primary care (pre-hospital setting) before being transferred to a PCI center, measured by time difference between admission and referral time from the referral center (16). Killip classification (17) and thrombolysis in myocardial infarction (TIMI) risk score (18) were evaluated at presentation.

Statistical methods

Categorical data are expressed as percentage and continuous data are expressed as mean ± standard deviation. For continuous data that are not distributed normally, the data are expressed as median (range). We compared the demographic and clinical characteristics of STEMI patients between PCI and non-PCI centers. The primary PCI procedural data were compared between academic and non-academic PCI centers. The characteristics of non-reperfused patients were also described. Continuous variables were compared with Student's *t*-test or Mann Whitney *U*-test and Chi-square test or Fisher`s exact test were used to compare categorical variables as appropriate. Multivariate predictor of prolonged DI-DO time was analyzed using logistic regression analyses in STEMI patients transferred for primary PCI. The cut-off for a prolonged DI-DO time in this study was >180 minutes.

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All statistical tests were two-tailed and a p-value <0.05 was considered significant. Statistical analyses were performed with SPSS for Windows version 17.0 (SPSS Inc, Chicago, Illinois, USA).

## Results

### Study sample

Between October 2014 and July 2015, a total of 1024 STEMI patients were admitted to the emergency departments of the participating health centers, 917 (89%) were admitted to PCI centers, and the remaining (11%) admitted to non-PCI center. Of these, the majority of STEMI patients (81%; N=826) were admitted to six academic PCI centers.

### Clinical characteristics

Both STEMI patients at PCI Centers (86%) and non-PCI centers (85%) were dominantly male. PCI centers received patients predominantly (56%; N=514) from a transfer process, while patients at non-PCI centers were dominantly patients who presented directly/self presentation (80%; N=86). Smoking was a common risk factor in the overall STEMI population (61%; N=628). Patients at non-PCI centers had more Killip class 1 but fewer TIMI score ≥4 as compared with patients admitted to PCI centers (Table 1).

### Characteristics of reperfusion therapy

The proportion of patients receiving acute reperfusion therapy (fibrinolytic therapy or primary PCI) was higher than non-reperfused patients [54%; (N=551) vs. 46%; (N=473), p<0.001], and primary PCI was the most commonly method of

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reperfusion (86%). As expected, the utilization of thrombolysis therapy was significantly higher at non-PCI centers than in PCI centers (17.7% vs. 6.4%, p<0.001) (Table 1).

Characteristics of non-reperfused patients

Non-reperfused STEMI patients admitted to PCI centers were commonly coming through a transfer process (52%), while most patients at non-PCI centers (79%) were self-presenters. The majority of non-reperfused patients arrived at the ED more than 12 hours after symptom onset (N=291; 61%) (Table 2).

Angiographic and procedural characteristics

Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers and underwent primary PCI had higher use of manual thrombectomy and drug-eluting stent implantation (60% vs.14%, p<0.001 and 87% vs. 69%, p=0.001, respectively), but had similar use of trans-radial approach and intra-aortic balloon pump (56% vs. 67%, and 2.2% vs 3.4%, respectively). The mean DTD time was 102 ± 68 minutes. At academic centers, the mean DTD time was shorter than at non-academic centers (96 ± 44.3 vs. 140 ± 151 minutes). The left anterior descending was the most common infarct-related artery (53%) (Table 3).

In-hospital mortality

In-hospital mortality of non-reperfused STEMI patients was significantly higher than STEMI patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%, p<0.001) (Table 4). The in-hospital mortality between academic and non-academic centers was similar (3.1% vs. 3.4%) (Table 3).

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Predictor of a prolonged DI-DO time in STEMI patients transferred for primary PCI

The mean DI-DO time in this study was 186 ± 111 minutes. After adjustment with several clinical variables (female sex, older age, diabetes mellitus, hypertension, Killip classification and TIMI risk score), TIMI risk score ≥ 4 on presentation was associated with a prolonged DI-DO time (>180 minutes) (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02) (Figure 1).

## Discussion

The JAC registry was created to improve the quality of care for ACS patients (particularly STEMI) by providing information on acute management of STEMI, risk prediction tool, timing and type of reperfusion treatment. The results from the registry analysis will be translated into clinical practice by giving knowledge on how to improve patient care and outcomes. Since its inception in 2007, the JAC registry has contributed to the improvement of STEMI care in the region (12-14). Recently, the JAC registry has been expanded to 56 health centers and like other registries (4-7), this report is used as performance measures for the STEMI care that included several insights to improve the STEMI care in the region which are described below. The challenges found in implementing the regional registry and the concept for future network in the region are also discussed.

### Changes in acute reperfusion therapy

The number of STEMI patients who received reperfusion therapy was higher than non-reperfused patients (54% vs. 46%) and primary PCI was commonly used (86%). An earlier report showed that the number of non-reperfused STEMI patients

was higher than patients receiving acute reperfusion therapy (59% vs. 41%) (11). The current finding suggests that implementation of the regional STEMI network has contributed to improvement of daily management of STEMI patient in the region, as shown by the higher proportion of patients receiving acute reperfusion therapy.

Our previous report (14) demonstrated the need to apply the registry extensively in the region as part of the STEMI network program. The wide adoption of the registry may partly explain the changes of reperfusion strategy in the region. Each participating center may evaluate the characteristics of patients admitted to the center, that in turn, it may increase the awareness of the emergency medical team to treat STEMI patients properly based on standard protocols. The increasing awareness of treating STEMI was also found in non-PCI centers as shown by higher utilization of fibrinolytic therapy than in PCI centers (Table 1).

The main reason for STEMI patients not receiving acute reperfusion therapy in this study was mainly due to high proportion of STEMI patients (61%) who were admitted to the hospital late after symptom onset (>12 h). A large proportion of non-reperfused patients (79%) were admitted directly to a non-PCI center (self presenters) (Table 2). These findings suggest that the awareness of the STEMI care in the community should also be raised. Such a program may include a public campaign to educate the public about the signs and symptoms of myocardial infarction, emphasis on early recognition and treatment, and national emergency call center campaign (119). These efforts are expected to give knowledge to the community to come earlier to the hospital if a heart attack is suspected.

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**Academic versus non-academic PCI center for STEMI care**

The majority of STEMI patients (81%) admitted to six academic PCI centers. PCI centers had more high-risk STEMI patients (killip class 2-4 and TIMI score ≥4) compared with patients at non-PCI centers. The uptake of trans-radial access for primary PCI is well accepted in the region, as shown by the majority of patients had trans-radial PCI at both academic and non-academic centers. The use of supporting device like IABP was similar. However, in academic center, the DTD time was shorter than non-academic centers. The reason is likely to be associated with the highly involvement of clinical trials for STEMI patients at the academic centers or the presence of mature processes of care for STEMI patients. This may also explain the higher use of DES and manual thrombectomy in academic centers. Importantly, the in-hospital mortality between academic and non-academic centers was similar (Table 3); however, longer-term follow-up may be necessary to determine whether there are substantive differences in outcomes between academic and non-academic centers.

A post-hoc analysis of data from the FAST-MI registry showed that when managing patients with STEMI, a hospital's capability to perform PCI matters more than its status as an academic or nonacademic medical center (19). Primary PCI centers should have a comprehensive approach to treat STEMI patients that encompasses the journey from ED to the cath-lab, regardless of academic affiliation.

**Calling for improvement in pre-hospital care of STEMI patients**

Non-reperfused STEMI patients at PCI centers are predominantly transferred from other centers through a transfer process (Table 2). We found that in STEMI patients transferred for primary PCI, TIMI risk score ≥ 4 was the strongest predictor of a prolonged DI-DO time (>180 minutes) with adjusted OR=2.08 (Figure 1). In

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other words, high-risk STEMI patients were likely to stay longer at the referral center, whereas such patients should be transferred to a PCI center for a rapid reperfusion therapy. Furthermore, 52% of non-reperfused STEMI patients at PCI centers were transferred through a transfer process. The results suggest that there are opportunities to improve pre-hospital care. The delay in transferring the patient suggests that there should be increased consideration of fibrinolytic therapy at the referral hospital, then rapid transfer to a PCI center similar to the STREAM trial protocol (20). Routine educational program for health care professionals (general practitioners and nurses) who worked at the ED of referral centers is the key to improve the skill and knowledge for treating and transferring STEMI patients rapidly. The pre-hospital triage form (data sheet) should be used extensively and collected in a real time manner.

