ORIGINAL RESEARCH

Performance Measures in the Management of ST-Segment Elevation Myocardial Infarction Patients at Manila Doctors Hospital

Published online: 11 November 2024
https://doi.org/10.69944/pjc.61270e7d28
https://pjc.philheart.org
ISSN: 0115-1029
e-ISSN: 2815-2123
Volume 52 Issue 2

Michelle Gotohio-Ong, MD[1] | Vhina Therese P. Sison, MD[1] | Joy-Anezka S. Guzman, MD[1] | April Ann A. Bermudez-delos Santos, MD[1] | Wilbert Allan G. Gumatay, MD[1] | Noemi S. Pestaño, MD[1] | Bernadette A. Tumanan-Mendoza, MD, MSc, MHE[1] | Felix Eduardo R. Punzalan, MD, MSc [1, 2]

[1] Section of Cardiology, Department of Internal Medicine, Manila Doctors Hospital, Manila, Philippines
[2] Division of Cardiovascular Medicine, Department of Medicine, Philippine General Hospital, University of the Philippines College of Medicine

Correspondence:
Michelle Gotohio-Ong, MD
E-mail: michelle_gotohio@yahoo.com

CONFLICTS OF INTEREST: None

Abstract

INTRODUCTION: ST-segment elevation myocardial infarction (STEMI) is a common and potentially fatal presentation of cardiovascular disease. Once a diagnosis is made, prompt intervention is crucial, with substantial effect on morbidity and even mortality.

OBJECTIVE: The aim of this study was to assess the adherence of physicians of a tertiary care hospital to American College of Cardiology/American Heart Association and European Society of Cardiology performance measures for the management of acute STEMI patients.

METHODOLOGY: This was a descriptive retrospective chart review of acute STEMI patients seen in a tertiary care hospital over a 2-year period.

RESULTS: A total of 118 STEMI patients were included in the study. Mean age was 57.8 years with male predominance. High adherence rates (100% achievement score) to recommended discharge medications and counseling for smoking cessation were observed. However, performance measures for time to reperfusion therapy via percutaneous coronary intervention (average, 16.7% over 2 years) and referral to cardiac rehabilitation (average, 38.0%) were consistently low, although time to percutaneous coronary intervention improved from an average of 170 minutes to 142 minutes in the second year of this study.

CONCLUSION: For 2 consecutive years, all STEMI patients seen in our institution were adequately managed with regard to recommended medications. All patients have been advised lifestyle change, particularly smoking cessation for current smokers. There is room for improvement with regards to time to reperfusion therapy and referral to cardiac rehabilitation. Some measures have been suggested, including shortening the time to secure patient consent.

KEYWORDS: myocardial infarction, performance measures, STEMI

INTRODUCTION

Ischemic heart disease now accounts for almost 1.8 million annual deaths, or 20% of all deaths in Europe.[1] The prevalence of ischemic heart disease in Southeast Asia is 1.54% and is highest in Thailand (2.32%), Malaysia (1.95%), and Singapore (1.95%), whereas the Philippines (1.68%) ranked third.[2]

ST-segment elevation myocardial infarction is an acute thrombotic narrowing or occlusion after plaque rupture, and it accounts for 25% to 40% of all AMI patients.[3]

Beltejar-Pimentel et al[4] analyzed the data at the Philippine Acute Coronary Syndrome Registry of the Philippine Heart Association from 2011 to 2015. Of 3346 patients with acute coronary syndrome (ACS), 37% suffered from STEMI. Patients with STEMI were mostly male, with a mean age of 58.66 years. Hypertension (70.5%) was the most prevalent risk factor, followed by history of smoking (56.4%).[4]

Several clinical practice guidelines (CPGs) have been developed for the proper management of STEMI. The two more widely adopted CPGs are the 2017 American College of Cardiology/ American Heart Association (ACC/AHA) Clinical Performance and Quality Measures for Adults With ST-Elevation and Non–ST-Elevation Myocardial Infarction and the 2017 European Society of Cardiology (ESC) Guidelines for the Management of AMI in Patients Presenting With ST-Segment Elevation.[1,5] Both guidelines included performance measures relating to reperfusion therapy after STEMI, discharge medications and medical advice, and others. Appendix 1 provides a comparative summary of the two guidelines.

