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**THE IMPLEMENTATION OF CODE STEMI PROGRAM TO AFFECT
THE QUALITY OF HEALTHCARE IN ST-ELEVATION
MYOCARDIAL INFARCTION (STEMI) PATIENTS:
A SYSTEMATIC LITERATURE REVIEW**

Eka Ginanjar*, Amal C Sjaaf

Faculty of Public Health, Universitas Indonesia

*Corresponding author's e-mail: ekginanjar@gmail.com

ABSTRACT

Backgrounds: *The Clinical importance of coronary artery disease manifests as Acute Coronary Syndrome with the highest mortality is known as ST-Elevation Myocardial Infarction (STEMI). Delay in STEMI management not only affect mortality and complications, but also healthcare quality. The CODE STEMI program was developed to shorten the time and reduce delay in treatments for STEMI patients. This study aims to review the effect of CODE STEMI program implementation on clinical outcome and healthcare quality in STEMI patients.*

Methods: *This study was a systematic review of literature that used meta-analysis (PRISMA) protocol. Data obtained from Electronic databases Google Scholar, PubMed, and MEDLINE that published over several years and we began on May 2019. Assessment of healthcare quality was based on Donabedian theory that consists of 7 main components, efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity. Analysis between studies was reported as descriptive narration.*

Results: *The search found 15 studies, of which 4 studies as the final results that are suitable for this literature review through the keyword findings CODE STEMI, STEMI, and quality of healthcare. Studies in several countries over the globe reported a decrease of door-to-balloon/ diagnosis-to-wire time. Some studies reported reduced mortality, complications, and cost after implementation of CODE STEMI program, while others only found insignificant trends.*

Conclusions: *Implementation of CODE STEMI protocol made a better Quality of Healthcare. However, it needs further study to review and evaluate the effect of CODE STEMI implementation, especially on the quality of healthcare in STEMI patients.*

Keywords: *CODE STEMI, STEMI, Quality of Healthcare, Donabedian Theory*

INTRODUCTION

Cardiovascular disease is one of the main global cause of death. According to WHO, 17.5% of global death are caused by cardiovascular disease [1]. And the prevalence of coronary artery disease in Indonesia is 1.5% [2] More than half of cardiovascular disease are caused by coronary artery disease (CAD), CAD has varieties of clinical manifestation from asymptomatic to acute condition such as Acute Coronary Syndrome (ACS). ACS includes STEMI (ST Elevation of myocardial infarction), NSTEMI (non ST Elevation myocardial infarction), and UAP (unstable angina pectoris) [3]. According to Euro Heart Survey in 2004, the mortality rate of STEMI in Europe reach 6-14%[4], and in Malaysia, mortality rate in hospital and 1 month after hospitalized is higher in Malay race (7%) than in Chinese and Indian race (4-6%). In Indonesia, the mortality rates of STEMI patients treated in Intensive Coronary Care Unit (ICCU) Dr. Cipto Mangunkusumo hospital from 1990 to 2007 was about 12%.[5] This percentage is

influenced by the number of risk factors, less invasive procedure and less time of reperfusion therapy [6].

The management of STEMI itself which includes identification, triage, and reperfusion must be done as soon as possible to prevent further damage to the heart muscles, so that mortality in patients with STEMI can be prevented. Reperfusion/revascularization therapy is the most important step in the management of ACS because it aims to overcome the etiology and improves the clinical condition of the patient. Reperfusion therapy is recommended by European and American guidelines in the first twelve hours after onset. If reperfusion or revascularization therapy is done early, it will certainly give better results. The Research by Eric Boersma at Rotterdam-Dijkzigt Hospital University, have showed that when reperfusion therapy was given 1 hour earlier to 6600 patients, there was an increase in 30-day survival with 15–27 patients per 1,000 patients [7]. Setyawan, et al. also reported in Dr Cipto Mangunkusumo Hospital in year 2010 that the proportion of deaths for STEMI was 18.6% [8].

