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Author: Dharma, Surya
Title: Perspectives in the treatment of cardiovascular disease : from prognostic parameters to therapeutic modalities
Issue Date: 2013-08-29

Temporal trends of system of care for STEMI: Insights from the Jakarta Cardiovascular Care Unit Network System

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Abstract

Background

Guideline implementation programs are of paramount importance in optimizing acute ST-elevation myocardial infarction (STEMI) care. Assessment of performance indicators from a local STEMI network will provide knowledge of how to improve the system of care.

Methods and Results

Between 2008-2011, 1505 STEMI patients were enrolled. We compared the performance indicators before (n=869) and after implementation (n=636) of a local STEMI network. In 2011 (after introduction of STEMI networking) compared to 2008-2010, there were more of inter-hospital referrals for STEMI patients (61% vs. 56%, p<0.001) more primary percutaneous coronary intervention (PCI) procedures (83% vs. 73%, p=0.005), and more patients reaching door-to-needle time ≤30 minutes (84.5% vs. 80.2%, p<0.001), but numbers of patients who presented very late (>12 hours after symptom onset) were similar (53% vs. 51%, p=NS). Moreover, the numbers of patients with door-to-balloon time ≤90 minutes and in-hospital mortality rate were similar in 2011 compared to 2008-2010 (49.1% vs. 51.3%, p=NS and 8.3% vs. 6.9%, p=NS, respectively).

Conclusion

After a local network implementation for patients with STEMI, there were significantly more inter-hospital referral cases, primary PCI procedures, and patients with a door-to-needle time ≤30 minutes, compared to the period before implementation of this network. However, numbers of patients who presented very late, the targeted door-to-balloon time and in-hospital mortality rate were similar in both periods. To improve the STEMI networking based on recent guidelines, existing pre-hospital and in-hospital protocols should be improved and managed more carefully, and should be accommodated whenever possible.

Keywords: system of care, acute myocardial infarction, performance indicators.

Introduction

The recent 2012 ESC guideline on ST-segment elevation myocardial infarction (STEMI) stressed the importance of networking for the management of acute myocardial infarction (AMI) [1]. In an earlier report, we emphasized the concept of a trained health system network in order to decrease the mortality rate of STEMI patients. The mission of such a network is how to increase the use of acute reperfusion treatment in the pre-hospital and in-hospital settings, using a pharmaco-invasive strategy in Jakarta, Indonesia [2].

After the initial introduction of the network, we analyzed the effectiveness of the system to improve the network protocols using a registry that we set up in 2008 as an integral part of modern health care [3,4]. We analyzed the quality of care and performance indicators of our local acute coronary syndrome registry, to further improve the STEMI system of care in Jakarta, Indonesia.

Methods

Data was collected from the Jakarta Acute Coronary Syndrome (JAC) registry and included 1505 patients admitted with acute STEMI in emergency department of the National Cardiovascular Center Harapan Kita, Jakarta, Indonesia (Figure 1). Initial diagnosis was made on the basis of presence of typical chest pain and ST-segment elevation (≥0.1 mV) in two or more contiguous leads on the initial ECG.

