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The Impact of a New STEMI Hotline on Cardiovascular Outcomes in STEMI Patients Undergoing Primary Percutaneous Coronary Intervention: A National Cohort Study

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Abstract

Introduction: ST-Elevation myocardial infarction (STEMI) remains a common and challenging clinical condition with a high risk of mortality. STEMI complications are related directly to prolonged ischemia time. Mohamad Bin Khalifa Cardiac Centre (MKCC) established a national STEMI Hotline program on January 2022, to facilitate early detection and transfer of STEMI cases in the country to a dedicated tertiary cardiac center capable of performing primary PCI.

Methods: This is an observational cohort study conducted on patients who presented to MKCC for primary PCI between August 2021 to February 2022. Patients who underwent primary PCI through referral from the newly developed STEMI hotline were compared to patients who presented through the traditional referral pathway. The primary outcome was the development of in-hospital cardiovascular complications—requirement of inotropes, mechanical support, mechanical ventilation, emergency surgery due to mechanical complications, cardiac arrest, or death. Multivariate logistic regression models were used to compare the outcomes and to estimate the effect of the hotline on patient outcomes.

Results: A total of 197 patients were included, out of which 96 were referred through the STEMI Hotline. The primary outcome occurred in 11.5% of patients in the hotline group as compared to 22.8% of patients in the traditional pathway. Upon adjusting for confounders in the multivariate regression model, the use of the hotline had an odds ratio of 0.39 (95% CI: 0.17–0.9; $p = 0.03$) for the primary outcome.

Conclusion: Our results indicate that the use of the STEMI Hotline decreased risk of in-hospital cardiovascular complication in patients with STEMI.

Keywords: Myocardial infarction, STEMI, Hotline, Cardiology, Invasive cardiology, Coronary angiogram, Percutaneous coronary intervention, PCI, Bahrain

1. Introduction

Heart disease remains the number one cause of death in the United States, as per data from 2019. Coronary heart disease accounted for approximately 12.6% of deaths in the United States in 2018, causing 360,900 deaths overall. According to data from 2005 to 2014, the estimated annual incidence of heart attacks in the United States is 605,000

new attacks and 200,000 recurrent attacks. Average age at the first heart attack was 65.6 years for males and 72.0 years for females [4].

ST-elevation myocardial infarctions (STEMIs) are caused by the acute occlusion of one or more coronary arteries, leading to myocardial ischemia, and if it not timely managed, myocardial infarction and myocardial death [1,2]. The most common cause of this occlusion of blood flow is usually plaque

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rupture/fissure and thrombus formation. Other causes include dissection of the coronary arteries [1]. The major risk factors for ST-elevation myocardial infarction include dyslipidemia, diabetes mellitus, hypertension, smoking, and family history of coronary artery disease [3]. STEMI is diagnosed based on clinical findings of ongoing chest pain (or chest pain equivalent) and ECG findings of ST elevation, according to guidelines [1].

Primary percutaneous coronary intervention (PCI) is the treatment of choice for patients with STEMI when performed by experienced operators in a timely fashion, as demonstrated in randomized trials and recommended by international guidelines [5]. Each year, there are about 258,000 STEMI presentations to emergency departments (ED) in the USA, with an incidence rate of 7.3 per 10,000 [6]. STEMI remains a common and challenging clinical condition with a high risk of mortality. The reported in-hospital mortality for STEMI in Bahrain is 5.1% according to a local study [7].

Guidelines recommend the development of regional pathways and protocols to facilitate the diagnosis and transfer initiation of STEMI patients to the nearest hospital with PCI services available [5,8]. Despite that, the main reperfusion therapy in Bahrain as per a 2012 study was thrombolysis, estimated at 56.5% of cases [7]. Similar findings were also reported by the Gulf COAST Registry in 2017, which showed that thrombolysis was the main reperfusion therapy at the time [9]. More recent data is not available in the literature.

Various countries have developed STEMI programs to facilitate early detection, appropriate transportation, and management of patients with STEMI. Some countries adopted a chest pain hotline activated by patients, while other countries organized STEMI networks with a primary PCI center receiving referrals from surrounding hospitals defined by specified catchment areas [10,11]. Programs have been shown to be successful through various implementations. In the USA, a 2008 to 2012 report from the American Heart Association showed improvement in STEMI treatment time with reduction in period of first medical contact to device from 93 to 84 min, including transportation time to the nearest PCI-capable hospital [12].

The National STEMI Hotline was initiated in Bahrain in January 2022. The goal behind this program is to provide timely coronary angiogram and angioplasty by facilitating early transfer of STEMI patients to MKCC; the only tertiary cardiac center with PCI capabilities in the country. The Kingdom of Bahrain has an area of 779.95 KM² and a population of 1.501 million (55% of which are non-Bahraini) [13].

Abbreviations

AIC	Akaike information criterion
BIC	Bayesian information criterion
CTC	Cardiac Transfer Clinic
CVD	Cardiovascular disease
ECG	Electrocardiogram
ED	Emergency department
HbA1c	Hemoglobin A1c
IABP	Intra-aortic balloon pump
ICD	Implantable cardioverter defibrillator
KHUH	King Hamad University Hospital
LDL	Low-density lipid
MI	Myocardial infarction
MKCC	Mohammad bin Khalifa Cardiac Center
MV	Mechanical ventilation
PCI	Primary percutaneous coronary intervention
SMC	Salmaniya Medical Center
STEMI	ST-elevated myocardial infarction

In this study, we compare cardiovascular outcomes for patients undergoing emergency PCI who are referred via the STEMI Hotline to cases referred through the previous traditional system, prior to the initiation of the Hotline.