The DI-DO time is used as the clinical performance of the pre-hospital care, as part of the quality indicator of the STEMI network at Jakarta and the surrounding area. In this study, the mean DI-DO time was 186 ± 111 minutes. In the real world experience, it is difficult to achieve a targeted DI-DO time of <30 minutes, as recommended by the guideline, particularly in developing countries. A recent report from a US study showed that the achievement of a DI-DO time <30 minutes was only 9.7% of STEMI patients transferred for primary PCI (21). More studies are needed focusing the DI-DO time at developing countries in order to evaluate factors associated with and solutions for a prolonged DI-DO time.

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**Challenges in implementing a regional STEMI registry**

Motivating physician to participate and controlling data completeness were two difficulties faced by the primary investigator when implementing the regional STEMI registry. However, routine discussions with physician at the other hospitals about the aim of the registry may eliminate such challenges. Other challenge includes convincing non-cardiac hospitals to participate and share their data. There is concern regarding data security and fear of a negative results from the analysis. These barriers should not exist since not all people have access to the database, and data were analyzed anonymously on a routine basis. Each hospital may have access to their data for an internal analysis.

**The concept of Megapolitan STEMI network**

Around 26 million inhabitants reside at Jakarta and the 4 districts surrounding the metropolitan. In total, there are 266 cardiologists and 46 PCI centers. Looking at the number of population, geographical and administration coverage, the STEMI network in the region is in transformation to a megapolitan network (Figure 2). The network service will be divided into nine zones. Each zone will develop a heart line (single call activation) located in the ED of the receiving PCI centers. The network is coordinated by the emergency medical service and it encompasses the public emergency system (prehospital units, primary health care-based emergency units, general hospitals and STEMI hospitals). A twelve lead ECG transmission scheme is mandatory in the protocol through several methods (14). The 24/7 STEMI hospitals at each zone will receive the ECG transmission. If a STEMI is diagnosed, the patients will be transferred to the nearest available PCI center. A pharmaco-invasive strategy

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is adopted in the network. The megapolitan network concept and potential time metrics identified can be seen on Figure 2 and 3.

The proliferation of PCI-capable hospitals with efficient regionalized integrated STEMI network, along with accelerating interventional cardiology education to young cardiologists is the main concept for developing the future STEMI network in order to improve outcomes for STEMI patients in the megapolitan area.

**Future health care research/registries in developing country**

In a developing country, it is more efficient to have a large electronic health database that can be used to evaluate the current theurapeutic modalities than doing experimental studies. Large health database provides opportunities for research and large data studies may greatly reduce costs without sacrificing quality. For example, in STEMI research, large database is usually used as source of data for measuring the performance of the STEMI network by analyzing the reperfusion therapy status, thus the results of the studies are used to improve the quality of care for STEMI patients.

In the future, large data set/registries will be used extensively as part of the modern health care system in developing countries and become the main data source for research that may facilitate the development and improvement of the national health care strategy. The current JAC registry has been expanded to other centers in the four districts, and will be used as the main concept for making a national ACS registry that is currently not available in Indonesia. The data will become the main source of data for measuring the performance of the STEMI care in the country.

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**Study limitation**

The major limitation found in this study is the data coverage. Currently, only 26% of all centers in the metropolitan area are participating in the registry. However, major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well.

**Conclusion**

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. Focusing the pre-hospital care in the network is still mandatory to improve the DI-DO time along with improvement of DTD time at PCI centers. The expansion of the registry affords the opportunity to improve the care of STEMI patients in the country.

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**Data sharing**: no additional data available

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**Figure Legends:**

Figure 1.

Multivariate predictors of a prolonged DI-DO time in STEMI patients transferred for primary PCI.

Figure 2.

The schematic diagram of the five districts (nine zones) in the Jakarta Megapolitan STEMI network.

Figure 3.

Time metrics variables identified in the Jakarta Megapolitan STEMI network. STEMI= ST-elevation myocardial infarction, PCI= percutaneous coronary intervention, IRA= infarct-related artery, DTD= door-to-device, DI-DO= door-in to door-out, FMC= first medical contact, EMS= emergency medical service.

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Table 1. JAC registry database consist of 1024 STEMI patients.

| | PCI Center (N=917 ) | Non-PCI Center (N=107) | P Value |
|---|---|---|---|
| Age, years | 55.93 ± 10.07 | 55.29 ± 10.31 | 0.535 |
| Male gender, N (%) | 788 (86%) | 91 (85%) | 0.80 |
| Onset of STEMI, hours | 7 (0.25 – 240) | 3 (0.50-120) | 0.004 |
| Systolic blood pressure, mmHg | 129 (53-254) | 130 (60-200) | 0.456 |
| Diastolic blood pressure, mmHg | 78 (30-182) | 80 (0-120) | 0.255 |
| Heart rate, beats per minute | 81 (20-210) | 86 (41-189) | 0.483 |
| Source of referral, N(%) | | | |
| Public health center | 6 (0.6%) | 6 (5.6%) | <0.001 |
| Inter-hospital | 514 (56%) | 10 (9.3%) | <0.001 |
| Intra-hospital | 17 (1.85%) | 2 (1.9%) | 1.0 |
| Self Walk-in | 367 (40%) | 86 (80%) | <0.001 |
| Private clinic | 13 (1.41%) | 3 (2.8%) | 0.23 |
| CAD Risk factors, N (%) | | | |
| Hypertension | 496 (54%) | 57 (53%) | 0.951 |
| Diabetes mellitus | 260 (28%) | 28 (26%) | 0.674 |
| Family history | 138 (15%) | 18 (17%) | 0.600 |
| Dyslipidemia | 278 (30%) | 25 (23%) | 0.151 |
| Smoker | 575 (63%) | 53 (49%) | 0.037 |
| Location of MI, N (%) | | | |
| Anterior | 238 (26%) | 37 (34.6%) | 0.01 |
| Killip class 1 at presentation, N (%) | 646 (70.4%) | 89 (83.2%) | 0.006 |
| TIMI Score ≥ 4 | 549 (59.8%) | 25 (23.3%) | <0.001 |
| Acute reperfusion therapy, N (%) | | | |
| Fibrinolytic Therapy | 59 (6.4%) | 19 (17.7%) | < 0.001 |
| Primary PCI | 473 (51.6%) | NA | NA |
| Non-reperfused | 385 (42%) | 88 (82.2%) | < 0.001 |
| STEMI= ST-elevation myocardial infarction, CAD= coronary artery disease, MI= myocardial infarction, TIMI= thrombolysis in myocardial infarction, PCI= percutaneous coronary intervention. | | | |

Table 2. Characteristics of non-reperfused STEMI patients.

| | PCI Center (N=387) | Non-PCI Center (N=86) | P-Value |
|---|---|---|---|
| Source of referral, N (%) | | | |
| Public health center | 1 (0.2%) | 6 (6.9%) | <0.001 |
| Inter-hospital | 203 (52%) | 8 (9.3%) | <0.001 |
| Intra-hospital | 12 (3.1%) | 2 (2.3%) | 0.7 |
| Self walk-in | 163 (42%) | 68 (79%) | <0.001 |
| Private clinic | 8 (2.1%) | 2 (2.3%) | 0.88 |

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| | | | |
|---|---|---|---|
| TIMI risk score ≥ 4 | 266 (69%) | 41 (48%) | <0.001 |
| Anterior wall MI, N (%) | 129 (33%) | 42 (49%) | 0.009 |
| Onset > 12 hours, N (%) | 264 (68%) | 27 (31%) | <0.001 |
| TIMI= thrombolysis in myocardial infarction, MI= myocardial infarction. | | | |