All demographic, clinical and laboratory variables were obtained from the registry. The profiles of STEMI patients were compared before the introduction of the STEMI networking (between 2008-2010) and after introduction of the network (in 2011). Reperfusion therapy was given according to the recommendations of the ESC [1] and ACCF/AHA/SCAI [5] guidelines.
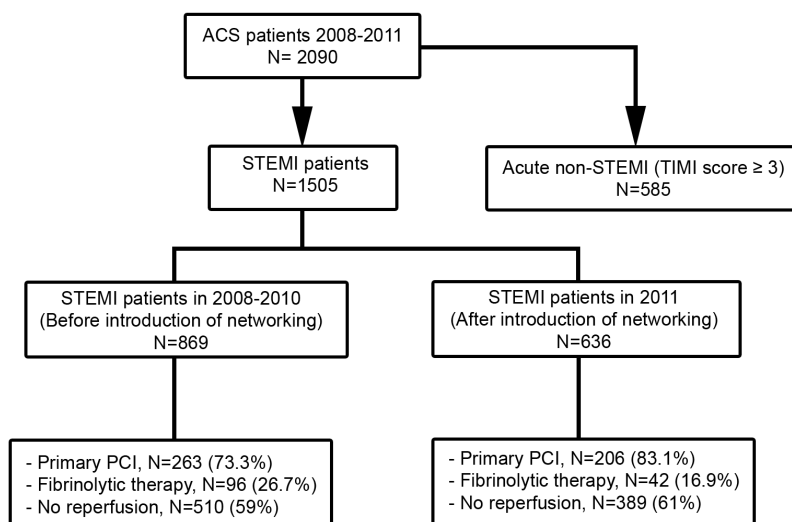
Figure 1. Patient distribution from the Jakarta Acute Coronary Syndrome registry.
ACS= acute coronary syndrome, STEMI= ST-elevation myocardial infarction, PCI= percutaneous coronary intervention, TIMI= Thrombolysis in Myocardial Infarction.

Study end-points

Study end-points are the performance indicators in two time periods: before and after the implementation of the network, such as the number of inter-hospital referral cases, number of primary PCI procedures, number of patients who presented very late (>12 hours after onset of chest pain), and the time delay between admission to the hospital and actual reperfusion (door-to-balloon time and door-to-needle time).

Statistical methods

Continuous variables are presented as mean values ± standard deviation (SD) or median (range) if not fitting a normal distribution. Categorical variables were expressed as percentages or proportions. Normally distributed variables were compared by Student's *t*-test and skewed distribution data by Mann-Whitney *U*-test. Categorical variables were tested by chi-square test. A p-value <0.05 was considered significant. All statistical analyses were performed with SPSS version 17.0.

Results

The median age of the STEMI patients was 55 years (ranging from 24 to 96 years) and most of them were male (86%). Similar with our earlier report [2], hypertension was the most common risk factor (54%) in our STEMI population. The source of referral was mostly from another hospital (58.3%) (Table 1).

Table 1. Demographic data and hospitalization information of STEMI patients (N=1505).

Variables	Description
Age, years	55 (24-96)
Gender	
Female	214 (14.2%)
Male	1291 (85.7%)
Source of referral	
Walk in/ambulance	502 (33.3%)
Primary physician	56 (3.7%)
Inter-hospital	878 (58.3%)
Intra-hospital	70 (4.6%)
Risk factor profile	
Raised BMI	320 (21.2%)
Carotid artery stenosis	3 (0.2%)
Family history of known CAD	368 (24.4%)
Dyslipidemia	580 (38.5%)
Hypertension	813 (54%)
Diabetes Mellitus	434 (29%)
Current smoker	698 (46.3%)

BMI= body mass index, CAD= coronary artery disease.

Table 2. STEMI profile based on network application period.

Variables	2008-2010 (before implementation of AMI networking) N=869	2011 (after implementation of AMI networking) N=636	P value
Referral status			
Walk in/ambulance	281 (32.3%)	221 (34.7%)	
Primary physician	43 (4.9%)	13 (2.0%)	
Inter-hospital	488 (56.2%)	390 (61.2%)	<0.001
Intra-hospital	57 (6.6%)	13 (2.0%)	
Onset of infarction			
≤12 hours	422 (48.8%)	299 (46.9%)	0.466
>12 hours	442 (51.2%)	338 (53.1%)	
Reperfusion strategy			
Primary PCI	263 (73.3%)	206 (83.1%)	0.005
Fibrinolytic therapy	96 (26.7%)	42 (16.9%)	

AMI= acute myocardial infarction, PCI= percutaneous coronary intervention.

Table 3. Characteristics of STEMI patients before and after implementation of Jakarta Cardiovascular Care Unit Network System.

