Quality of Care of Adult Patients with ST-Elevation Myocardial Infarction (STEMI) at the Emergency Room of a Tertiary Hospital in the Philippines

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ABSTRACT

Introduction. Coronary artery disease (CAD) remains a significant public health problem worldwide and in the Philippines. Adherence to guideline-directed therapy improves the quality of care (QOC).

Objective. We aimed to evaluate the QOC initially received by ST-Elevation Myocardial Infarction (STEMI) patients at our Emergency Room (ER), based on compliance to 2014 PHA CAD guidelines recommendations.

Methods. We reviewed the charts of adult patients with STEMI admitted at the ER who were not previously managed in a different hospital. The primary outcome was QOC assessed through quality indicators (QI) based on class I and IIa recommendations in the PHA CAD guidelines.

Results. Of the 29 patients included, all had ECG done upon admission, but only four were done within 10 minutes (QI: 13.79%). All eligible patients received antiplatelets (QI: 100%). Six eligible patients (QI: 100%) received nitrates, and four eligible patients (QI: 100%) received morphine. Of 16 eligible patients, only six were reperfused within the recommended 12 hours of ischemia (QI: 37.5%), two by thrombolysis and four by the primary percutaneous coronary intervention (PCI).

Conclusion. The timely performance of initial ECG and reperfusion need improvement. Suitable performance measures for the provision of nitrates and morphine to eligible patients were met. Investigating intrinsic and extrinsic factors that lead to the time delays observed are also recommended.

Key Words: ST-elevation myocardial infarction, quality indicators, emergency services

BACKGROUND / INTRODUCTION

Coronary artery disease (CAD) remains a significant public health concern worldwide. In the Philippines, cardiovascular disease remains among the top 10 diseases causing morbidity. It is the leading cause of mortality in 2009.[1] The mortality rate was 7.8% for Acute Coronary Syndrome (ACS), and 8.2% for ST-Elevation Myocardial Infarction (STEMI), based on the 2-year report of the Philippine Heart Association Acute Coronary Syndrome registry that was launched in 2011.[2] According to the American Heart Association / American College of Cardiology (AHA/ACC), 25% to 40% of myocardial infarctions present as STEMI.[3]

The Philippine Heart Association (PHA) Council on Coronary Artery Disease released in 2014 the Philippine Guidelines on the Management of Coronary Artery Disease (which will be referred to here as "2014 PHA CAD guidelines") with the main objective of improving the quality

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of care (QOC) of Filipinos with CAD through a defined local set of standards upon which future recommendations and improvements in health care delivery can be based.[1] Pertinent recommendations among patients with STEMI enumerated in the latest PHA CAD guidelines are summarized in Appendix 1.

QOC improvement strategies and policies need studies that would describe the current pattern of delivery of care in the concerned institution and identify potential areas for improvement. Because most diagnoses of STEMI occur at the Emergency Room (ER), we decided to focus our QOC evaluation on the ER phase of STEMI management.

Studies have been conducted in our institution, as early as 2000, describing the QOC of patients with ACS admitted at our ER. These generally reported positive outcomes in terms of compliance to guideline-recommended management. At the time of conduct of this study, the most recent was the unpublished cross-sectional study by Morales et al. in 2015 on the QOC on patients with ACS. They used Class I recommendations by the European Society of Cardiology (ESC) to manage ST-elevation and non-STEMI as quality indicators (QI). They found that there was good compliance to the following: 12-lead electrocardiogram (ECG) and cardiac biomarker determination, use of anti-ischemic drugs, antiplatelets, anticoagulants, lipid-lowering agents, and Angiotensin-Converting Enzyme Inhibitors (ACEI) and Angiotensin Receptor Blockers (ARB). This study, however, noted poor compliance with ESC recommendations on 2D echocardiogram, lipid profile determination, and reperfusion therapy.[4]

The most recent study that used quality indicators based on local guidelines was Alcover et al. in 2012. This cross-sectional study used indicators based on recommendations by the 2009 PHA CAD guidelines and described the QOC of patients suspected with ACS admitted at our institution's ER. They likewise found a high rate of physician compliance to guideline-recommended medications for ACS for fibrinolysis (thrombolysis). However, the timing of delivery of services, such as mean door-to-ECG time and mean door-to-needle time, were suboptimal, at 1 hr 49 mins and 3 hrs 37 mins, respectively.[5]

Since the study by Alcover et al., the PHA has released a newer version of the CAD Guidelines. The significant changes focused on pre-hospital recognition, transfer strategies, and antiplatelet therapy for patients with STEMI. In our institution, improvements have been observed in the availability of thrombolytic agents, particularly streptokinase and recombinant tissue plasminogen activator (rtPA), and the accessibility of early primary percutaneous coronary intervention (PCI).

Significance

The results of this study on the QOC received by patients with STEMI treated at our institution's ER, and the clinical practice pattern of physicians who treat them may help improve services and intensify health programs in managing patients with STEMI in our institution.

Furthermore, the results of this study may lead to the identification of key factors and health resources to be addressed to catalyze measures to improve the quality and efficiency of health service delivery, prevent delays in life-saving management, and impact health resource allocation and health financing. This research supports the creation and refinement of clinical pathways and policies for the optimal and timely management for such patients and ultimately improves outcomes.