Performance measures serve as vehicles to accelerate translation of scientific evidence into clinical practice. These measure sets were developed to provide health care practitioners with tools to measure the quality of care provided and likely improve outcomes of patients with STEMI.[5]

In a study on compliance to inpatient performance measures in management of heart failure patients, Bermudez et al[6] noted that compliance of physicians at a local tertiary care hospital to measures of care in heart failure management was at par with international and local data.

The aim of this study was to assess the adherence of physicians of tertiary care hospital to the ACC/AHA and the ESC performance measures for the management of patients admitted for acute STEMI from March 2018 to February 2020.

METHODOLOGY

This was a descriptive retrospective chart review of all acute STEMI patients seen over a 2-year period (March 2018 to February 2020) was conducted. It included all adult patients (18 years and older) admitted at the emergency room of a tertiary care hospital with a diagnosis of acute STEMI and managed exclusively in our institution for the entire duration of their illness were considered for the study. Patients who died during hospitalization, discharged against medical advice (<24-hour admission) or transferred to and from another other hospital/ facility were excluded.

Sample Size

Sample size was computed using the results from a previous study on adherence rates to the ACC/AHA 2011 inpatient performance measures in the management of heart failure. Adherence ranged from 82.5% adherence to β-blocker therapy for patients with left ventricular systolic dysfunction to 93.5% adherence to left ventricular ejection fraction assessment.[6] Sample size was calculated as 158 using 5% level of significance with 10% margin of error.[7]

Definitions

Performance measure adherence was expressed as a ratio of the denominator (defined as all eligible patients) and the numerator (defined as all patients who actually received treatment or medical advice as prescribed by the respective guidelines). Denominator exclusions and exemptions were applied as described per performance measure (Appendix 2). Denominator exclusions refer to any criteria that result in the outright removal of a patient or patients from the denominator without assessing the numerator. Denominator exceptions, on the other hand, refer to any condition/specifications that should remove a patient or patients from the denominator of the performance measure only if the numerator criteria are not met.[8]

The formula for each performance measure was set as follows: % Adherence = (number of patients who received treatment or medical advice per CPG) / (number of eligible patients). Eligible patients were defined as patients without denominator exclusions/exemptions and/or patients with denominator exemptions but who still received the prescribed treatment or medical advice.

Data Collection, Processing and Analysis

Retrospective chart review was performed to collect demographic and clinical data. All data were recorded directly into a Microsoft Excel spreadsheet (Microsoft Corp, Redmond, Washington). No patient-identifiable data were recorded.

Statistical software used included Microsoft Excel and Stata 13.1 (StataCorp LP, College Station, Texas). Descriptive statistics, that is, percentages and mean/SD, were used to summarize the data. Confidence level was set at 95%.

Ethical Considerations

This study adopted all the principles of the Declaration of Helsinki. Data gathering was done purely through chart review with no patient interaction. All identifiers were kept confidential. This was submitted and approved by the Committee on Research and Institutional Review Board.

After securing Institutional Review Board certification, permission to access data was secured from the data privacy officer. The investigators did not include any data that may be used to identify patients in compliance with the Data Privacy Act of 2017. The records from this study were kept confidential. No individual entities were used in any reports or publications resulting from the study. All patients were assigned reference numbers to preserve anonymity. Only the researchers and national regulatory bodies, when required, had access to the results obtained. After the study was completed, all collected data collection forms were stored in a password-protected file, to be stored up to a period of 10 years from the time of data collection, and then destroyed.

RESULTS

A total of 192 STEMI patients were seen at our institution from March 2018 to February 2020. After exclusion of the following: 2 were discharged against medical advice, 14 died, 7 were direct to room admission, and 19 were transferred to or from other hospital; retrospective data from 52 patients seen from March 2018 to February 2019 and 66 patients seen from March 2019 to February 2020 were included in the study. Chart