Delay in the management of STEMI patient becomes the cause of high mortality and major adverse cardiac events (MACE) in hospital. In general hospitals, apart from heart centers, patients came with a variety of major complaints such as diarrhea, stroke, trauma and chest pain. Lack of attention from the staff in emergency room and the absence of a system causing delays for revascularization in patients with STEMI. The delay of STEMI management in general hospital can actually be solved by the implementation of CODE STEMI program to increase awareness, a type of protocol that stands for revascularization of STEMI. It is also a code used in many emergency department in hospital that essentially means identifying a STEMI patients as soon as possible and formally requesting lifesaving team and equipment immediately [9]. Implementation of CODE STEMI might not only improve STEMI patient's outcome, but also the healthcare quality of patient and family. Optimal length of stay (LOS) in hospitals are influenced by individual factors, heart disease risk factors, comorbidity, functional status, and patient social support. Several studies have shown that low-risk patients who successfully undergo primary per cutaneous coronary intervention (PCI) and having complete revascularization can be discharged from the hospital in second or third day after PCI. Criteria for the Second Primary Angioplasty in Myocardial Infarction (PAMI-II) or the Zwolle primary PCI Index criteria can be used to assess the risk of patients who have PCI. According to PAMI-II criteria, patients at low risk are aged less than 70 years, LVEF (Left ventricular ejection fraction) more than 45%, only have one or two vessel diseases, successful PCI procedure, and does not have persistent arrhythmias [10]. Therefore, patients must immediately continue follow ups and follow a strict rehabilitation program after having a PCI. Patients with successful reperfusion therapy without complications must be treated in ICCU for at least 24 hours if possible, and after that can be monitored for another 24–48 hours. Early return (within 48–72 hours) can be considered in low-risk patients if an early rehabilitation program is adequate [10].

The problem involves many elements in hospital such as emergency room, catheterization lab, and Intensive Coronary Care Unit (ICCU). Evaluation of the use of CODE STEMI must not only be assessed from the clinical outcome such as MACE and mortality rate, but also from the perspective of hospital governance. This study evaluates the implementation of the CODE STEMI program onj the quality of healthcare using Donabedian theory which evaluates the program from the inputs, processes, outputs and outcomes. Donabedian Theory covers the quality of patient service consisting of 7 main components; efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity [11].

The efficacy in the quality of healthcare is how science and technology could give benefits and overcome health problems effectively of the patients in optimal conditions. Efficacy is the result of some research, experience and international consensus that determines the standard of procedure. In this case, the efficacy aspect was assessed from the clinical management of STEMI patient based on guideline that applied in hospitals. The effectiveness is a relative concept that can be assessed from comparison between health services that have been carried out with the standard in optimal conditions. For example

in STEMI management can be assessed by the compatibility of the management that has been given to patients with the guidelines or standard of procedure. The efficiency is the ability to reduce costs and service costs without reducing the benefits of services to patients. Efficiency can be increased if at the same cost, health service benefits can be increased, or if with the same health service benefits, service costs can be reduced. The optimization aspect is a balance between the health benefits obtained and compared to the costs. The acceptability is how patient services could adjust the expectations of patients and their families. Acceptability is influenced by 5 main factors, they are accessibility, doctor-patient relationship, founding service facilities easily, patient perceptions about fair things between him and another. The Accessibility means the convenience of patients to get services. This thing depends on physical factors and location such as the distance of health care providers, availability and transportation costs; economic factors such as income and the availability of health insurance guarantees; and socio-cultural factors such as the tendency of people to seek treatment influenced by habit or religion. The legitimacy aspect is how patient service in line with rules, laws, values, norms and principles in the public. The last is equity, this is the principle of fair and fair treatment in the distribution of health services to community members [11]. Thus, hospitals are encouraged to implement CODE STEMI program for a holistic management of STEMI patients to produce better outcome in healthcare quality.