Table 3. Primary PCI characteristics at PCI centers (N=473). Characteristics of STEMI patients who underwent primary PCI.

| | Academic Center (N=415) | Non-Academic Center (N=58) | P-Value |
|---|---|---|---|
| Vascular access , N (%) | | | |
| Radial artery | 228/409 (56%) | 39/58 (67%) | 0.09 |
| Thrombectomy, N (%) | 248/413 (60%) | 8/58 (14%) | < 0.001 |
| Door-to-device time, minutes | 96 ± 44 | 140 ± 151 | <0.001 |
| Stent type | | | |
| Drug-eluting stent | 348/400 (87%) | 38/55 (69%) | 0.001 |
| Coronary artery by-pass graft | 1 (0.2%) | 0 (0) | 1.0 |
| Use of intraaortic balloon pump, N (%) | 9 (2.2%) | 2 (3.4%) | 0.63 |
| Infarct Related Artery, N (%) | | | |
| LAD | 217/409 (53%) | 30/56 (53.6%) | 0.94 |
| LCX | 24/409 (5.9%) | 4/56 (7.1%) | 0.76 |
| RCA | 168/409 (41%) | 22/56 (39.3%) | 0.79 |
| LM | 0 | 0 | NA |
| Coronary Angiography Result | | | |
| 1 VD | 177 (42.7%) | 21 (36.8%) | 0.39 |
| 2 VD | 134 (32.4%) | 16 (28%) | 0.51 |
| 3 VD | 103 (24.9%) | 20 (35.1%) | 1.0 |
| Clinical outcome, N (%) | | | |
| Cerebrovascular disease | 9 (2.2%) | 0 (0) | 0.61 |
| Mechanical complication | 4 (0.9%) | 0 (0) | 1.0 |
| In-hospital mortality, N (%) | 13 (3.1%) | 2 (3.4%) | 0.70 |

Table 4. Crude In-hospital mortality.

| | Primary PCI (N=473) | Fibrinolytic therapy (N=78) | Non-reperfused patients (N=473) | P-Value |
|---|---|---|---|---|
| In-hospital mortality, N (%) | 15 (3.2%) | 3 (3.8%) | 43 (9.1%) | <0.001 |

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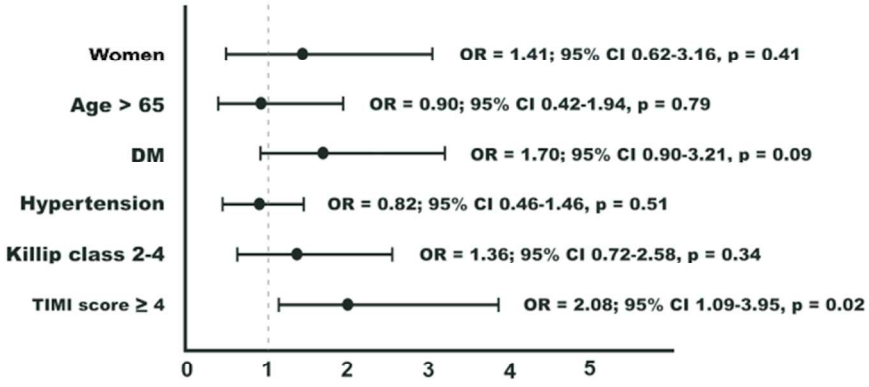


Figure 1

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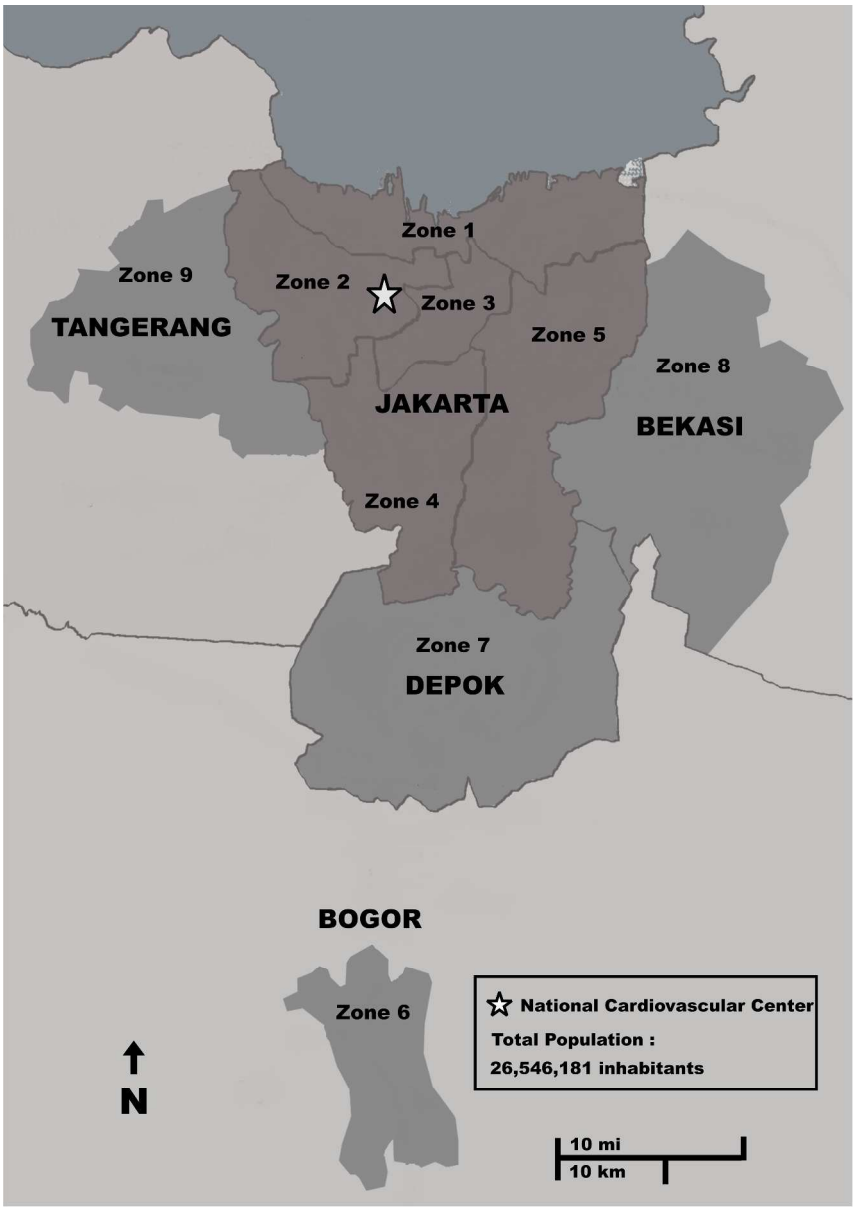


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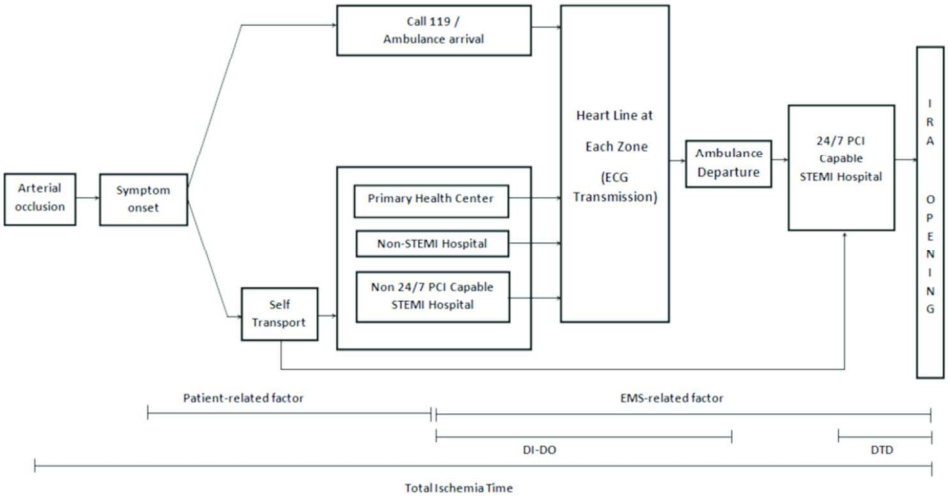