Table 1. Demographics of Included Patients

Characteristics	March 2018–February 2019 (n = 52)	March 2019–February 2020 (n = 66)	Overall (n = 118)
Age, y	58.1 ± 11.0	57.5 ± 10.2	57.8 ± 10.5
Sex Male Female	 42 (80.8%) 10 (19.2%)	 57 (86.4%) 9 (13.6%)	 99 (83.9%) 19 (16.1%)
Comorbidities			
Hypertension	31 (59.6%)	39 (59.1%)	70 (59.3%)
Coronary artery disease	2 (3.8%)	7 (10.6%)	9 (7.6%)
Previous MI	3 (5.8%)	9 (13.6%)	12 (10.2%)
Dyslipidemia	27 (51.9%)	28 (42.4%)	55 (46.6%)
Diabetes mellitus	25 (48.1%)	35 (53.0%)	60 (50.8%)
Chronic kidney disease	14 (26.9%)	12 (18.2%)	26 (22.0%)
Asthma/COPD	3 (5.8%)	7 (10.6%)	10 (8.5%)
Smoking history			
No	23 (44.2%)	23 (33.3%)	46 (39.0%)
Previous	22 (42.3%)	36 (54.5%)	58 (49.2%)
Current	7 (13.5%)	7 (10.6%)	14 (11.9%)
Presenting symptoms			
Chest pain/discomfort	32 (61.5%)	55 (83.3%)	87 (73.7%)
Difficulty of breathing	9 (17.3%)	8 (12.1%)	17 (14.4%)
Diaphoresis	3 (5.8%)	1 (1.5%)	4 (3.4%)
Others			
Epigastric pain	4 (7.7%)	3 (4.5%)	7 (5.9%)
Loss of consciousness	2 (3.8%)	0	2 (1.7%)
Weakness	1 (1.9%)	1 (1.5%)	2 (1.7%)
Dizziness	1 (1.9%)	0	1 (0.8%)
Choking sensation	0	1 (1.5%)	1 (0.8%)
Vital signs			
Blood pressure, mm Hg			
Systolic	114.0 ± 28.6	125.6 ± 29.5	120.5 ± 29.5
Diastolic	71.9 ± 17.9	78.3 ± 16.8	75.5 ± 17.5
Heart rate, beats per minute	79.8 ± 21.3	83.2 ± 21.9	81.7 ± 21.6
Body mass index	25.3 ± 4.3	26.1 ± 3.9	25.8 ± 4.1
Normal	26 (50.0%)	28 (42.4%)	54 (45.8%)
Overweight	20 (38.5%)	28 (42.4%)	48 (40.7%)
Obese class I	5 (9.6%)	8 (12.1%)	13 (11.0%)
Obese class II	0	2 (3.0%)	2 (1.7%)
Obese class III	1 (1.9%)	0	1 (0.8%)

Abbreviations: COPD, chronic obstructive pulmonary disease; MI, myocardial infarction.

records of 32 patients could not be retrieved. A total of 118 eligible patients were identified. Because this was less than the computed sample size, all 118 patients were included in the study. Table 1 shows the demographic profile of the included patients. Patient clinicodemographic profile was generally similar across time periods. Overall mean age was 57.8 years with male predominance (83.9%). The top three comorbidities were hypertension (59.3%), diabetes mellitus (50.8%), and dyslipidemia (46.6%). Most patients had history of smoking. Majority of patients were overweight or obese.

Table 2. Diagnostics and Management Done

Characteristics	March 2018–February 2019 (n = 52)	March 2019–February 2020 (n = 66)	Overall (n = 118)
Diagnostics 2D echocardiogram Stress test	 52 (100%) 0	 66 (100%) 2 (3.0%)	 118 (100%) 2 (1.7%)
Management done			
PCI	36 (69.2%)	45 (68.2%)	81 (68.6%)
<60 min	0	1	1
60–90 min	5	3	8
>90 min	18	27	45
Fibrinolytic therapy	6 (11.5%)	3 (4.5%)	9 (7.6%)
<10 min	0	0	0
10–30 min	2	0	2
>30 min	4	3	7
Discharge medications/advice			
Aspirin	50 (96.2%)	63 (95.5%)	113 (95.8%)
P2Y12 inhibitor	51 (98.1%)	63 (95.5%)	114 (96.6%)
β-Blocker	45 (86.5%)	55 (83.3%)	100 (84.7%)
High-intensity statin	48 (92.3%)	61 (92.4%)	109 (92.4%)
ACEI/ARB	50 (96.2%)	58 (87.9%)	108 (91.5%)
Cardiac rehabilitation	17 (32.7%)	24 (36.4%)	41 (34.7%)
Smoking cessation	7 (13.5%)	9 (13.6%)	16 (13.6%)

Abbreviations: 2D, two-dimensional; ACEI/ARB, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; PCI, percutaneous coronary intervention.