METHODS

Literature search

The presented review was conducted up to May 2019 by using the preferred reporting for systematic review and meta analysis (PRISMA) protocol. We review all the topics on implementation of CODE STEMI program, STEMI management, and the impacts of its implementation to healthcare quality according to Donabedian theory that consist of efficacy, effectivity, efficiency, optimality, accessibility, legitimacy and equity.

Literature search was done by using Google Scholar, PubMed, and MEDLINE databases, researches, review article, and reports that have been published over 20 years. While the inclusion criteria in this review are all studies from several countries on STEMI management, and the implementation of CODE STEMI program in hospital and its impact to healthcare quality for over past 20 years. While the exclusion criteria are studies in other language besides English and articles that does not suit the aim of this review.

Search Strategy

We used the keyword like ACS, STEMI, CODE STEMI, and assessment of health care quality based on Donabedian theory. Analysis between studies were reported as descriptive narration.

RESULTS

After searching, we used 4 studies of 15 literatures founded. They compared the impact of CODE STEMI program activation in effectivity, efficacy, efficiency, optimality, and acceptability aspects. We could not find articles related to legitimacy and equity aspects for this impact. (see table 1)

Table 1. Results of Literature Searching

Author and year	Title	Key point
Ayahya, 2017	The impact of introduction of Code-STEMI program on the reduction of door-to-balloon time in acute ST-elevation myocardial infarction patients undergoing	There is a significantly reduction door to balloon time in CODE STEMI group with time frame 63-90 minutes, compared in pre CODE STEMI group with time frame 74-149 minutes. But the complication detected only reduction in recurrent myocardium

Author and year	Title	Key point
	primary percutaneous coronary intervention: A single-center study in Saudi Arabia	infarction which significant (P=0.043), and hospital mortality was low in both groups and showed no difference
Koh, 2017	In-hospital ‘CODE STEMI’ improves door-to-balloon time in patients undergoing primary percutaneous coronary intervention	The primary outcome comparing median times revealed significant reductions in door to door time and door to balloon time, for door to door time in pre CODE STEMI group to CODE STEMI group from 46.3±30.9 minutes to 29.4±23.3. while door to balloon time, from 67.1±34.9 minutes to 0 45.0±22.7
Parikh, 2009	An emergency physician activated protocol, ‘Code STEMI’ reduces door-to-balloon time and length of stay of patients presenting with ST-segment elevation myocardial infarction	Code STEMI activation significantly reduces door-to-balloon time (112 minutes to 74 minutes, with p=0.001), and hospital length of stay decreased from 4 to 3 days, p=0.01. There is no any statistically significant difference in all-cause in-hospital mortality (p = 0.6).
Le may 2003	Hospitalization Costs of Primary Stenting Versus Thrombolysis in Acute Myocardial Infarction Cost Analysis of the Canadian STAT Study	In centers in which facilities and experienced interventionists are available, primary stenting is less costly and more effective than thrombolysis. It can be seen from The length of initial hospitalization was 6.7 - 11.3 days in the stent group and 8.7 - 6.7 days in the tPA group (P<0.001). Total hospitalization days at 6 months were 8.3 - 13 days in the stent group and 12.1 - 14.0 days in the tPA group (P<0.001) and hospitalization costs were less in the stent group for the initial hospitalization, \$6354 - 6382 versus \$7893 - 4429 (P<0.001), and at 6 months, \$7100 - 7111 versus \$9559 - 6933 (P<0.001).

The European Society of Cardiology (ESC) recommends a reperfusion strategy in the form of primary PCI if it is still within 12 hours onset and can be performed in ≤ 120 minutes (diagnosis to wire crossing time) of the diagnosis of STEMI [10]. Whereas American Heart Association recommends a primary PCI reperfusion strategy within 90 minutes after the patient receives a first medical contact if the patient is admitted to a hospital with PCI facilities, or ≤ 120 minutes if the patient is admitted to the hospital without PCI facilities and need to be transferred to a hospital with PCI facilities (door to balloon / FMC to device time)[12]. By this definition, many hospitals and health centers implement the CODE STEMI program to accelerate the treatment given to STEMI patients.