RESEARCH QUESTION

What are the observed clinical practice patterns of physicians in managing adult patients admitted at our institution's ER for STEMI, and how consistent are these practices with the 2014 PHA CAD guidelines?

RESEARCH OBJECTIVE

To evaluate the QOC initially received by patients with STEMI admitted at our institution's ER in one year (May 2018 to May 2019) and to describe the clinical profile of these patients.

Primary Objectives

1. To determine the compliance of physicians at our institution's ER to 2014 PHA CAD guideline recommendations on
   a. ECG
   b. Antiplatelets (e.g. aspirin, clopidogrel, ticagrelor)
   c. Nitrates
   d. Morphine
   e. Reperfusion, either by thrombolysis or Primary PCI
2. To determine the proportion of patients who received reperfusion therapy

Secondary Objectives

1. To describe the mean duration (in minutes) from ER admission to the performance of the following emergency management
   a. Performance of the initial ECG
   b. Loading of antiplatelets
   c. Decision to perform reperfusion, either by thrombolysis or primary PCI
   d. Administration of thrombolytic therapy
   e. Performance of Primary PCI
2. To describe the clinical profile of patients with STEMI at the ER
3. To determine the time interval from onset of symptoms to hospital arrival of STEMI patients
4. To describe the medications received by STEMI patients at the ER

METHODS

Study Design

Cross-sectional study

Study setting

Emergency Room of a tertiary hospital in the Philippines.

The ER charts of patients who were diagnosed with STEMI at the ER will be reviewed.

Sampling, Study Population, and Data Collection

Inclusion Criteria

All patients age 19 years old and above, admitted at the ER and referred to the Cardiology service for STEMI were included in the study.

Exclusion Criteria

We excluded patients who received initial treatment at a previous hospital or healthcare facility and then transferred to our institution's ER.

Terms used in this study were operationalized (Appendix 2). A data collection form or checklist (Appendix 3) was used to review the patient's chart, electrocardiogram (ECG) tracing, and other available laboratory results. This form was used to collect baseline demographic data such as age, gender, height, weight, BMI, chief complaint, entry route. Also compiled were the clinical profile and CAD risk factors of the patients such as Killip Class, NYHA Functional Class, renal function, walls affected based on ECG, contraindications/hindrances to reperfusion, history of smoking, type of physical activity; personal history of diabetes, hypertension, dyslipidemia, prior myocardial infarction, prior revascularization, heart failure, chronic kidney disease, cerebrovascular disease, peripheral artery disease and family history of CAD.

Time intervals were described in minutes and were based on a review of written records (e.g., triage logbook, inpatient chart, nurses' notes, ECG tracing, laboratory results). From the onset of symptoms to arrival in the hospital, time intervals were described as the mean/average and median time in hours from the time the index chest pain occurred and the time encoded in the ER triage officer records (referred to as "door"). The first ECG was based on the timestamp printed by the ECG machine on the ECG strip. The time of administration of medications (e.g., antiplatelets, nitrates, and morphine) was based on the therapeutic sheet in the chart. The time when the reperfusion, either by thrombolysis or PCI, was decided upon and eventually carried out was based on the chart entry of the attending physician.

Data abstracted from the data collection forms were recorded into an electronic database. All patients' information and records were anonymized, de-identified, and kept strictly confidential.

OUTCOMES AND DATA ANALYSIS

Quality of Care Evaluation

Assessment of QOC was analyzed through quality indicators referring to selected "strongly recommended" (Class I) and "recommended" (Class IIa) diagnostic and therapeutic indications in the 2014 PHA CAD Guidelines (Appendix 1).

Outcome Measures

The proportion of patients eligible (with indications and without contraindications) for specific diagnostic and therapeutic indications was determined. Rating for each quality indicator (QI) was expressed as:

$$\text{QI (\%)} = \frac{\text{all eligible patients who actually received management}}{\text{all patients eligible for management}}$$

Quality Indicators meeting 75% were considered the optimal QOC and good adherence to recommendations in the guidelines.[5]

Key quality indicators investigated were:

1) ECG

$$\text{QI (\%)} = \frac{\text{all patients with ECG done within 10 mins of ER admission}}{\text{all patients eligible for ECG}}$$

Only patients who had a 12-Lead ECG performed within 10 minutes of ER admission were counted in the numerator.

2) Antiplatelets

$$\text{QI (\%)} = \frac{\text{all patients who received antiplatelets upon ER admission}}{\text{all patients eligible for antiplatelets}}$$

For ACS in general, loading doses of antiplatelets are routinely administered upon diagnosis, even without an ECG or Troponin. In the cases of STEMI, the same management applies. Upon ER admission, antiplatelets (e.g., aspirin, clopidogrel) must be routinely administered unless contraindicated (e.g., massive bleeding, hypersensitivity). There is no recommended timeframe or "golden period" within which antiplatelets may be given. Local and foreign (e.g., AHA, ESC) Guidelines for STEMI recommend that the loading doses of these antiplatelets be given as soon as the diagnosis is made or as soon as the patient arrives at the ER. For this study, we included in the numerator of the QI formula all STEMI patients who received antiplatelets at the ER regardless of the time of administration.