Chest pain was the most common symptom reported (73.7%), followed by difficulty of breathing (14.4%) and diaphoresis (3.4%). Mean systolic and diastolic blood pressure were 120.5 and 75.5 mm Hg, respectively (Table 1).

Upon STEMI diagnosis, patients received reperfusion therapy via primary PCI (68.6%) or fibrinolytic therapy (7.6%). The rest were advised to undergo surgical treatment (eg, coronary artery bypass graft surgery) or were managed conservatively due to delayed consult and/or lack of patient consent. Upon discharge, nearly all patients were given aspirin, P2Y12 inhibitor, β-blocker, high-intensity statin, and angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker (ACEI/ARB). Only 41 STEMI patients (34.7%) were enrolled in cardiac rehabilitation program. All included current smokers were advised smoking cessation. All patients had two-dimensional (2D) echocardiogram done during hospital stay. Two patients (1.7%) underwent stress testing for conservative management (Table 2).

The results of the chart review revealed that 5 of 23 (21.7%) and 4 of 31 (12.9%) eligible patients seen in March 2018 to February 2019 and in March 2019 to February 2020, respectively, met the performance criteria set by the ACC/AHA for time to PCI for nonarrested patients (≤90 minutes), whereas no patient (none of two patients overall) in the two respective time periods met the time to PCI requirements for arrested patients (≤120 minutes). On the other hand, two of six patients (33.3%) from March 2018 to February 2019 were given fibrinolytic therapy within the recommended time of ≤30 minutes, whereas none of three patients in the subsequent time period were able to meet the requirements. All patients were managed adequately with regard to in-hospital or discharge medications. Stress testing was not performed for one eligible patient and performed for all two eligible patients from March 2018 to February 2019 and March 2019 to February 2020, respectively. Only 17 of 45 (37.8%) and 24 of 63 (38.1%) patients were referred for cardiac rehabilitation (Table 3).

Using the ESC guidelines, no patient out of 23 eligible patients seen in March 2018 to February 2019 and 1 of 31 (3.2%) eligible patients seen in March 2019 to February 2020 met the performance criteria set for time to PCI (≤60 minutes). For both time periods, no eligible patient was treated with fibrinolytic agents within the ESC-recommended time of <10 minutes from STEMI diagnosis. All patients had 2D echocardiography done to evaluate ejection fraction. All patients were prescribed in-hospital/discharge medications as recommended. All eligible patients received smoking cessation advice as well. Only 37.8% and 38.1% of patients were referred for cardiac rehabilitation (Table 4).

Table 3. Performance Measures According to ACC/AHA Guidelines

Characteristics	March 2018–February 2019(n = 52)	March 2019–February 2020(n = 66)
Reperfusion therapy		
Time to PCI, min	170.3 ± 75.4	142.5 ± 64.7
≤90 min	5/23 (21.7%)	4/31 (12.9%)
≤120 min (for arrested patient)	0/1 (0%)	0/1 (0%)
Time to fibrinolytic therapy ≤30 min	2/6 (33.3%)	0/3 (0%)
Aspirin Within 24 h On discharge	 51/51 (100%) 50/50 (100%)	 65/65 (100%) 63/63 (100%)
$P2Y_{12}$ inhibitor on discharge	51/51 (100%)	63/63 (100%)
β-Blocker on discharge	45/45 (100%)	55/55 (100%)
ACEI/ARB on discharge	50/50 (100%)	58/58 (100%)
High intensity statin on discharge	48/48 (100%)	61/61 (100%)
Evaluation of LVEF	52/52 (100%)	66/66 (100%)
Stress testing for conservative management	0/4 (0%)	2/3 (66.7%)
Cardiac rehabilitation referral	17/45 (37.8%)	24/63 (38.1%)

Abbreviations: ACC/AHA, American College of Cardiology/American Heart Association; ACEI/ARB, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention.