This is the algorithm from Ibanez, et al in ESC guideline in 2017, that shows the mode of presentation, ischemic time component and flowchart for reperfusion strategy selection. When STEMI diagnosis is made in the out-of-hospital setting (via Emergency Medical system) or in a non-PCI centre, the decision for choosing reperfusion strategy is based on the estimated time from STEMI diagnosis to PCI-mediated reperfusion (wire crossing) [10].

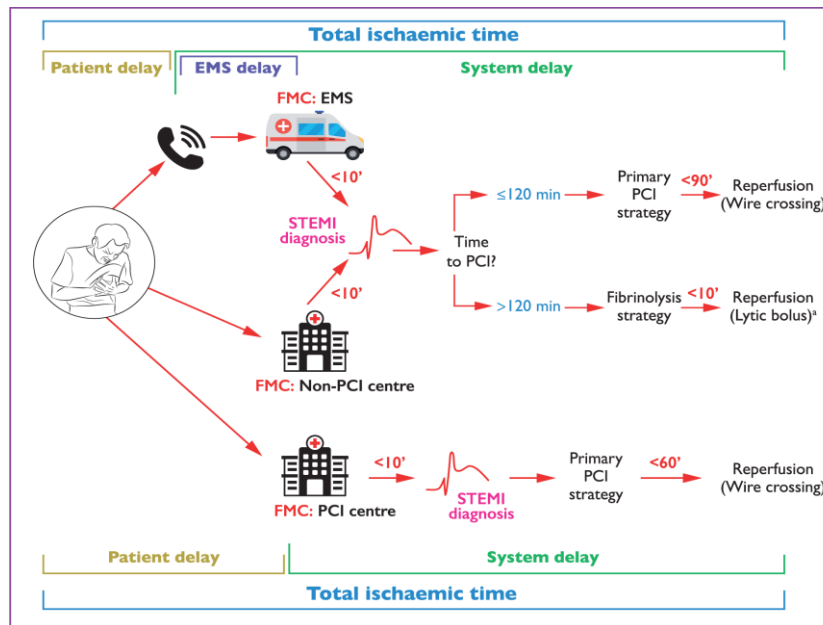


Figure 1. Modes of patient presentation, components of ischaemia time and flowchart for reperfusion strategy selection [10].

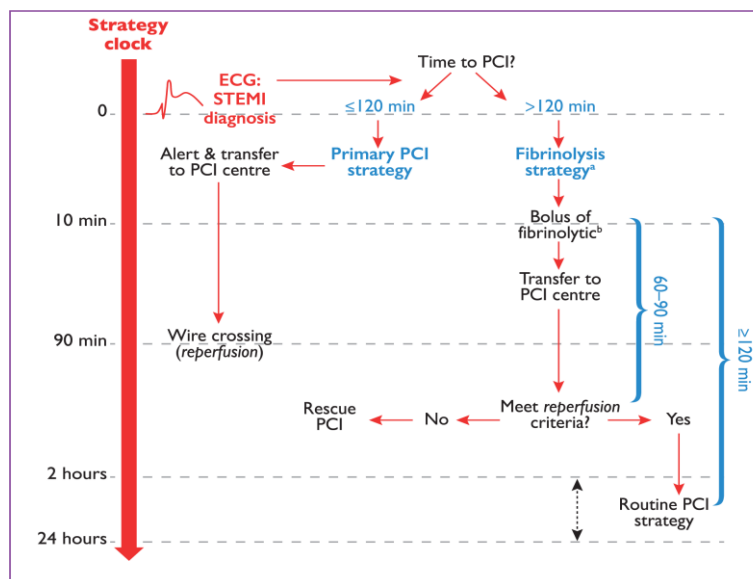


Figure 2. Maximum target times according to reperfusion strategy selection in patients presenting via EMS or in a non-PCI center [10].