Variables	2008-2010 (before implementation of AMI networking) N=869	2011 (after implementation of AMI networking) N=636	P value
Location of MI			
Anterior	530 (61%)	376 (59.1%)	0.464
Non anterior	339 (39%)	260 (40.9%)	
Killip class			
I	598 (69.2%)	429 (68.5%)	
II	223 (25.8%)	151 (24.1%)	0.047
III	25 (2.9%)	17 (2.7%)	
IV	18 (2.1%)	29 (4.6%)	
DTN ≤30 minutes	77 (80.2%)	120 (84.5%)	<0.001
DTB ≤90 minutes	135 (51.3%)	105 (49.1%)	0.364
In-hospital mortality	60 (6.9%)	53 (8.3%)	0.303

AMI= acute myocardial infarction, DTN= door-to-needle, DTB= door-to-balloon.

The number of inter-hospital referrals for STEMI cases has significantly increased in 2011 compared to 2008-2010 (61.2% vs. 56.2%, p<0.001), but numbers of patients with STEMI who presented very late were similar (53.1% vs. 51.2%, p=0.466). There was a significant increase of primary PCI in 2011 (83.1% vs. 73.3% p=0.005) (Table 2). For patients who received fibrinolytic therapy, the numbers of patients with a door-to-needle time ≤30 minutes was higher in 2011 than in 2008-2010 (84.5% vs. 80.2%, p<0.001). For patients who underwent primary PCI, the number of patients with a door-to-balloon time ≤90 minutes had not improved (49.1% vs. 51.3%, p= 0.364) (Table 3). In-hospital mortality had not changed between 2011 and 2008-2010 (8.3% vs. 6.9%, p=0.303).

Discussion

The Jakarta Cardiovascular Care Unit Network system was built to improve the system of care of AMI in Jakarta, Indonesia, serving about 11 million people with 15,000 people/km^2 of density [2]. The effectiveness of the system can be monitored by recording the performance indicators in STEMI patients, such as number of patients receiving acute reperfusion treatment (numbers of primary PCI and fibrinolytic therapy), time from door-to-reperfusion, and number of patients who presented very late [4,6].

After the introduction of the network, there was a growing awareness of the primary physician in the primary hospital, as is shown by the increased numbers of STEMI patients referred from another hospital.

In the receiving center, the number of patients receiving primary PCI has increased after the application of the network, which might suggest that the pre-hospital protocol to make an accurate diagnosis of AMI has improved. However, the proportion of patients who received PCI with a door-to-balloon time ≤90 minutes, as recommended by the guideline, had not improved between the two periods. It has shown earlier that when PCI-related time delay increases, the mortality benefit decreases [7-9]. Moreover, the 2012 ESC guideline [1] on management of STEMI patients has strengthen the importance of shortening the time delay for primary PCI, and recommends a door-to-balloon time <60 minutes in a PCI-capable hospital. To further improve the protocol of the receiving center, we (as the host of the network) have installed a catheterization laboratory in the emergency department that contributes to the fast track AMI service. This system might reduce the time delay related to reperfusion treatment, including administration delay. This program has started since October 2012.

The number of patients receiving fibrinolytic therapy has decreased in 2011, although more patients had reached a door-to-needle time ≤30 minutes compared to the 2008-2010 period before the network was introduced. If the estimated first medical contact-to-balloon time is >120 minutes, we like to start, in the near future, fibrinolytic therapy in the pre-hospital setting, as recommended by the guideline [1]. Local authorities have to collaborate in training all health care providers on how to perform fibrinolytic therapy according to a standard protocol.

Finally, the proportion of patients with STEMI who presented very late (>12 h) had not improved between the two periods. This might explain the similar in-hospital mortality in the two periods. As late presentation is associated with high mortality [2], we should get the

patients to the hospital that provides reperfusion therapy earlier. For that purpose we have to analyse how to improve patient delay (delay in recognizing the symptom) and system delay (under use of ECG transmission, lack of ambulance organization, etc). Pre-hospital 12-lead electrocardiogram plays an important role in a system of care for STEMI patients [10-12]. Currently, we are using a fax machine for ECG transmission but this system has several limitations, such as the unavailability of a fax machine in the ambulance. Therefore, we should transmit the ECG by a telephone- or internet-based system.