Table 4. Performance Measure According to ESC Guidelines

Characteristics	March 2018–February 2019(n = 52)	March 2019–February 2020(n = 66)
Reperfusion therapy Time to PCI ≤60 min Time to fibrinolytic therapy ≤10 min	 0/23 (0%) 0/6 (0%)	 1/31 (3.2%) 0/3 (0%)
Aspirin During hospitalization On discharge	 51/51 (100%) 50/50 (100%)	 65/65 (100%) 63/63 (100%)
P2Y12 inhibitor on discharge	51/51 (100%)	63/63 (100%)
β-Blocker on discharge	45/45 (100%)	55/55 (100%)
ACEI/ARB on discharge	50/50 (100%)	58/58 (100%)
High-intensity statin on discharge	48/48 (100%)	61/61 (100%)
Evaluation of LVEF	52/52 (100%)	66/66 (100%)
Cardiac rehabilitation referral	17/45 (37.8%)	24/63 (38.1%)
Smoking cessation advice	7/7 (100%)	7/7 (100%)

Abbreviations: ACEI/ARB, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; ESC, European Society of Cardiology; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention.

DISCUSSION

Timely reperfusion either mechanical via PCI or pharmacologic via fibrinolytic therapy should be administered in all STEMI patients with symptom onset within 12 hours, along with evidence-based medical therapy, and has been proven to decrease mortality, decrease cardiovascular events, and improve quality of life.

Primary PCI has been shown to be superior to fibrinolytic therapy in recanalizing the infarcted-related artery and offers better clinical outcome such as lower rates of short-term mortality, nonfatal reinfarction, stroke, and fewer hospitalization for recurrent ischemia or heart failure.[9] As such, PCI is the first line of treatment offered to STEMI patients in our institution.

Among the 54 patients who had PCI done, only nine patients underwent the procedure in ≤90 minutes (following ACC/AHA guideline), and only one patient was given the intervention in <60 minutes (following ESC guideline) from the time of STEMI diagnosis. This did not meet the ACC/AHA STEMI

Recognition–recommended achievement score of ≥75% of patients treated with PCI within 90 minutes of arrival at a receiver center (Mission: Lifeline® Hospital STEMI and NSTEMI Recognition|American Heart Association). The time to PCI recommendations by either society guideline may not be a realistic goal in the Philippine setting because of financial barriers and the current Philippine health care system, which still operates primarily on out-of-pocket settlements of hospital expenditures. Punzalan et al looked into the coverage for ACS and invasive interventions by PhilHealth (Philippine Health Insurance Corporation), the Philippines' universal health care program, and found that the current coverage is significantly less than the actual cost of treatment. The authors proposed revised coverage rates for hospitalization due to ACS that should enable the patient to avail of timely and appropriate health care and hopefully to better clinical outcomes.[10] Another cause of the low adherence rate could be limited facilities. Our institution had only one operational cardiac catheterization laboratory unit (cath lab) from 2018 to early 2020, which could cause backlogs and delay in time to PCI in situations when there are two or more patients needing urgent cardiac intervention. This was the reason of the delay in nine (16.7%) of those who underwent urgent PCI after securing consent in our institution. At present, there are two operational cath labs to serve more patients.

Looking at similar studies, a local article by Fernandez-Limbungan and Ho reported 27.7% adherence rate with regard to door-to-balloon time. The authors noted that patients with timely door-to-needle and door-to-balloon times did not have significantly different mortality or complication rates up to 72 hours postprocedure compared with those who did not, although patients who adhered to the recommended door-to-balloon had shorter hospital stay.[11] Budhani and Ramboyong[12] reported mean door-to-balloon times of 216 minutes at another local institution. Prakash et al[13] noted similar causes to delayed intervention in a similar study conducted in India. They noted that a major cause of prolonged PCI time in their setup was delay in giving consent by the patient's relatives and financial issues.[13] A study on six hospitals in the United States revealed an overall adherence rate of 87.8% according to performance measures set by ACC/AHA.[14] A possible cause of this disparity in adherence rates between US and local/Asian studies is the difference in socioeconomic status and health care systems where patients in third-world countries typically do not have health insurance and have to pay hospital bills out of pocket. This leads to possible delays in securing consent as patients and/or the family of patients have to secure funds for PCI treatment.