3) Nitrates

$$\text{QI (\%)} = \frac{\text{all patients who received nitrates}}{\text{all patients eligible to receive nitrates}}$$

Nitrates may be given for patients with angina and with hypertension or heart failure. Likewise, the administration

of nitrates does not have a recommended timeframe or "golden period." All patients eligible to receive nitrates who were indeed given nitrates were included in the numerator of the QI rating. Sublingual nitrates were given for rapid relief of angina at the ER. Patients with hypotension, right ventricular infarction, or a history of PDE-5 inhibitor use within 48 hours were not eligible to receive nitrates.

4) Morphine

$$\text{QI (\%)} = \frac{\text{all patients who received morphine}}{\text{all patients eligible to receive morphine}}$$

Morphine may be given to relieve chest pain. The AHA/ACC also recommends its use for STEMI patients with pain, anxiety, and pulmonary edema. Similar to nitrates, the administration of morphine does not have a recommended timeframe or "golden period." Patients with contraindications (e.g., hypotension, bradycardia, lethargy, hypersensitivity) could not receive morphine.

5) Reperfusion

$$\text{QI (\%)} = \frac{\text{all patients who received reperfusion within 12 hours}}{\text{all patients eligible to receive reperfusion}}$$

Reperfusion or revascularization may be done pharmacologically by thrombolysis with fibrinolytic agents or invasively by PCI at the cardiac catheterization laboratory. The golden period for which reperfusion, in general, must be given is within 12 hours of symptom onset unless contraindicated. Thrombolysis and PCI each have specific contraindications, and the attending physician at the ER was expected to assess for the patient's eligibility or ineligibility accordingly.

Statistical analysis

Descriptive analysis using tables, frequency and mean values, percentages, and standard deviations to summarize and analyze the data collected were used.

Ethical Issues

The study was conducted upon approval of the UPMREB. To ensure confidentiality, number codes were assigned to hide patients' identities. No other information was obtained aside from what was stated in the protocol. There was no conflict of interest in this study that may arise from financial, familial, or proprietary considerations of the primary and co-investigators or the study site. There was no direct benefit to the patients. There were no anticipated risks for the patients whose data were included in the study.

RESULTS

In a 1-year collection period from May 2018 to 2019, there were 96 STEMI patients received at our ER. However, many were excluded since they were transferred from other institutions. A total of 29 walk-in, or treatment-naïve, STEMI patients were included in this study. Table 1 shows the distribution of subjects according to

Table 1. Demographic characteristics and clinical profile

	Mean ± SD
***Age** (in years)*	57.17 ± 11.50
***Height** (in meters)*	1.63 ± 0.06
***Weight** (in kg)*	67.74 ± 9.62
BMI	25.43 ± 3.55
***Renal Function** (EGFR)*	66.33 ± 32.10
	Frequency (%)
Sex	
Male	24 (83)
Female	5 (17)
Chief Complaint	
Chest pain	22 (76)
Dyspnea/Shortness of breath	3 (10)
Abdominal Pain	3 (10)
Unilateral weakness	1 (3)
Killip Class	
I	18 (62)
II	7 (24)
III	0 (0)
IV	4 (14)
NYHA	
I	2 (11)
II	12 (63)
III	4 (21)
IV	1 (5)
Walls based on ECG	
Anterior wall	23 (79)
Septal wall	14 (48)
Inferior Wall	7 (24)
Lateral Wall	13 (45)
Massive, all walls	1 (3)
Presence of Contraindications to Reperfusion	
Present	13 (45)
Absent	16 (55)
Hindrances to Reperfusion	
No consent	7 (54)
GI bleeding	2 (15)
More than 12 hours from index chest pain	3 (23)
Discharged against medical advice	1 (8)
History of Heart Failure	
Present	19 (66)
Absent	10 (34)
History of Chronic Kidney Disease	
Present	5 (17)
Absent	22 (76)
No mention	2 (7)
History of Cerebrovascular Disease	
Present	4 (14)
Absent	23 (79)
No mention	2 (7)
History of Coronary Artery Disease	
Present	1 (3)
Absent	27 (93)
No mention	1 (3)

Table 2. Time intervals in hours

	n	Mean ± SD	Median (Range)
Time from onset of symptoms to hospital arrival ("door")	29	22.39 ± 30.48	9.72 (0.25-120)
Time from arrival to first ECG	29	1.40 ± 1.31	1.07 (0.05-6.80)
Time from onset of symptoms to loading of antiplatelets	24	20.32 ± 23.28	11.62 (1.42-97.3)
Time from arrival to loading of antiplatelets	23	1.81 ± 1.91	1.13 (0.17-7.33)
Time from arrival to decision to perform reperfusion, either by thrombolysis or primary percutaneous intervention	22	6.87 ± 11.31	2.56 (0.33-50.67)
Time from arrival to when reperfusion was done	13	9.27 ± 7.05	8.13 (2.37-24.92)
Time from arrival to PCI (Door-to-balloon time)	11	9.73 ± 7.57	8.13 (2.37-24.92)
Time from arrival to thrombolysis (Door-to-needle time)	2	6.73 ± 2.56	6.73 (4.92-8.53)
Time from symptom onset to reperfusion	13	23.38 ± 27.52	14.93 (4.37-106.82)
Time from symptom onset to PCI	11	26.12 ± 29.22	15.08 (4.37-106.82)
Time from symptom onset to thrombolysis	2	8.27 ± 3.21	8.27 (6-10.53)

Data in hours

Table 3. Guideline-based quality indicators

Quality Indicators	Eligible (n)	Received (n)	Percentage (%)
ECG within 10 minutes of arrival	29	4	13.79
Antiplatelets	27	27	100
Nitrates	6	6	100
Morphine	4	4	100
Reperfusion within 12 hours of ischemic symptoms	16	6	37.50

demographic characteristics and clinical profile. Their ages ranged from 35 to 83 years, with a mean age of 57 years. Most of the patients were males, and chest pain was the most common chief complaint. ST-segment elevations in the anterior wall were the most common ECG finding.