In a study of the implementation of CODE STEMI in 2014-2015 in Melbourne, Australia showed a decrease time in door to balloon by 22.1 minutes and an increase in the proportion of patients undergoing PCI within ≤90 minutes by 22% compared to before the implementation of CODE STEMI [13]. Other research shows that the median door to balloon time is reduced by 38 minutes after the implementation of CODE STEMI. This research divides door to balloon time into 3 phases, door to ECG, ECG to cath lab, and cath lab to balloon. The largest proportion is found in the ECG to cath lab phase that shows a reduction time in door to balloon phase up to 16 minutes [14].

The implementation of CODE STEMI in Ottawa, Canada showed that door to balloon time ≤ 90 minutes was reached up to 80% in patients who were immediately treated with CODE STEMI [15]. Whereas research in Riyadh, Saudi Arabia showed that after the implementation of the CODE STEMI, 70% of STEMI patients were treated with door to balloon time ≤ 90 minutes. Whereas, before the implementation of the CODE STEMI, only 27% of STEMI patients were treated with door to balloon time ≤ 90 minutes [9]. Every delay in management of STEMI patients for 30 minutes can increase risk of mortality for 1 year as 7.5%. A study in Ottawa, Canada, hospital mortality rates decreased from 10% (2002 - 2004) to 4.7% in the first year after implementation of CODE STEMI (2005 - 2006). After that, the mortality rate due to STEMI still below 5%, this thing shows a decreasing of mortality rate up to 50% in 2002 - 2004. During the first year CODE STEMI was applied, the average length of stay (LOS) of patients dropped to 4 days [15]. Another study also reported that the average LOS of STEMI patients after the implementation of CODE STEMI also decreased from 4 to 3 days [14].

From the assessment of efficiency, primary PCI strategies also reduce the cost and length of stay of STEMI patients if we compared with the fibrinolysis strategy. The length of stay of patients with primary PCI strategies was reported to have an average of 6.7 ± 11.3 days, compared with patients with the fibrinolysis strategy who had a mean length of stay of 8.7 ± 6.7 days. The total cost of caring for patients was also found to be lower in patients with a primary PCI strategy with an average of \$ 6354 \pm 6382 compared to the cost of treating patients with a fibrinolysis strategy that had an average of \$ 7893 \pm 4429 [15].

DISCUSSION

Quality of healthcare includes all of the actions that are taken to provide, protect and improve health services in patients. At present, the term of patient service quality is not only related to medical services, but also the quality of service that includes the performance of health workers as well as comfort, safety, and convenience for patients [11].

This quality of health service is the result of two main factors, the health science and technology, and its practical application. According to Donabedian, the quality of patient services can be assessed from 7 main components, like efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity [11].

From several studies, the implementation of CODE STEMI program has been proven in reducing door-balloon or diagnosis to wire time, and also complications, length of stay and total cost. But one study from Alyahya et al, show that from all the MACE after STEMI complications, only reducing recurrent myocardium infarction ($P=0.043$). Hospital mortality was low in both groups and showed no difference. Similar result also shown by Parikh et al, which is found there is no any statistically significant difference in all-cause in-hospital mortality. These results are very interesting. All four studies found that CODE STEMI program made a better time output but in terms of clinical improvement, CODE STEMI has not shown a better result in mortality. In terms of LOS and cost, this program showed a better result.

This study has limitations because the publications on CODE STEMI program is still very limited. Therefore, further research is needed using different population such as the Indonesian population where the application of CODE STEMI is still very limited. Assessment by using Donabedian Theory is necessary to assess the output in Indonesian. If the implementation of CODE STEMI program is proven to be good then it should be encouraged to be applied widely and even implemented as national policy.

CONCLUSION

Implementation of CODE STEMI program proves to improve quality of healthcare. Further research should be made using the cohort study by assessing all existing parameters. Hopefully the results of this

study will provide great benefits, especially for patients. Thus it can be the basis for the implementation of policies to implement CODE STEMI programs in general hospitals.

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