When time of secured patient consent to time of vessel opening was taken into account instead of first medical contact to PCI time, 70% and 76% of eligible patients from the 2018/2019 and the 2019/2020 time periods, respectively, were able to receive PCI treatment within the ACC/AHA-recommended time to PCI of ≤90 minutes. This shows that securing patient consent as early as possible is one way of significantly reducing time to PCI in our institution. The data of Prakash et al[13] showed that overall delay in STEMI diagnosis to balloon time in their center was 121 minutes. One of their remedial actions was counseling about the need of early intervention.[13]

Fibrinolytic therapy is offered as an alternative treatment strategy to patients when it is anticipated that PCI cannot be performed within 90 to 120 minutes. Study results revealed low adherence rate to both ACC/AHA– and ESC-recommended time to fibrinolytic therapy. When time of secured patient consent to infusion of thrombolysis was taken into account instead of door-to- needle time, all eligible patients from the 2-year period were able to receive fibrinolytic treatment within the ACC/AHA–recommended time period to fibrinolysis of ≤30 minutes.

The data showed that the institution had a 100% adherence rate to evidence-based drugs without contraindication (namely, aspirin, P2Y12 inhibitor, ACEI/ARB, β-blocker, high-intensity statin) and diagnostics (2D echocardiogram) in managing patients with STEMI. These have shown beneficial to reduce cardiovascular events, recurrent myocardial infarction, and all-cause mortality. Evaluation of left ventricular ejection fraction is important for therapeutic management and prognostication. For those patients managed conservatively, noninvasive stress testing should be done prior to discharge, preferably a submaximal test to assess the presence and extent of inducible ischemia and further risk stratify patients who needed invasive angiography with possible revascularization to prevent recurrent ischemia/infarction.

Our results showed high adherence rates with regard to medical therapy and evaluation of ejection fraction. This is comparable, if not better, to the results of a similar study conducted by Hudzik et al[15] in Poland.

Secondary prevention strategies have been proven to be effective means of delaying the progression of cardiovascular diseases, and one of the key approaches is cardiac rehabilitation.[16] Among the different cardiovascular diseases, cardiac rehabilitation is a class I indication for those with recent myocardial infarction, heart failure, or coronary artery bypass grafting surgery. Recent studies suggest that patient education by physicians and other health care providers regarding cardiac rehabilitation benefits may be the most effective strategies to improve cardiac rehabilitation referral and participation rates.[17] Despite being recommended by guidelines, referral to and participation in cardiac rehabilitation have been historically poor worldwide.[18] Hudzik et al[15] had 54.3% referred to cardiac rehabilitation following STEMI, which is in line with our institution's achievement score of 37.8% and 38.1%. As part of our institution's initiative to encourage referral for cardiac rehabilitation, a dedicated unit for cardiac rehabilitation was recently made available to patients.

There was 100% adherence rate to smoking cessation being advised to all 14 current smokers in a 2-year period as a measure in the ESC guideline.

Time to PCI was almost twice the recommended time in the first year since publication of the two practice guidelines (March

2018 to February 2019). In the subsequent year, although there was one less patient who met the performance measure, time to PCI improved by almost 30 minutes. Discharge medications have consistently high compliance rate, whereas cardiac rehabilitation referrals were consistently low in the 2-year period.

Compliance to the ACC/AHA or ESC measure sets can standardize care processes and reduce morbidity and mortality. In addition, implementation of these performance measures by health care providers and physician practices will enhance the quality of care and improve outcomes of patients hospitalized with myocardial infarction.[19] In the United States, they noted that there had been a steady decline in mortality over the last several decades. They mentioned that the reduction of death from STEMI is due to (1) recognition of risk factors, (2) smoking cessation, and (3) adherence to practice guidelines and improve compliance to established treatment strategies with MI.[20]

Limitations of the Study

The study gathered data from chart review; hence, some data may be incomplete due to lack of documentation.