Table 2 reports the time intervals examined in this study. Median duration of 9.72 hours was noted from onset of symptoms to hospital arrival ("door"), while from arrival to first ECG, the median duration was 1.07 hours. The time from arrival to loading of antiplatelets has a median of 1.13 hours. Median duration of 2.56 hours was observed from arrival to decision to perform reperfusion. However, it took a median of 8.13 hours for reperfusion to be completed, either by thrombolysis or primary percutaneous intervention. Specifically, the door-to-balloon time observed was 9.73 hours averaged from 11 patients, while the door-to-needle time was 6.73 hours as averaged from 2 patients. The mean and median time intervals from the onset of ischemic symptoms to the time of reperfusion in the 13 eligible patients were beyond the 12 hours recommended in the PHA CAD guidelines. Time intervals in individual reperfusion groups were examined. The thrombolysis group was able to meet recommended 12 hour period, with mean and median times of 8.27 hours. However, the PCI group's mean and median times were beyond the 12-hour window.

Table 3 and Figure 1 show the distribution of subjects according to guideline-based quality indicators. All patients had an ECG done on admission, but only four patients had this done within 10 minutes of arrival (QI: 13.79%; 95% CI:

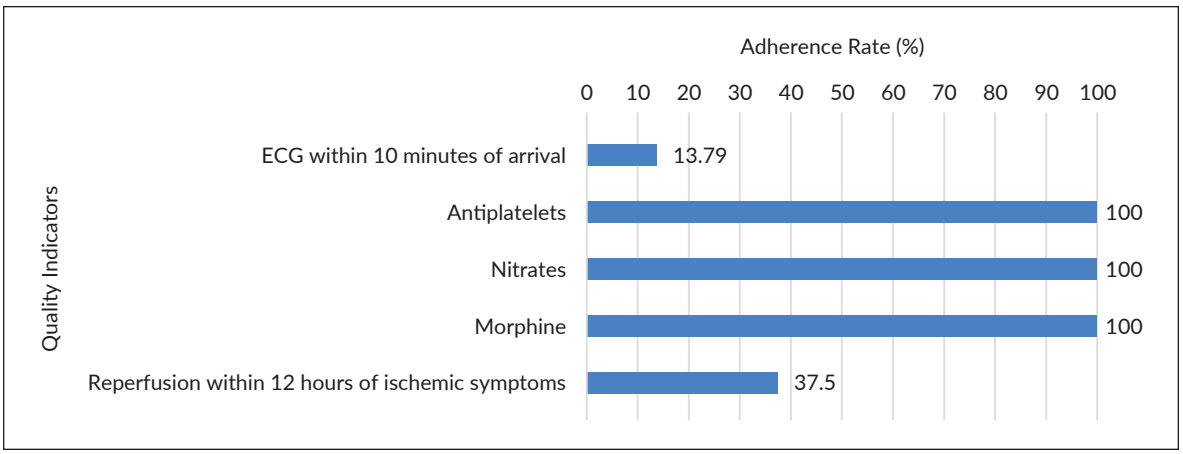

Figure 1. Adherence to Guideline-based Quality Indicators. Quality Indicators meeting 75% were considered an optimal quality of care and good adherence to recommendations in the guidelines.[5]

3.89-31.6%). All eligible patients received antiplatelet therapy (QI: 100%). Six eligible patients (QI: 100%) received nitrates, and four eligible patients (QI: 100%) received morphine.

Of the 29 STEMI patients in this study, two patients had an absolute contraindication to reperfusion due to gastrointestinal bleeding, one patient went home against medical advice, seven patients had no consent to reperfusion, and three patients were seen at our ER more than 12 hours after index chest pain or symptom onset. The remaining 16 patients were eligible for reperfusion by either primary PCI or thrombolysis. Of these, 13 patients received reperfusion therapy, of which 2 received thrombolysis and 11 received PCI. The PHA CAD guidelines recommended reperfusion to be performed within 12 hours of ischemic symptoms. Out of the 16 eligible patients for reperfusion, only six received reperfusion within this time frame (QI 37.5%; 95% CI: 15.20-64.57%) – two by thrombolysis and four by primary PCI. The other nine patients who underwent PCI were done beyond 12 hours.