Figure 3

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation |
|---|---|---|
| **Title and abstract** | 1 | √ (*a*) Indicate the study's design with a commonly used term in the title or the abstract |
| | | √ (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found |
| **Introduction** | | |
| Background/rationale | 2 | √ Explain the scientific background and rationale for the investigation being reported |
| Objectives | 3 | √ State specific objectives, including any prespecified hypotheses |
| **Methods** | | |
| Study design | 4 | √ Present key elements of study design early in the paper |
| Setting | 5 | √ Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection |
| Participants | 6 | √ (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed |
| Variables | 7 | √ Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable |
| Data sources/ measurement | 8* | √ For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group |
| Bias | 9 | √ Describe any efforts to address potential sources of bias |
| Study size | 10 | √ Explain how the study size was arrived at |
| Quantitative variables | 11 | √ Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why |
| Statistical methods | 12 | √ (*a*) Describe all statistical methods, including those used to control for confounding |
| | | √ (*b*) Describe any methods used to examine subgroups and interactions |
| | | √ (*c*) Explain how missing data were addressed |
| | | √ (*d*) If applicable, explain how loss to follow-up was addressed |
| | | (*e*) Describe any sensitivity analyses |
| **Results** | | |
| Participants | 13* | √ (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed |
| | | (b) Give reasons for non-participation at each stage |
| | | (c) Consider use of a flow diagram |
| Descriptive data | 14* | √ (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders |
| | | (b) Indicate number of participants with missing data for each variable of interest |
| | | √ (c) Summarise follow-up time (eg, average and total amount) |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time |
| Main results | 16 | √ (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included |



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| | | |
|---|---|---|
| | | √ (*b*) Report category boundaries when continuous variables were categorized |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period |
| Other analyses | 17 | √ Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses |
| **Discussion** | | |
| Key results | 18 | √ Summarise key results with reference to study objectives |
| Limitations | 19 | √ Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias |
| Interpretation | 20 | √ Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence |
| Generalisability | 21 | √ Discuss the generalisability (external validity) of the study results |
| **Other information** | | |
| Funding | 22 | √ Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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BMJ Open

# Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry



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| | |
|---|---|
| | Aminda, Sissy K; Koja General Hospital<br>Basalamah, M Abas; Persahabatan General Hospital<br>Rao, Sunil ; The Duke Clinical Research Institute, Durham, North Carolina |
| Primary Subject Heading: | Cardiovascular medicine |
| Secondary Subject Heading: | Cardiovascular medicine, Health services research |
| Keywords: | Adult cardiology < CARDIOLOGY, Myocardial infarction < CARDIOLOGY, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT |
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# TITLE PAGE

Full Title: Characteristics, treatment, and in-hospital outcomes of STEMI patients in a metropolitan area of a developing country: An initial report of the extended Jakarta Acute Coronary Syndrome Registry

Short title: STEMI system of care in a developing country

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Objective

We studied the characteristics of STEMI patients after expansion of a STEMI registry as part of the STEMI network program in the metropolitan city and the surrounding area covering ~ 26 million inhabitants.

Design

Retrospective cohort study

Setting

Emergency department of 56 health centers

Participants

3015 patients with acute coronary syndrome, of which 1024 patients had STEMI

Main outcome measure

Characteristics of reperfusion therapy

Results

The majority of STEMI patients (81%; N=826) were admitted to 6 academic PCI centers. PCI centers received patients predominantly (56%; N=514) from a transfer process. The proportion of patients receiving acute reperfusion therapy was higher than non-reperfused patients (54% vs. 46%, p<0.001), and primary PCI was the most common method of reperfusion (86%). The mean door-to-device (DTD) time was 102 ± 68 minutes. In-hospital mortality of non-reperfused patients was higher than patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%,



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p<0.001). Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers who underwent primary PCI had shorter mean DTD time (96 ± 44 minutes vs. 140 ± 151 minutes, p<0.001), higher use of manual thrombectomy (60.2% vs.13.8%, p<0.001) and drug-eluting stent implantation (87% vs. 69%, p=0.001), but had similar use of radial approach and intra-aortic balloon pump (55.7% vs. 67.2%, and 2.2% vs. 3.4%, respectively). In patients transferred for primary PCI, TIMI risk score ≥ 4 on presentation was associated with a prolonged door-in to door-out (DI-DO) time (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02).

Conclusions

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. In developing countries, focusing the pre-hospital care in the network should be a major focus of care to improve the DI-DO time along with improvement of DTD time at PCI centers.

Keywords: STEMI, system of care, registry, developing country, metropolitan

Strengths and limitations of this study

1. We were able to include 56 health centers that participate in this study and enroll 3015 patients with acute coronary syndrome, of which 1024 patients had STEMI.
2. This study describes detailed reperfusion characteristic in the 56 health centers located in the metropolitan area of a developing country.

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3. This study is part of the performance measures of the STEMI care (Jakarta Cardiovascular Care Unit Network System) and the results are used to improve the care of STEMI patients in the metropolitan area.
4. This study focuses the pre-hospital care of STEMI patients, by means of the door-in to door-out time (DI-DO); Improvement of the time metrics (DI-DO) may improve the reperfusion time for STEMI patients in the metropolitan city of a developing country.
5. An important limitation of the study is data coverage. At the time of analysis, the coverage of the health centers participating in the registry is 26% of all centers in the metropolitan area, but major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well.

## Introduction

The main goal of a clinical registry of ST-segment elevation myocardial infarction (STEMI) patients is to narrow the gap between evidence and clinical practice, by providing important data to cardiologists and health care authorities. The registry data consist of acute management of STEMI, demographic profile, risk prediction tool, timing and type of reperfusion treatment, and outcomes (1-2). The registry records the full spectrum of patients with STEMI, and usually used as a source of data for measuring the performance of an existing STEMI network. The performance measures provide feedback to clinicians and are used to improve the quality of STEMI care and outcomes (3).



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During the last decade, the results from several established large health database/registries in developed countries such as GRACE (2), FAST-MI (4), NCDR (3,5), NRMI (6), and Vienna STEMI (7) gave important contribution in optimizing the care of acute coronary syndrome (ACS) patients. All the established registries may reflect the true characteristics of the ACS patients in each region because other hospitals in the region are actively involved in data collection. Findings from registries may optimize the care of ACS patients not only in the region where the registry is being conducted, but the data may also inform the treatment of ACS patients worldwide; thus the findings from these registries are often adopted into the European (8) and American guidelines recommendations (9).

In contrast to those registries in developed countries, there are still limited numbers of ACS registries in developing countries (10). The present study was done to analyze the characteristics of STEMI patients in a large metropolitan catchment area of a developing country where a STEMI registry, the Jakarta Acute Coronary syndrome (JAC) registry, has been applied extensively as part of the regional STEMI network program in the metropolitan city and the surrounding area that consist of ~ 26 million inhabitants. The results of the present study are expected to give insights to improve the STEMI care in the country.

## Methods

### JAC registry

The JAC registry is an on-going, observational registry collecting data on demographic, characteristics, management, and outcomes of patients with ACS that began as an initiative only in the emergency department (ED) of a tertiary academic hospital located in a metropolitan city (Jakarta, Indonesia) (11). Since October 2014,

the JAC registry has gradually been applied in other hospitals in the metropolitan and the surrounding areas.