CONCLUSION

The results of the study showed that for 2 consecutive years all STEMI patients seen in our institution were adequately managed with regard to recommended in-hospital and discharge medications. Additionally, all patients have been given ample lifestyle change advice, particularly smoking cessation for current smokers. Although certain high-level factors to timely intervention, such as low universal health coverage and poverty, were identified, there is still room for improvement on the local institutional level with regard to time to reperfusion therapy and referral to cardiac rehabilitation. Some measures have been suggested, including shortening the time to secure patient consent. A follow-up study is recommended to evaluate the effects of improvements in cath lab and cardiac rehabilitation. A multicenter study is also recommended to determine if the results of the study are consistent with other health care institutions in the country.

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APPENDIX

Appendix 1. Comparative Summary of the AHA/ACC[5] and the ESC Performance Measure for Management of STEMI[1]

Outcome Measures	AHA/ACC	ESC	Difference
Reperfusion therapy Time to fibrinolytic therapy (door-to-needle time)	✓	✓	≤30 min (ACC/AHA) vs <10 min (ESC)
Time to PCI (PCI capable) (FMC-to-PCI)	✓	✓	≤90 min (ACC/AHA) vs ≤60 min (ESC)
Time to PCI (for arrested patients)	✓ (≤120 min after resuscitation)		None for ESC
Aspirin prescribed during hospitalization	✓	✓	It should be given within 24 h received at hospital arrival (ACC/AHA)
Aspirin prescribed at discharge	✓	✓	Same
$P2Y_{12}$ receptor inhibitor prescribed at discharge	✓	✓	Same
β-Blocker prescribed at discharge	✓	✓	Same
ACEI or ARB prescribed at discharge	✓	✓	Same
High-intensity statin prescribed at discharge	✓	✓	Same
Evaluation of LVEF before discharge	✓	✓	Same
Noninvasive stress testing before discharge for conservatively managed patients	✓		None for ESC
Cardiac rehabilitation prescribed before discharge	✓	✓	Same
Smoking cessation advice before discharge		✓	None for ACC/AHA
Timely reperfusion therapy for transferred patients: <30 min door-in–door-out time	✓	✓	Same Not applicable to current study
Time from ED arrival at STEMI referral facility to ED discharge from STEMI referral facility in patients transferred for primary PCI	✓	✓	Same Not applicable to current study
Time to PCI (for transfer patients) (FMC to PCI ≤120 min)	✓	✓	Same Not applicable to current study

Abbreviations: ACEI/ARB, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; ACC/AHA, American College of Cardiology/American Heart Association; ED, emergency department; ESC, European Society of Cardiology; FMC, first medical contact; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.
Definition: Time to fibrinolytic therapy: time from STEMI diagnosis to bolus or infusion start of fibrinolysis in patient unable to meet primary PCI. Time to PCI: time from STEMI diagnosis to wire crossing of infarct-related artery at PCI-capable hospital. Door-in–door-out time: duration from arrival of the patient at the hospital to discharge of the patient in an ambulance en route to the PCI center.

Appendix 2. Definition and Eligibility Criteria for Specific Outcome Measures[1,5]

1. **Reperfusion therapy:** Either fibrinolytic therapy or primary percutaneous coronary intervention (PCI) performed in a timely manner (given to patients with symptoms of ischemia of ≤12-hour duration)

   A. **Primary PCI:** The American College of Cardiology/American Heart Association (ACC/AHA) defined this as any patient who received primary PCI ≤90 minutes from first medical contact to PCI time (time from ST-segment elevation myocardial infarction (STEMI) diagnosis to wire crossing of infarct related artery) as compared with European Society of Cardiology (ESC) performance measure target time of ≤60 minutes.

   - Denominator exception: documentation of a medical reason for delayed primary PCI (eg, cardiopulmonary arrest, cardiogenic shock, vascular access or lesion crossing issues, respiratory distress requiring intubation, late presentation of symptoms >12 hours after symptom onset, patients who have received fibrinolytic as initial reperfusion therapy, no identifiable culprit or without obstructive lesion, severe coronary artery disease necessitating urgent coronary artery bypass graft surgery, attempted but unsuccessful PCI), received fibrinolytic therapy as initial reperfusion therapy, documentation that patient/family refused (eg, financial barrier).