DISCUSSION

STEMI is an ACS with a significant morbidity and mortality burden. In medical practice, it has been established that the diagnosis and treatment of STEMI are time-sensitive, with better outcomes when immediate interventions are instituted.[6] In recent years, several QOC assessment measures have been started in our institution to quantify and describe the disease burden in our institution. Periodically assessing quality indicators is essential to ensure good service and patient care.[7]

Our institution is the largest tertiary government hospital in the country and one of the PCI-capable hospitals in Metro Manila. In the one-year duration of this study from May 2018 to May 2019, there were 96 STEMI patients received at our ER. For the analysis of this study, we did not include patients who were initially managed in a previous hospital since our objective was to evaluate quality indicators of how STEMI patients are managed at our ER. Of these, 29 were walk-in or treatment-naïve patients, while the rest were initially managed at local hospitals then transferred to our institution for further treatment. This proportion of more transfers than walk-ins is expected in a PCI-capable tertiary referral center such as our institution. It is similar to the findings of an unpublished study by Lim and Chan conducted in 2018. Only 25 out of 56 STEMI patients in a 7-month collection period were walk-ins or treatment-naïve.[8]

The demographic characteristics of the patients included in this study reflect similar patient profiles and risk factors of patients with CAD.[9] These profiles were also comparable to profiles reported in a large local multicenter registry of ACS patients managed in ERs of 39 Philippine hospitals in 2010 by Sinon et al.[10] In our study, the majority were middle-aged males, with BMI in the overweight to obese categories based on WHO Asia Pacific standards. Of those with heart failure, the majority were in Functional Class II. However, chronic kidney disease, cerebrovascular disease, and known CAD were not common comorbidities in our patients.

Likewise, the chief complaint of our STEMI patients was similar to previously reported in the literature.[5,10] Majority of the patients presented with chest pain, with most of the patients in Killip Class I on presentation, similar to the patient profile in the STEMI QOC study done by Alcover et al.[5] However it is important to note that one-fourth of our patients presented with atypical symptoms such as dyspnea and abdominal pain. Hence, it is crucial to maintain good clinical acumen in identifying ACS in patients who do not present with chest pain. A clinical suspicion of an ACS based on symptomatology is important. It pushes the attending physician to order an immediate ECG, which is vital in identifying STEMI and subsequently initiating time-sensitive reperfusion strategies.[11]

Quality of Care

Quality of care indicators meeting 75% was considered the optimal QOC. Although ECG was performed on all patients, only four were done within 10 minutes of admission, as recommended by the PHA guidelines. Of the parameters measured in this study, the performance of ECG within 10 minutes is most severely deficient and must be a priority target of intervention for improvement.

There were 27 patients eligible to receive antiplatelets received the intervention, while two patients did not receive antiplatelets due to gastrointestinal bleeding. Aspirin was given to all 27 eligible patients of the antiplatelets loaded on admission. For the second antiplatelet, 25 patients received loading doses of clopidogrel, and one patient received ticagrelor. However, the loading dose and medication of the second antiplatelet were not documented in the ER chart of 1 patient, but succeeding entries reflected the maintenance dose.

Patients eligible to receive nitrates and morphine for relief of anginal chest pain were given these medications at the ER. This indicates that these medications were readily available in our ER and pharmacy, and the attending physicians were knowledgeable in the indications and contraindications for their use.

This study found that the QI for timely reperfusion in our ER was unsatisfactory, with a rating of 37.5%. Between the two reperfusion strategies, primary PCI was still the more common method of reperfusion employed. Being a PCI-capable hospital, and given the established superiority of PCI over thrombolysis as a reperfusion strategy, it was expected that more patients were offered primary PCI over thrombolysis at our ER. However, interpreting this low QI must be a multifaceted approach, especially since the QI parameter of reperfusion within 12 hours of symptom onset reflects the efficiency of patient management in our ER and involves pre-admission events and factors outside

of the control of our ER and hospital. However, when we exclude pre-hospital factors and circumstances, we can also observe that there is also a considerable delay in our door-to-reperfusion times (Table 2). Factors and processes that affect this specific time interval are intrinsic and are therefore aspects of care that we can investigate and improve accordingly. Addressing these intrinsic factors will still positively impact our overall symptom onset-to-reperfusion time and consequently increase our QI rating for reperfusion, even if we cannot control or modify extrinsic factors in the pre-hospital phase.

In clinical practice, decisions by attending physicians on the diagnosis and management of STEMI are guided by more than just the 2014 PHA guidelines, which is just one of the several guidelines on STEMI, because newer and better evidence-based recommendations are continually being presented in scientific venues internationally as well. Hence, physicians also consider the latest guidelines published by the European and American cardiology societies on STEMI management. This real-world practice would account for the remainder of patients who were reperfused via PCI beyond the 12-hour mark. The 2013 ACCF/AHA guideline-recommended primary PCI for STEMI patients with ongoing ischemia even up to 24 hours from symptom onset (class IIa).[3] While in the 2017 ESC guideline, primary PCI was still recommended for evolved and recent STEMI with hemodynamic or electrical instability (class IC) and for asymptomatic and stable STEMI patients beyond 12 hrs up to 48 hrs (class IIaB).[12]

It is also important to mention that among the 29 patients included in this study, contraindication to reperfusion was reported in almost half of the cases. The lack of consent, which is an absolute contraindication, was the most common. Three patients were not offered reperfusion since the index chest pain occurred more than 24 hours before admission and has not recurred, and therefore did not meet the cut-off of 12 hours recommended in the guidelines. Gastrointestinal bleeding occurred in 2 patients. Compared to the reperfusion rates reported by Alcover et al. in 2014, the significantly improved reperfusion rates in this study may be primarily due to the elimination of financial constraints as a hindrance to reperfusion.[5] This was made possible by better financial support from the combined efforts of government resources and donations from private charity foundations to shoulder the cost of stents and other fees.