At the time of present analysis, 56 centers were actively participating in the JAC registry. All consecutive ACS patients admitted to each center are recorded into a standardized registry form. Data quality is maintained through a careful evaluation by the cardiologist or physician at the participating center. After verification, the data are sent electronically to the data analytic center at the National Cardiovascular Center Harapan Kita, on a regular basis. At the data analytic center, the data are controlled by a monthly data monitoring by the primary investigator of the JAC registry (SD). Using the JAC registry database (recruitment period: October 2014-July 2015), we analyzed the characteristics of ACS patients (N=3015), of which 1024 were STEMI patients.

The JAC registry is the main data source for measuring the performance of the regional STEMI network, namely Jakarta Cardiovascular Care Unit (CCU) Network System. Several performance measures have been undertaken, and the results were used to improve the system of care for acute myocardial infarction (AMI) in the region (11-14).

Jakarta CCU Network System

Since 2010, the "get with the guidelines" project for STEMI in Jakarta was translated by building a STEMI network (Jakarta CCU Network System). The metropolitan city (Jakarta) has ~ 11 million inhabitants (13,14). In the surrounding area of Jakarta, there are many hospitals that by administration do not belong to Jakarta province, but geographically, located near the metropolitan city. Therefore, in daily practice, many STEMI patients at the surrounding area of Jakarta are transferred



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to PCI centers at the metropolitan city for reperfusion therapy. In total, there are ~ 26 million inhabitants in the five districts of the catchment area (Jakarta, Bogor, Depok, Tangerang, Bekasi) (Figure 1).

The network has provided several STEMI algorithms, including the pre-hospital triage and checklist for fibrinolytic therapy. An ECG transmission scheme is mandatory using several transmission methods (13,14). This study is part of the regular analysis of the performance measures for the regional STEMI network.

Management protocol

The acute management of STEMI patients was in accordance with the European Society of Cardiology guidelines (8) and applied at all participating centers. For patients undergoing primary PCI, 600 mg of clopidogrel or 180 mg ticagrelor was given either in the pre-hospital or in-hospital setting. Before primary PCI, all patients received an intravenous bolus of unfractionated heparin in the cath-lab (50 IU/kg if receiving glycoprotein IIb/IIIa inhibitor [GPI] or 100 IU/kg if not receiving GPI).

The choice of vascular access, thrombus aspiration, direct stenting, balloon predilation, and use of intra-aortic balloon pump during primary PCI were at the operator's discretion.

Pre-hospital care of STEMI patients

The STEMI algorithm was used as the main protocol for treating STEMI patients in the region (11,14) including a pre-hospital triage form (13). The main metrics to evaluate the pre-hospital care of STEMI patients transferred for primary PCI is the door-in to door-out (DI-DO) time.

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Study outcome and definition

The primary outcome of the study was the proportion of patients receiving acute reperfusion therapy (primary PCI or fibrinolytic therapy). Other outcomes were in-hospital mortality and DI-DO time. Academic center was defined as university teaching hospital for medical students engaged in research, or clinical or related service (15). DI-DO time (in minutes) was defined as the time spent by a STEMI patient at the first health-center before being transferred to a PCI center for primary PCI, measured by time difference between admission and referral time from the referral center (16). Killip classification (17) and thrombolysis in myocardial infarction (TIMI) risk score (18) were evaluated at presentation.

Statistical methods

Categorical data are expressed as percentage and continuous data are expressed as mean ± standard deviation. For continuous data that are not distributed normally, the data are expressed as median (range). We compared the demographic and clinical characteristics of STEMI patients between PCI and non-PCI centers. The primary PCI procedural data were compared between academic and non-academic PCI centers. The characteristics of non-reperfused patients were also described. Continuous variables were compared with Student's *t*-test or Mann Whitney *U*-test and Chi-square test or Fisher`s exact test was used to compare categorical variables as appropriate. Multivariate predictor of prolonged DI-DO time was analyzed using logistic regression analyses in STEMI patients transferred for primary PCI. The cut-off for a prolonged DI-DO time in this study was >180 minutes.

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All statistical tests were two-tailed and a p-value <0.05 was considered significant. Statistical analyses were performed with SPSS for Windows version 17.0 (SPSS Inc, Chicago, Illinois, USA).

## Results

### Study sample

Between October 2014 and July 2015, a total of 1024 STEMI patients were admitted to the emergency departments of the participating health centers, 917 (89%) were admitted to PCI centers, and the remaining (11%) admitted to non-PCI center. Of these, the majority of STEMI patients (81%; N=826) were admitted to six academic PCI centers.

### Clinical characteristics

Both STEMI patients at PCI Centers (86%) and non-PCI centers (85%) were dominantly male. PCI centers received patients predominantly (56%; N=514) from a transfer process, while patients at non-PCI centers were dominantly patients who presented directly/self presentation (80%; N=86). Smoking was a common risk factor in the overall STEMI population (61%; N=628). Patients at non-PCI centers had more Killip class 1 but fewer TIMI score ≥4 as compared with patients admitted to PCI centers (Table 1).

### Characteristics of reperfusion therapy

The proportion of patients receiving acute reperfusion therapy (fibrinolytic therapy or primary PCI) was higher than non-reperfused patients [54%; (N=551) vs. 46%; (N=473), p<0.001], and primary PCI was the most common method of



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reperfusion (86%). As expected, the utilization of thrombolysis therapy was significantly higher at non-PCI centers than in PCI centers (17.7% vs. 6.4%, p<0.001) (Table 1).

Characteristics of non-reperfused patients

Non-reperfused STEMI patients admitted to PCI centers were commonly coming through a transfer process (52%), while most patients at non-PCI centers (79%) were self-presenters. The majority of non-reperfused patients arrived at the ED more than 12 hours after symptom onset (N=291; 61%) (Table 2).

Angiographic and procedural characteristics

Compared with non-academic PCI centers, STEMI patients admitted to academic PCI centers and underwent primary PCI had higher use of manual thrombectomy and drug-eluting stent implantation (60% vs.14%, p<0.001 and 87% vs. 69%, p=0.001, respectively), but had similar use of trans-radial approach and intra-aortic balloon pump (56% vs. 67%, and 2.2% vs 3.4%, respectively). The mean DTD time was 102 ± 68 minutes. At academic centers, the mean DTD time was shorter than at non-academic centers (96 ± 44.3 vs. 140 ± 151 minutes). The left anterior descending was the most common infarct-related artery (53%) (Table 3).

In-hospital mortality

In-hospital mortality of non-reperfused STEMI patients was significantly higher than STEMI patients receiving primary PCI or fibrinolytic therapy (9.1% vs. 3.2% vs. 3.8%, p<0.001) (Table 4). The in-hospital mortality between academic and non-academic centers was similar (3.1% vs. 3.4%) (Table 3).



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Predictor of a prolonged DI-DO time in STEMI patients transferred for primary PCI

The mean DI-DO time in this study was 186 ± 111 minutes. After adjustment with several clinical variables (women, older age, diabetes mellitus, hypertension, Killip classification and TIMI risk score), TIMI risk score ≥ 4 on presentation was associated with a prolonged DI-DO time (>180 minutes) (adjusted odds ratio 2.08; 95% confidence interval 1.09-3.95, p=0.02) (Figure 1).

## Discussion

The JAC registry was created to improve the quality of care for ACS patients (particularly STEMI) by providing information on acute management of STEMI, risk prediction tool, timing and type of reperfusion treatment. The results from the registry analysis will be translated into clinical practice by giving knowledge on how to improve patient care and outcomes. Since its inception in 2007, the JAC registry has contributed to the improvement of STEMI care in the region (12-14). Recently, the JAC registry has been expanded to 56 health centers and like other registries (4-7), this report is used as performance measures for the STEMI care that included several insights to improve the STEMI care in the region which are described below. The challenges found in implementing the regional registry and the concept for future network in the region are also discussed.