   B. **Fibrinolytic**: The ACC/AHA defined this as any patient who received fibrinolytic therapy (as the primary reperfusion modality) with a time from hospital arrival to fibrinolysis ≤30 minutes as compared with ESC target time of ≤10 minutes when primary PCI cannot be performed within 120 minutes of STEMI diagnosis.

   - Denominator exception: documentation of a medical reason for delayed fibrinolytic therapy (eg, cardiopulmonary arrest, initial suspicion of bleeding/stroke or other contraindication to fibrinolytic therapy, respiratory distress requiring intubation, late presentation of symptoms >12 hours after symptom onset), documentation of patient barrier (refusal, financial barrier).

2. **Aspirin during hospitalization and at discharge:** The ACC/AHA and ESC described as acute myocardial infarction (AMI) patients were given acetylsalicylic acid (ASA) during hospitalization and prescribed once for discharge; additionally, the ACC/AHA stated that ASA should be given within 24 h after hospital arrival.

   - Denominator exception: allergy to ASA or intolerance, active bleeding (gastrointestinal ulcer), history of CVD bleed.

3. **$P2Y_{12}$ inhibitor therapy at discharge:** The ACC/AHA and ESC described as AMI patients prescribed with $P2Y_{12}$ inhibitor at hospital discharge.

   - Denominator exceptions: allergy or intolerant to $P2Y_{12}$ inhibitor, on oral anticoagulant at discharge, active bleeding, patients with planned coronary artery bypass graft surgery procedure after discharge.

4. **β-Blocker therapy with left ventricular systolic dysfunction before discharge:** The ACC/AHA and ESC defined this measure as AMI patients especially those with LVSD who are prescribed with β-blocker at hospital discharge.

   - Denominator exception: advance heart block, significant bradycardia or hypotension prior to discharge, active asthma, or chronic obstructive pulmonary disease.

5. **Angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker (ACEI/ARB) for LVSD before discharge:** The ACC/AHA and ESC defined this measure as AMI patients especially those with LVSD who are prescribed with ACEI/ARB at hospital discharge.

   - Denominator exception: acute or worsening renal function, intolerance to treatment (angioedema), hypotension/hyperkalemia (serum potassium >5 mmol/L), renal artery stenosis.

6. **High-intensity statin at discharge:** The ACC/AHA and ESC described as patients diagnosed with AMI who are prescribed with high-intensity statin at hospital discharge.

   - Denominator exception: liver failure, intolerance, documentation of moderate-intensity statin for those older than 75 years

7. **Evaluation of LVEF before discharge:** The ACC/AHA and ESC defined as documentation that LVEF is being evaluated during hospitalization. The measurement can be either quantitative or qualitative.

8. **Cardiac rehabilitation referral:** The ACC/AHA and ESC defined as AMI patients who are referred to cardiac rehabilitation program during their hospital stay.

   - Denominator exception: financial barriers

9. **Immediate angiography after cardiac arrest:** The ACC/AHA defined as any patients who will receive invasive angiography within 120 minutes after resuscitation from out-of-hospital cardiac arrest with electrocardiographic finding of STEMI. This was a class Ib recommendation by ESC guideline. However, it was not included in their assessment of performance measure.

   - Denominator exception: documentation of medical or patient reason for not receiving intervention (eg, terminal illness/futile medical condition, patient's or family decision).

10. **Stress test in conservatively treated patients:** The ACC/AHA defined as AMI patients who are initially managed conservatively (medical therapy alone and did not perform invasive angiography) and with documentation that noninvasive stress testing was done before discharge. ESC also stated that noninvasive imaging should be done for nonreperfused patients. However, this measure set was not required by ESC.

- Denominator exception: documentation of (1) medical reason for not receiving the test (eg, contraindication to vasodilator or dobutamine, patients with ongoing ischemia), (2) patient choice not to undergo ischemic workup or to postpone to outpatient setting, (3) patient eventually decided to undergo angiography without the need for noninvasive stress test.

11. **Smoking cessation:** The ESC checked on patients given advice on smoking cessation whose measure was being retired by the 2017 ACC/AHA as compared with their previous measure set because of the consistently high levels of performance achieved.

    - Denominator exception: No history of smoking or smoker who already quit smoking.