Time Intervals

This study revealed that although the median time from symptom onset to reperfusion was 14.93 hours, it already took a median of 9.72 hours for patients to seek admission at our ER after symptom onset. This indicates that the pre-admission or pre-hospital phase factors significantly contribute to the delay. These may include the patient's proximity to the hospital, access to ambulance service, insurance coverage, socioeconomic class, and even patient inertia when seeking consult once with symptoms. These are all factors that must be examined. Although beyond the QOC parameters directly studied in this paper, pre-hospital care is a crucial facet to be considered and addressed in the care of STEMI patients, especially since it impacts ischemia time, which is likewise directly associated with infarct size.[13] A cohort study by Rivero et al. in 2016 showed that delays in seeking medical care among STEMI patients correlated with greater in-hospital and 1-year mortality.[14]

The door-to-ECG time in this study showed a median of 1.07 hours and a mean of 1.38 hours. This observed time interval in this study is marginally shorter than the mean door-to-ECG time of 1 hour and 49 minutes reported by Alcover et al. in 2014.[5] However. this performance is still suboptimal compared to the guideline recommendation of 10 minutes only. The lack of significant improvement of door-to-ECG time since the previous study warrants investigating factors causing this delay and appropriate interventions to improve this performance measure. During the data collection period of this study, there was no dedicated ECG machine within the ER complex. A stat ECG request form had to be brought from the ER to the ECG station; then, the attending physician waited for an ECG technician to get the ECG machine to the patient's bedside. This process was a source of delay. Providing at least one dedicated ECG machine to facilitate immediate ECG in all patients coming in with chest pain or anginal equivalents will significantly improve door-to-ECG time in our ER. Likewise, ER physicians and nurses must be trained on proper ECG lead placement. ER physicians must also be capable of efficiently and quickly assessing the clinical likelihood of ACS within a few minutes of admission so that an ECG can be done within the 10-minute window.

The time intervals from ER arrival to therapeutic interventions were investigated as these reflect the efficiency of service delivery. The median time from ER arrival to the loading of antiplatelets was 1.13 hours, and a mean of 1.81 hours. Since the door-to-ECG time and the door-to-antiplatelets time were not largely different, it may be inferred that as soon as STEMI was recognized, physicians at the ER were swift to initiate appropriate medical treatment with loading doses of antiplatelets.

However, there was an observed delay in their decision time to perform reperfusion, either by thrombolysis or primary PCI. From the time of arrival at the ER, it would take an average of 6.87 hours and a median of 2.56 hours for the physician to decide on reperfusion. Despite the shorter median time, which is less affected by outliers, taking almost 3 hours to decide upon reperfusion must be improved as this contributes to longer ischemia time. A delay in the turnaround time of the ECG tracing may be a factor. In cases when the physician was not at the bedside to read the ECG tracing in real-time while it was performed on a patient, the tracing had to be photocopied from the ECG station and be brought back to the ER physician for interpretation. It is also

possible that the technician who performed the ECG did not notify the ER physician of the STEMI tracing immediately after it was completed. Even when the ECG tracing was given to the physician immediately, a misinterpretation of the tracing may lead to a "missed" diagnosis of STEMI and delay the decision to reperfuse. The time from arrival at the ER to reperfusion, whether by PCI or by thrombolysis, took an average of 9.27 hours. The door-to-balloon time (mean 9.73 hours) and the door-to-needle time (mean 6.73 hours) were beyond the 90 minutes and 60 minutes, respectively, recommended in the guidelines. As previously discussed, reperfusion within 12 hours of symptom onset was only met 37.5% of the time, which may be affected by extrinsic and intrinsic factors. Aside from the observations above, other intrinsic factors may include delays by the ER physicians in referring to the Cardiology service, delays by the Cardiology service to see patients immediately after the referral was called, or logistics concerns such as unavailability of a ward/ICU bed, and unavailability of a catheterization laboratory suite and its staff (from nurses to consultant back-up) to perform PCI. These are just some factors that will need further investigation in comprehensive system analysis.

Interventions that may improve efficiency and the QOC we provide to our patients include but are not limited to: provision of a dedicated ECG machine at the ER, continuous training and education of physicians in the clinical diagnosis of an ACS and ECG recognition of STEMI, implementing a well-made STEMI pathway or order set, and increasing the number of staff of the PCI team to allow for 24-hour staffing of the catheterization laboratory.

Limitations of the Study

Because our study opted to limit its sample to treatment-naïve patients only, we could not report on the QOC provided to the other 67 STEMI patients who were transferred from previous hospitals.

We recommend that broader QOC studies be done to evaluate how all STEMI patients are managed in our ER, regardless of entry mode, to provide a more inclusive and comprehensive assessment of our QOC parameters. Being one of the few tertiary PCI-capable hospitals in Metro Manila, our catchment area is large, with patients within Metro Manila and some southern provinces. We can therefore expect to continue receiving a more significant proportion of trans-ferred STEMI patients than treatment-naïve patients in the coming years until another PCI-capable center is established in the vicinity to accept and treat these transfers as well.

We will also need to evaluate how well we manage these transferred patients in critical domains such as reperfusion strategies, completion of medications not provided at the previous hospital, appropriate referrals to subspecialty services, and the corresponding time intervals.