Based on the results of the performance indicators before and after network introduction, also the pre-hospital protocol should be improved. Two models of a pre-hospital triage form and an ambulance communication chart form are illustrated in Figures 2 and 3. These forms should be filled by the health care provides in the pre-hospital setting.

Prior AMI guideline implementation programs have improved the patient care and the patient's outcome [13-15]. However, the widespread dissemination of evidence-based medicine in daily practice is still lacking and a significant number of patients remain undertreated [16-20]. Therefore, the integrated STEMI care program we developed and implemented will include pre-hospital and in-hospital care. As preliminary data looks promising, we have to improve at all points of the health care system.
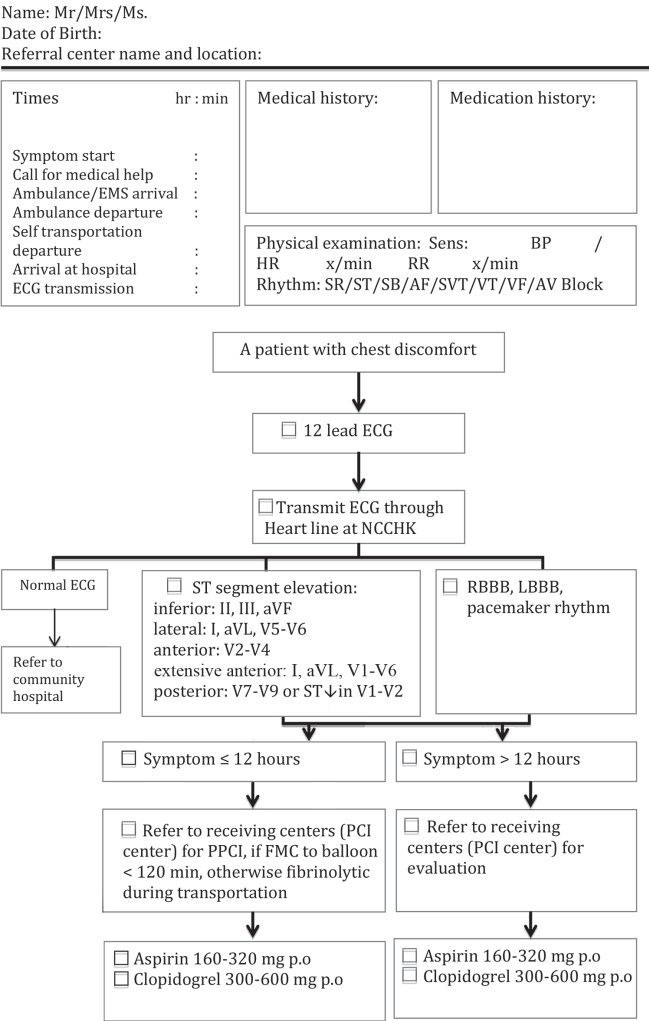
Study limitations

This single center registry should be combined with the registries of other receiving centers to know the real STEMI profile in Jakarta. However, our center is the cardiac referral hospital in Jakarta with the highest case load, thus characteristics of the patients in our National Cardiovascular Center Harapan Kita registry will reflect the STEMI profile in Jakarta very well.

Conclusion

For STEMI patients, the introduction of a regional AMI network has significantly increased the number of inter-hospital referral cases and the number of patients who underwent acute reperfusion procedures in the receiving center, with more patients who reached door-to-needle time ≤30 minutes. However, the proportion of patients who presented very late, the door-to-balloon time, and the in-hospital mortality have not improved. The receiving and referral center protocols have to be adapted in order to increase the quality of care of AMI patients in Jakarta.