### Changes in acute reperfusion therapy

The number of STEMI patients who received reperfusion therapy was higher than non-reperfused patients (54% vs. 46%) and primary PCI was commonly used (86%). An earlier report showed that the number of non-reperfused STEMI patients

was higher than patients receiving acute reperfusion therapy (59% vs. 41%) (11). The current finding suggests that implementation of the regional STEMI network has contributed to improvement of daily management of STEMI patient in the region, as shown by the higher proportion of patients receiving acute reperfusion therapy.

Our previous report (14) demonstrated the need to apply the registry extensively in the region as part of the STEMI network program. The wide adoption of the registry may partly explain the changes of reperfusion strategy in the region. Each participating center may evaluate the characteristics of patients admitted to the center, that in turn, it may increase the awareness of the emergency medical team to treat STEMI patients properly based on standard protocols. The increasing awareness of treating STEMI was also found in non-PCI centers as shown by higher utilization of fibrinolytic therapy than in PCI centers (Table 1).

The main reason for STEMI patients not receiving acute reperfusion therapy in this study was mainly due to high proportion of STEMI patients (61%) who were admitted to the hospital late after symptom onset (>12 h). A large proportion of non-reperfused patients (79%) were admitted directly to a non-PCI center (self presenters) (Table 2). Besides, there are still a number of patients that seek for medical help, but then refuse to receive reperfusion therapy due to financial problem, afraid of hospitalization, etc. These findings suggest that the awareness of the STEMI care in our community should be raised. Such a program may include a public campaign to educate the public about the signs and symptoms of myocardial infarction (19), emphasis on early recognition and treatment, and national emergency call center campaign. The Ministry of Health Republic of Indonesia will launch the national call center (119) to improve the medical emergency service in Indonesia. These efforts are

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expected to give knowledge to the community to come earlier to the hospital if a heart attack is suspected.

**Academic versus non-academic PCI center for STEMI care**

The majority of STEMI patients (81%) admitted to six academic PCI centers. PCI centers had more high-risk STEMI patients (killip class 2-4 and TIMI score ≥4) compared with patients at non-PCI centers. The uptake of trans-radial access for primary PCI is well accepted in the region, as shown by the majority of patients had trans-radial PCI at both academic and non-academic centers. The use of supporting device like IABP was similar. However, in academic center, the DTD time was shorter than non-academic centers. The reason is likely to be associated with the highly involvement of clinical trials for STEMI patients at the academic centers or the presence of mature processes of care for STEMI patients. This may also explain the higher use of DES and manual thrombectomy in academic centers. Importantly, the in-hospital mortality between academic and non-academic centers was similar (Table 3); however, longer-term follow-up may be necessary to determine whether there are substantive differences in outcomes between academic and non-academic centers.

A post-hoc analysis of data from the FAST-MI registry showed that when managing patients with STEMI, a hospital's capability to perform PCI matters more than its status as an academic or nonacademic medical center (20). Primary PCI centers should have a comprehensive approach to treat STEMI patients that encompasses the journey from ED to the cath-lab, regardless of academic affiliation.

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**Calling for improvement in pre-hospital care of STEMI patients**

Non-reperfused STEMI patients at PCI centers are predominantly transferred from other centers through a transfer process (Table 2). We found that in STEMI patients transferred for primary PCI, TIMI risk score ≥ 4 was the strongest predictor of a prolonged DI-DO time (>180 minutes) with adjusted OR=2.08 (Figure 1). In other words, high-risk STEMI patients were likely to stay longer at the referral center, whereas such patients should be transferred to a PCI center for a rapid reperfusion therapy. Furthermore, 52% of non-reperfused STEMI patients at PCI centers were transferred through a transfer process. The results suggest that there are opportunities to improve pre-hospital care. The delay in transferring the patient suggests that there should be increased consideration of fibrinolytic therapy at the referral hospital, then rapid transfer to a PCI center similar to the STREAM trial protocol (21). Routine educational program for health care professionals (general practitioners and nurses) who worked at the ED of referral centers is the key to improve the skill and knowledge for treating and transferring STEMI patients rapidly. The pre-hospital triage form (data sheet) should be used extensively and collected in a real time manner.

The DI-DO time is used as the clinical performance of the pre-hospital care, as part of the quality indicator of the STEMI network at Jakarta and the surrounding area. In this study, the mean DI-DO time was 186 ± 111 minutes. We chose 180 minutes as the cut-off for a prolonged DI-DO times based on our daily observations and it is nearly reached the mean value of DI-DO times found in this study. In the real world experience, it is difficult to achieve a targeted DI-DO time of <30 minutes, as recommended by the guideline, particularly in developing countries. A recent report from a US study showed that the achievement of a DI-DO time <30 minutes was only



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9.7% of STEMI patients transferred for primary PCI (22). More studies are needed focusing the DI-DO time at developing countries in order to evaluate factors associated with and solutions for a prolonged DI-DO time.

**Challenges in implementing a regional STEMI registry**

Motivating physician to participate and controlling data completeness were two difficulties faced by the primary investigator when implementing the regional STEMI registry. However, routine discussions with physician at the other hospitals about the aim of the registry may eliminate such challenges. Other challenge includes convincing non-cardiac hospitals to participate and share their data. There is concern regarding data security and fear of a negative results from the analysis. These barriers should not exist since not all people have access to the database, and data were analyzed anonymously on a routine basis. Each hospital may have access to their data for an internal analysis.

**The concept of Megapolitan STEMI network**

Around 26 million inhabitants reside at Jakarta and the 4 districts surrounding the metropolitan. In total, there are 266 cardiologists and 46 PCI centers. Looking at the number of population, geographical and administration coverage, the STEMI network in the region is in transformation to a megapolitan network (Figure 2). The network service will be divided into nine zones. Each zone will develop a heart line (single call activation) located in the ED of the receiving PCI centers. The network is coordinated by the emergency medical service and it encompasses the public emergency system (prehospital units, primary health care-based emergency units, general hospitals and STEMI hospitals). A twelve lead ECG transmission scheme is



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mandatory in the protocol through several methods (14). The 24/7 STEMI hospitals at each zone will receive the ECG transmission. If a STEMI is diagnosed, the patients will be transferred to the nearest available PCI center. A pharmaco-invasive strategy is adopted in the network. The megapolitan network concept and potential time metrics identified can be seen on Figure 2 and 3.

The proliferation of PCI-capable hospitals with efficient regionalized integrated STEMI network, along with accelerating interventional cardiology education to young cardiologists is the main concept for developing the future STEMI network in order to improve outcomes for STEMI patients in the megapolitan area.

**Future health care research/registries in developing country**

In a developing country, it is more efficient to have a large electronic health database that can be used to evaluate the current theurapeutic modalities than doing experimental studies. Large health database provides opportunities for research and large data studies may greatly reduce costs without sacrificing quality. For example, in STEMI research, large database is usually used as source of data for measuring the performance of the STEMI network by analyzing the reperfusion therapy status, thus the results of the studies are used to improve the quality of care for STEMI patients.

In the future, large data set/registries will be used extensively as part of the modern health care system in developing countries and become the main data source for research that may facilitate the development and improvement of the national health care strategy. The current JAC registry has been expanded to other centers in the four districts, and will be used as the main concept for making a national ACS registry that is currently not available in Indonesia. The data will become the main source of data for measuring the performance of the STEMI care in the country.



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## Study limitation

The major limitation found in this study is the data coverage. At the time of the present analysis, only 26% of all centers in the metropolitan area are participating in the registry. However, major secondary and tertiary care hospitals with high volume ACS cases have been participating actively; thus, it may reflect the characteristics of the STEMI patients in the region very well. In the future, other centers in the region are expected to be involved actively in the registry. Finally, the retrospective nature of the study may introduce some bias and missing values.

## Conclusion

In the expanded JAC registry, a higher proportion of STEMI patients received reperfusion therapy, but 46% still did not. Focusing the pre-hospital care in the network is still mandatory to improve the DI-DO time along with improvement of DTD time at PCI centers. The expansion of the registry affords the opportunity to improve the care of STEMI patients in the country.