At the time of this study, a standardized clinical pathway or order set was not yet implemented hence the method and completeness of charting by physicians and nurses were variable. Pertinent metrics such as but not limited to the time of arrival, time seen by Cardiology service, presence of ongoing symptoms, time medications were loaded, among others, were inconsistently recorded by the attending physicians and nurses. Similar to the observations of Alcover et al., which posed difficulties with their data collection process, there is a need for better documentation and records-keeping at our ER and our medical records section. Transitioning to electronic forms with checklists and required fields may help physicians and nurses streamline this process and ensure that pertinent data are recorded uniformly and quickly.

Results from this study will provide the hospital with valuable insights for creating and implementing a standardized "chest pain pathway." Hopefully, a protocolized course of action will improve our response times and management provided to patients with ACS. This study was also limited by only using the PHA CAD guidelines as a basis for the QOC indicators investigated. We recommend that future QOC studies also examine QI based on key recommendations by the other relevant STEMI guidelines currently used in real-world practice. We also recommend that further studies investigate factors that affect the implementation duration of interventions to improve our QI performance.

CONCLUSION

Our institution needs to improve on two key QI: initial ECG within 10 minutes and reperfusion within 12 hours of symptom onset.

Acceptable performance measures for reperfusion provision of nitrates and morphine to eligible patients who suffered from STEMI were met. Measures to improve compliance to guideline-recommended time intervals are warranted, with a subsequent re-evaluation of outcomes after an intervention period. Further studies are recommended to investigate intrinsic and extrinsic factors that may cause delays in the first ECG and time to reperfusion.

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Statement of Authorship

All authors contributed in the conceptualization of work, acquisition and analysis of data, drafting and revising and approved the final version submitted.

Author Disclosure

All authors declared no conflicts of interest.

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APPENDICES

Appendix 1. Summary of Recommendations for the Initial Management of STEMI by the 2014 PHA CAD Guidelines

Recommendations for Initial Management of patients with STEMI	Level of Recommendation
Targeted history taking, physical examination, and 12-lead ECG within 10 minutes of arrival at the ER	I
Upon arrival at the ER, routine administration of the following, unless contraindicated: • Aspirin 160 to 320 mg tablet (non-enteric coated, chewed); • Clopidogrel 300 to 600 mg whether or not fibrinolysis will be given; • Clopidogrel 600 mg or prasugrel 60 mg or ticagrelor 180 mg when a patient will undergo PCI; • Nitrates, either via sublingual or intravenous (IV) routes • Morphine 2 to 4 mg IV for relief of chest pain	IIa
Reperfusion (primary PCI or thrombolytics), unless contraindicated, for patients presenting with chest discomfort and 0.1mv ST-segment elevation in 2 contiguous leads	I
Reperfusion for all eligible patients with symptom onset within the prior 12 hours	IIa
Primary PCI if with ischemic symptoms of less than 12 hours duration	IIa
Primary PCI if with ischemic symptoms of less than 12 hours duration and with contraindications to fibrinolytic therapy, regardless of the time delay from first medical contact.	IIa
Primary PCI if with cardiogenic shock or acute severe heart failure (HF), regardless of the time delay from MI onset.	IIa
Immediate thrombolysis, unless contraindicated, with a door-to-needle time of less than 60 minutes as goal	I
Thrombolysis for patients presenting within 12 hours of onset of symptoms if primary PCI cannot be delivered within 120 minutes of the time when fibrinolysis could have been given.	IIa
Do ECG 60 to 90 minutes after thrombolysis to determine the presence of failed reperfusion	IIa
If with failed reperfusion, offer immediate coronary angiography, with follow-on PCI if indicated	IIa

Each recommendation will be screened for indications and contraindications in individual patients.

Full Statements of the 2014 PHA CAD Guidelines Recommendations Used as Quality Indicators for The Initial Management of Patients with STEMI

STRONGLY RECOMMENDED
Statement 2: Initial Evaluation at Emergency Room It IS STRONGLY RECOMMENDED that a targeted history taking, physical examination, and a 12-lead ECG should be taken within 10 minutes of arrival at the ER.
Statement 3: ECG Evaluation It IS STRONGLY RECOMMENDED that patients presenting with chest discomfort and ECG finding of at least 0.1 mV ST-segment elevation in two contiguous leads should receive reperfusion therapy (e.g., primary PCI or thrombolytics), if not contraindicated
Statement 8: Fibrinolysis It IS STRONGLY RECOMMENDED to undergo immediate thrombolysis (unless contraindicated), with a door-to-needle time of less than 60 minutes as a goal.

RECOMMENDED
Statement 5: Initial ER Management Unless contraindicated, it IS RECOMMENDED that the following routine treatment measures be administered in STEMI patients upon arrival at the ER: • Aspirin 160 to 320 mg tablet (non-enteric coated, chewed); • Clopidogrel 300 to 600 mg whether or not fibrinolysis will be given; • Clopidogrel 600 mg or prasugrel 60 mg or ticagrelor 180 mg when a patient will undergo PCI; • Nitrates, either via sublingual or intravenous (IV) routes. Nitrates are contraindicated in patients with hypotension or those who took a phosphodiesterase 5 (PDE5) inhibitor within 24 hrs (48 hrs for tadalafil); • Morphine 2 to 4 mg IV for relief of chest pain
Statement 6: In-hospital Treatment Reperfusion therapy IS RECOMMENDED to all eligible patients with STEMI with symptom onset within the last 12 hours.
Statement 8: Fibrinolysis It IS RECOMMENDED to perform an ECG on patients treated with fibrinolysis 60 to 90 minutes after administration to determine the presence of failed reperfusion. **Fibrinolysis** IS RECOMMENDED to people with acute STEMI presenting within 12 hours of onset of symptoms if primary PCI cannot be delivered within 120 minutes of the time when fibrinolysis could have been given. In the case of failed reperfusion, offer immediate coronary angiography with follow-on PCI if indicated. Do not repeat fibrinolytic therapy.
Statement 9: Primary Percutaneous Coronary Intervention (PCI) **Primary PCI** IS RECOMMENDED in patients with STEMI and ischemic symptoms of less than 12 hours. **Primary PCI** IS RECOMMENDED in patients with STEMI and ischemic symptoms of less than 12 hours' duration who have contraindications to fibrinolytic therapy, irrespective of the time delay from first medical contact. **Primary PCI** IS RECOMMENDED in patients with STEMI and cardiogenic shock or acute severe heart failure (HF), irrespective of time delay from MI onset.