Name: Mr/Mrs/Ms.
Date of Birth:
Referral center name and location:

Times	hr : min
Symptom start	:
Call for medical help	:
Ambulance/EMS arrival	:
Ambulance departure	:
Self transportation departure	:
Arrival at hospital	:
ECG transmission	:

Medical history:

Medication history:

Physical examination: Sens: BP   /
HR   x/min   RR   x/min
Rhythm: SR/ST/SB/AF/SVT/VT/VF/AV Block

A patient with chest discomfort

↓

☐ 12 lead ECG

↓

☐ Transmit ECG through Heart line at NCCHK

Normal ECG

↓

Refer to community hospital

☐ ST segment elevation:
inferior: II, III, aVF
lateral: I, aVL, V5-V6
anterior: V2-V4
extensive anterior: I, aVL, V1-V6
posterior: V7-V9 or ST↓in V1-V2

☐ RBBB, LBBB, pacemaker rhythm

☐ Symptom ≤ 12 hours

☐ Symptom > 12 hours

↓

☐ Refer to receiving centers (PCI center) for PPCI, if FMC to balloon < 120 min, otherwise fibrinolytic during transportation

☐ Refer to receiving centers (PCI center) for evaluation

↓

☐ Aspirin 160-320 mg p.o
☐ Clopidogrel 300-600 mg p.o

☐ Aspirin 160-320 mg p.o
☐ Clopidogrel 300-600 mg p.o

Figure 2. The pre-hospital triage of AMI patients in Jakarta Cardiovascular Care Unit Network System. An internet-based ECG transmission system (Heart line) is located in the Emergency Department of the National Cardiovascular Center Harapan Kita Hospital with 24 hours service. Diagnosis and choice of reperfusion therapy will be decided through Heart line. The choice of fibrinolytic agent is Streptokinase or Alteplase. In post-fibrinolytic patients, rescue PCI will be performed for failed fibrinolysis. After successful fibrinolytic therapy, coronary angiography will be performed within 3-24 hours.

EMS= emergency medical service, BP= blood pressure, HR= heart rate, RR= respiratory rate, SR= sinus rhythm, SB= sinus bradycardia, ST= sinus tachycardia, AF= atrial fibrillation, SVT= supra-ventricular tachycardia, VT= ventricular tachycardia, VF= ventricular fibrillation, AV= atrioventricular, NCCHK= National Cardiovascular Center Harapan Kita, RBBB= right bundle branch block, LBBB= left bundle branch block, PPCI= primary percutaneous coronary intervention, FMC= first medical contact, p.o= per os (oral).

Date: __ /__ /____   First ambulance call: ____:____   Ambulance ID:

Patient's information:

Name:
Date of birth/age:__ __ ____/ _____ years
Body weight:_____ kg
Start of symptom: ___ : ___
Diagnosis: STEMI   Non-STE ACS   Non cardiac
First ECG transmitted:____:____
Call Heart line: ___ : ___
Estimated duration of arrival at receiving center (PCI center): _____ minutes
Receiving center destination:

Fibrinolytic check list:
Did the patient have:
- previous intracranial hemorrhage or stroke ?   Yes/No
- ischaemic stroke in the preceding 6 months?   Yes/No
- CNS damage or neoplasms or AV malformation?   Yes/No
- recent major trauma/surgery/head injury?   Yes/No
- gastrointestinal bleeding within the past month?   Yes/No
- known bleeding disorder?   Yes/No
- aortic dissection?   Yes/No
- non compressible punctures in the past 24 hours?   Yes/No
- transient ischemic attack in the last 6 months?   Yes/No
- received oral anticoagulant therapy?   Yes/No
- systolic BP > 180 mmHg or diastolic BP > 110 mmHg?   Yes/No
- advanced liver disease?   Yes/No
- infective endocarditis?   Yes/No
- active peptic ulcer?   Yes/No
- prolonged or traumatic resuscitation?   Yes/No

If all questions are answered with NO, fibrinolytic therapy could be given. Consult
to Heart line team at NCCHK before starting fibrinolytic therapy.

Time of fibrinolytic started: ___ : ___
Fibrinolytic agent: Streptokinase/Alteplase

Figure 3. The communication form and fibrinolytic check list for the emergency medical service/ambulance staff.

STEMI= ST-segment elevation myocardial infarction, non STE ACS= non-ST elevation acute coronary syndrome, CNS= central nervous system, AV= arteriovenous, BP= blood pressure, NCCHK= National Cardiovascular Center Harapan Kita.

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