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**Contributorship statement**: SD, HA, IP, ID, SVR have contributed in designing the study, writing, analysing and reviewing the manuscript. Other authors have contributed in data collection, analysing and reviewing the manuscript.

**Competing interest**: nothing to declare

**Funding**: no external funding support

**Data sharing**: no additional data available

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**Figure Legends:**

Figure 1.

Multivariate predictors of a prolonged DI-DO time in STEMI patients transferred for primary PCI.

Figure 2.

The schematic diagram of the five districts (nine zones) in the Jakarta Megapolitan STEMI network.

Figure 3.

Time metrics variables identified in the Jakarta Megapolitan STEMI network. STEMI= ST-elevation myocardial infarction, PCI= percutaneous coronary intervention, IRA= infarct-related artery, DTD= door-to-device, DI-DO= door-in to door-out, EMS= emergency medical service.

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Table 1. JAC registry database consist of 1024 STEMI patients.

| | PCI Center (N=917 ) | Non-PCI Center (N=107) | P Value |
|---|---|---|---|
| Age, years | 55.93 ± 10.07 | 55.29 ± 10.31 | 0.535 |
| Male gender, N (%) | 788 (86%) | 91 (85%) | 0.80 |
| Onset of STEMI, hours | 7 (0.25 – 240) | 3 (0.50-120) | 0.004 |
| Systolic blood pressure, mmHg | 129 (53-254) | 130 (60-200) | 0.456 |
| Diastolic blood pressure, mmHg | 78 (30-182) | 80 (0-120) | 0.255 |
| Heart rate, beats per minute | 81 (20-210) | 86 (41-189) | 0.483 |
| Source of referral, N(%) | | | |
| Public health center | 6 (0.6%) | 6 (5.6%) | <0.001 |
| Inter-hospital | 514 (56%) | 10 (9.3%) | <0.001 |
| Intra-hospital | 17 (1.85%) | 2 (1.9%) | 1.0 |
| Self Walk-in | 367 (40%) | 86 (80%) | <0.001 |
| Private clinic | 13 (1.41%) | 3 (2.8%) | 0.23 |
| CAD Risk factors, N (%) | | | |
| Hypertension | 496 (54%) | 57 (53%) | 0.951 |
| Diabetes mellitus | 260 (28%) | 28 (26%) | 0.674 |
| Family history | 138 (15%) | 18 (17%) | 0.600 |
| Dyslipidemia | 278 (30%) | 25 (23%) | 0.151 |
| Smoker | 575 (63%) | 53 (49%) | 0.037 |
| Location of MI, N (%) | | | |
| Anterior | 238 (26%) | 37 (34.6%) | 0.01 |
| Killip class 1 at presentation, N (%) | 646 (70.4%) | 89 (83.2%) | 0.006 |
| TIMI Score ≥ 4 | 549 (59.8%) | 25 (23.3%) | <0.001 |
| Acute reperfusion therapy, N (%) | | | |
| Fibrinolytic Therapy | 59 (6.4%) | 19 (17.7%) | < 0.001 |
| Primary PCI | 473 (51.6%) | NA | NA |
| Non-reperfused | 385 (42%) | 88 (82.2%) | < 0.001 |
| STEMI= ST-elevation myocardial infarction, CAD= coronary artery disease, MI= myocardial infarction, TIMI= thrombolysis in myocardial infarction, PCI= percutaneous coronary intervention. | | | |

Table 2. Characteristics of non-reperfused STEMI patients.

| | PCI Center (N=387) | Non-PCI Center (N=86) | P-Value |
|---|---|---|---|
| Source of referral, N (%) | | | |
| Public health center | 1 (0.2%) | 6 (6.9%) | <0.001 |
| Inter-hospital | 203 (52%) | 8 (9.3%) | <0.001 |
| Intra-hospital | 12 (3.1%) | 2 (2.3%) | 0.7 |
| Self walk-in | 163 (42%) | 68 (79%) | <0.001 |
| Private clinic | 8 (2.1%) | 2 (2.3%) | 0.88 |

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| | | | |
|---|---|---|---|
| TIMI risk score ≥ 4 | 266 (69%) | 41 (48%) | <0.001 |
| Anterior wall MI, N (%) | 129 (33%) | 42 (49%) | 0.009 |
| Onset > 12 hours, N (%) | 264 (68%) | 27 (31%) | <0.001 |
| TIMI= thrombolysis in myocardial infarction, MI= myocardial infarction. | | | |

Table 3. Primary PCI characteristics at PCI centers (N=473). Characteristics of STEMI patients who underwent primary PCI.

| | Academic Center (N=415) | Non-Academic Center (N=58) | P-Value |
|---|---|---|---|
| Vascular access , N (%) | | | |
| Radial artery | 228/409 (56%) | 39/58 (67%) | 0.09 |
| Thrombectomy, N (%) | 248/413 (60%) | 8/58 (14%) | < 0.001 |
| Door-to-device time, minutes | 96 ± 44 | 140 ± 151 | <0.001 |
| Stent type | | | |
| Drug-eluting stent | 348/400 (87%) | 38/55 (69%) | 0.001 |
| Coronary artery by-pass graft | 1 (0.2%) | 0 (0) | 1.0 |
| Use of intraaortic balloon pump, N (%) | 9 (2.2%) | 2 (3.4%) | 0.63 |
| Infarct Related Artery, N (%) | | | |
| LAD | 217/409 (53%) | 30/56 (53.6%) | 0.94 |
| LCX | 24/409 (5.9%) | 4/56 (7.1%) | 0.76 |
| RCA | 168/409 (41%) | 22/56 (39.3%) | 0.79 |
| LM | 0 | 0 | NA |
| Coronary Angiography Result | | | |
| 1 VD | 177 (42.7%) | 21 (36.8%) | 0.39 |
| 2 VD | 134 (32.4%) | 16 (28%) | 0.51 |
| 3 VD | 103 (24.9%) | 20 (35.1%) | 1.0 |
| Clinical outcome, N (%) | | | |
| Cerebrovascular disease | 9 (2.2%) | 0 (0) | 0.61 |
| Mechanical complication | 4 (0.9%) | 0 (0) | 1.0 |
| In-hospital mortality, N (%) | 13 (3.1%) | 2 (3.4%) | 0.70 |
| LAD= left anterior descending, LCX= left circumflex artery, RCA= right coronary artery, LM= left main, VD= vessel disease. | | | |

Table 4. Crude In-hospital mortality.

| | Primary PCI (N=473) | Fibrinolytic therapy (N=78) | Non-reperfused patients (N=473) | P-Value |
|---|---|---|---|---|
| In-hospital mortality, N (%) | 15 (3.2%) | 3 (3.8%) | 43 (9.1%) | <0.001 |



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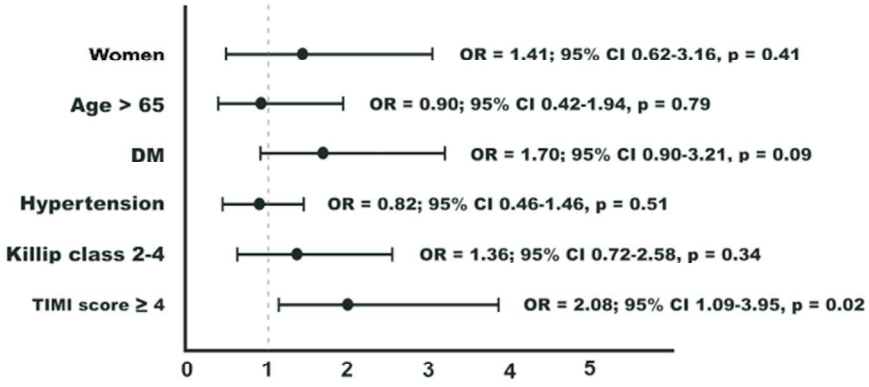