Appendix 2. Operational Definitions

STEMI	We defined STEMI based on the clinical presentation of angina or anginal equivalents and the electrocardiographic criteria (by voltage and contiguous distribution) as diagnosed by the attending physician at the ER
Killip Class [6]	A prognostic classification scheme based on the presence and severity of crackles in patients with STEMI. *(Braunwald's Heart Disease 10th edition)* Class I: No crackles and no third heart sound. Class II: With crackles, but only to a mild to moderate degree (<50% of lung fields), and may or may not have a third heart sound. Class III: With crackles involving more than half of each lung field; frequently with pulmonary edema. Class IV: In cardiogenic shock
NYHA Functional Class	Classified patients' heart failure based on symptom severity. *(AHA)* Class I: No limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea. Class II: Slight limitation of physical activity. Comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea. Class III: Marked limitation of physical activity. Comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea. Class IV: Unable to carry on any physical activity without discomfort. Symptoms of heart failure at rest. If any physical activity is undertaken, discomfort increases.
Quality of care [7]	"the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" *(Mainz, 2003)*
Indicators [7]	Are measures that are based on standards of care and are used as guides to monitor, evaluate, and improve the quality of patient care, clinical support services, and organizational function that affect patient outcomes. *(Mainz, 2003)*
ER Admission	Referred to as "door." The time of a patient's arrival at the ER as encoded in the ER triage officer records/logbook
Reperfusion	Also referred to as revascularization. Restoration of coronary blood flow either pharmacologically through thrombolysis with fibrinolytic agents or invasively through PCI at the cardiac catheterization laboratory
Walk-in STEMI patients	Patients admitted at our ER for STEMI who were "treatment-naïve" or were not previously managed in a previous hospital

Appendix 3. Data Collection Sheet

Code : _____ Type of Admission: □ Pay □ Charity
Date of Admission: _____ Date of Data Collection: _____

Baseline Characteristics

Clinical Profile	
Age (years)	
Gender	□ Male □ Female
Height (m)	
Weight (kg)	
BMI (kg/m^2)	
Chief Complaint (e.g., Dyspnea, Chest pain, Syncope, Abdominal pain, others)	
Entry route Walk-in Transfer/conduction from another hospital	
Renal Function (EGFR)	
Killip Class	□ I □ II □ III □ IV
NYHA Functional Class	□ I □ II □ III □ IV
Walls affected based on ECG	
Contraindications to reperfusion	□ Present. Contraindications identified: _____ □ Absent
Hindrances to reperfusion □ financial constraints □ no consent □ cathlab nonfunctional □ no streptokinase / rTPA available □ others	
Risk Factors	
History of Smoking	□ Present □ Absent
Physical activity (Sedentary vs. Active)	□ Sedentary □ Active
Diabetes	□ Present □ Absent
Hypertension	□ Present □ Absent
Dyslipidemia	□ Present □ Absent
History of myocardial infarction	□ Present □ Absent
History of prior revascularization	If Present: □ PCI □ Fibrinolysis □ CABG □ Absent
History of heart failure	□ Present □ Absent
History of Chronic Kidney Disease	□ Present □ Absent
History of Cerebrovascular Disease	□ Present □ Absent
History of Peripheral Artery Disease	□ Present □ Absent
Family history of Coronary Artery Disease	□ Present □ Absent

Was this done/given?	Yes / No	Remarks
ECG	□ Yes □ No Reason _____	
Dual antiplatelets	□ Yes □ Aspirin dose _____ □ Clopidogrel dose _____ □ Ticagrelor dose _____ □ No Reason _____	
Nitrates	□ Yes □ Intravenous ISDN □ Oral ISDN _____ □ Nitrate patch _____ □ No Reason _____ □ Not applicable	
IV Morphine	□ Yes Dose _____ □ No Reason _____ □ Not applicable	
Reperfusion	□ Yes □ Thrombolysis □ Primary PCI □ No Reason _____ □ Not applicable	

Time Intervals *(Please indicate as HH:MM am/pm)*	Remarks
Time symptom (chief complaint) started	
Time of arrival at ER (DEM Triage Logbook timestamp)	
Time of ECG	
Time antiplatelets (e.g. aspirin, clopidogrel, ticagrelor) were administered	
Time of decision to perform reperfusion (either by thrombolysis or primary percutaneous coronary intervention)	
The time when reperfusion was done (if applicable)	