Figure 1

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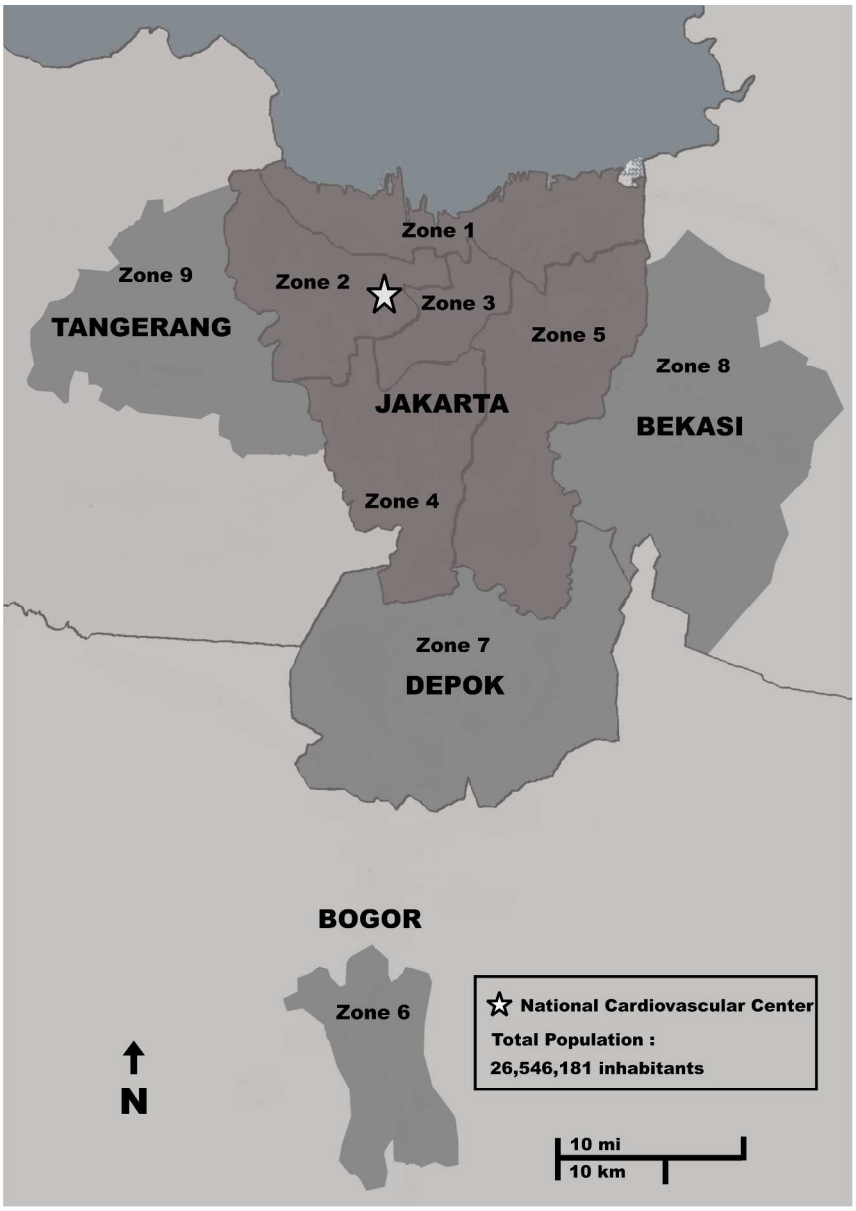


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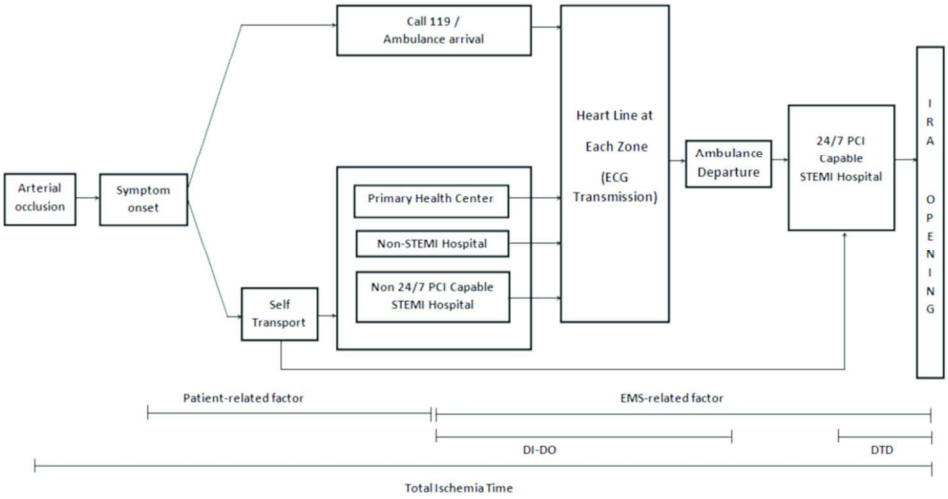


Figure 3

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation |
|---|---|---|
| **Title and abstract** | 1 | √ (*a*) Indicate the study's design with a commonly used term in the title or the abstract (page 1) |
| | | √ (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found (page 1-2) |
| **Introduction** | | |
| Background/rationale | 2 | √ Explain the scientific background and rationale for the investigation being reported (page 3-4) |
| Objectives | 3 | √ State specific objectives, including any prespecified hypotheses (page 4) |
| **Methods** | | |
| Study design | 4 | √ Present key elements of study design early in the paper (page 4) |
| Setting | 5 | √ Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (page 5,6) |
| Participants | 6 | √ (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (page 5,6) |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed |
| Variables | 7 | √ Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (page 7) |
| Data sources/ measurement | 8* | √ For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (page 4-6) |
| Bias | 9 | √ Describe any efforts to address potential sources of bias (page 5,6) |
| Study size | 10 | √ Explain how the study size was arrived at (page 5) |
| Quantitative variables | 11 | √ Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (page 7) |
| Statistical methods | 12 | √ (*a*) Describe all statistical methods, including those used to control for confounding (page 7,8) |
| | | √ (*b*) Describe any methods used to examine subgroups and interactions (page 7,8) |
| | | (*c*) Explain how missing data were addressed (NA) |
| | | (*d*) If applicable, explain how loss to follow-up was addressed (NA) |
| | | (*e*) Describe any sensitivity analyses (NA) |
| **Results** | | |
| Participants | 13* | √ (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (page 8) |
| | | (b) Give reasons for non-participation at each stage (NA) |
| | | (c) Consider use of a flow diagram (NA) |
| Descriptive data | 14* | √ (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (page 8-10) |
| | | (b) Indicate number of participants with missing data for each variable of interest (NA) |
| | | √ (c) Summarise follow-up time (eg, average and total amount) (page 9) |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time (page 9) |
| Main results | 16 | √ (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders |



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| | | |
|---|---|---|
| | | were adjusted for and why they were included (page 10) |
| | | √ (*b*) Report category boundaries when continuous variables were categorized (page 10) |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (NA) |
| Other analyses | 17 | √ Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (page 8, 9) |
| **Discussion** | | |
| Key results | 18 | √ Summarise key results with reference to study objectives (page 10) |
| Limitations | 19 | √ Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (page 16) |
| Interpretation | 20 | √ Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (page 10-15) |
| Generalisability | 21 | √ Discuss the generalisability (external validity) of the study results (page 14-15) |
| **Other information** | | |
| Funding | 22 | √ Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (page 16) |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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# Correction: *Characteristics, treatment and in-hospital outcomes of patients with STEMI in a metropolitan area of a developing country: an initial report of the extended Jakarta Acute Coronary Syndrome registry*

Dharma S, Andriantoro H, Purnawan I, *et al*. Characteristics, treatment and in-hospital outcomes of patients with STEMI in a metropolitan area of a developing country: an initial report of the extended Jakarta Acute Coronary Syndrome registry. *BMJ Open* 2016;6:e012193. The name of the 12th co-author of this paper is incorrect. The correct name is: Tjatur Bagus Gunarto.

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*BMJ Open* 2016;**6**:e012193corr1. doi:10.1136/bmjopen-2016-012193corr1