2. Methods

This is an ambidirectional cohort study conducted on patients undergoing emergency PCI due to STEMI at Mohammed bin Khalifa Cardiac Center (MKCC) between August 2021 and February 2022. MKCC is a tertiary cardiac center and the only center that provides invasive cardiology services for STEMI in Bahrain. All STEMI patients in Bahrain are eligible for primary PCI if clinically indicated, regardless of entitlement, insurance, or nationality.

All STEMI patients in Bahrain are eligible for primary PCI if clinically indicated, regardless of entitlement, insurance, or nationality. Procedures related to the new STEMI hotline were as follows:

1. The new STEMI hotline was based at the cardiac transfer clinic in the cardiac center at MKCC. The STEMI hotline was covered by an in-house cardiologist 24/7.
2. Procedures related to the new STEMI hotline were as follows: The new STEMI hotline was based at the cardiac transfer clinic in the cardiac center at MKCC. The STEMI hotline was covered by an in-house cardiologist 24/7.
3. Physicians from any hospital/clinic and paramedics on the field have access to the National STEMI Hotline to refer STEMI cases.
4. Patient identification, data and clinical history is referred over the phone by the referring physician or paramedic.

5. The ECG is transferred via a WhatsApp message to the Hotline. The ECG is interpreted by the cardiologist covering the hotline, while over-the-phone consultation with the referring physician/paramedic takes place to gather other clinical details that can help in the decision making.
6. If a STEMI is diagnosed, the Cath lab is activated, and the patient is transferred directly to the Cath lab.
7. Patient confidentiality is maintained, as only the ECG is transferred by the WhatsApp messaging system, while hiding out patient data.

The objective of the study is to determine the effect of a simple newly developed STEMI hotline on the development of a complicated hospital stay. The primary outcome was the development of a complicated hospital stay. This is defined as requirement of inotropes, mechanical support, mechanical ventilation, emergency surgery due to mechanical complications, cardiac arrest, or death.

All STEMI cases undergoing emergency PCI at MKCC have been included. Data was extracted from the electronic medical records, cardiac transfer unit records, and Cath lab records. Study participants' hospital stay details were manually extracted from the electronic medical records. The data gathered included patients' demographic details, vital signs, laboratory test results, past medical history, ECG findings, echocardiographic finding, and outcomes. We retrospectively collected data from August 2021 to mid-January 2022 for patients in the traditional pathway. Since the start of the STEMI hotline in the mid of January, cases were collected prospectively, as the STEMI hotline only receives STEMI transfers for primary PCI or rescue PCI if applicable.

All patients undergoing primary PCI between mid-January 2022 and February 2022 through the activation of the STEMI hotline represented the 'STEMI Hotline Pathway'. The traditional pathway included patients who were referred for emergency PCI between August 2021 and mid-January 2022. These were referred via the traditional ED-referral. These cases were collected retrospectively. Any case undergoing emergency PCI either for a STEMI or a rescue PCI were included. Cases with Non-ST elevation MI or unstable angina were excluded (as the STEMI hotline was only accepting STEMI cases requiring PCI – primary or rescue). Data from August 2021 to the inauguration of the STEMI hotline in January 2022 represent the most easily available and accurate data, hence this time frame was chosen. No crossover between the two groups was possible as they occurred in two different time frames. [Figure 1](#) is a flow chart illustrating the two compared pathways.

2.1. Statistical analysis

The distribution of groups were summarized. Bivariate associations were analyzed using Chi-squared (χ^2) tests for categorical variables and t-test for continuous variables. We assessed outcomes and their associations with both groups.

Multivariable logistic regression model was used to estimate the relationship between the two groups and the outcome. Given that 33 cases developed the outcome, and in order to prevent model over fitting, 3 variables at most were allowed in the model building. In order to choose the adjusted factors in the multivariate model, a univariate analysis between other variables and the outcome was conducted. Variables without group differences were excluded from the univariate analysis. A p-value of 0.2 was used to screen the other variables. Colinear variables were excluded from the multivariate model. The included covariates were selected based on each variable association with the outcome and the predictor in a univariate analysis. Post estimation testing using AIC and BIC were used to compare regression models and select the final model.

A two-sided p-value of 0.05 was considered statistically significant. Stata software, version 15.1, was used to execute the statistical analyses (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.).

2.2. Ethical approval

The protocol and manuscript for this study were reviewed and approved by the MKCC Research Committee in Bahrain. All methods and analysis of data was approved by the Research and Ethics Committee, and carried out in accordance with the local guideline and ethical guidelines of the Declaration of Helsinki 1975. All data used in this study was collected as part of normal medical procedures. Informed consent was waived by the Research and Ethics Committee for this study due to its observational nature and the absence of any patient identifying information.

3. Results

101 cases through the traditional pathway and 96 cases through the new hotline pathway were included, totaling 197 cases. [Table 1](#) summarizes the baseline characteristics of both groups. The mean age was similar between the two groups. Bahraini nationals were the majority of cases through the traditional pathway (53.5%), whereas non-Bahraini

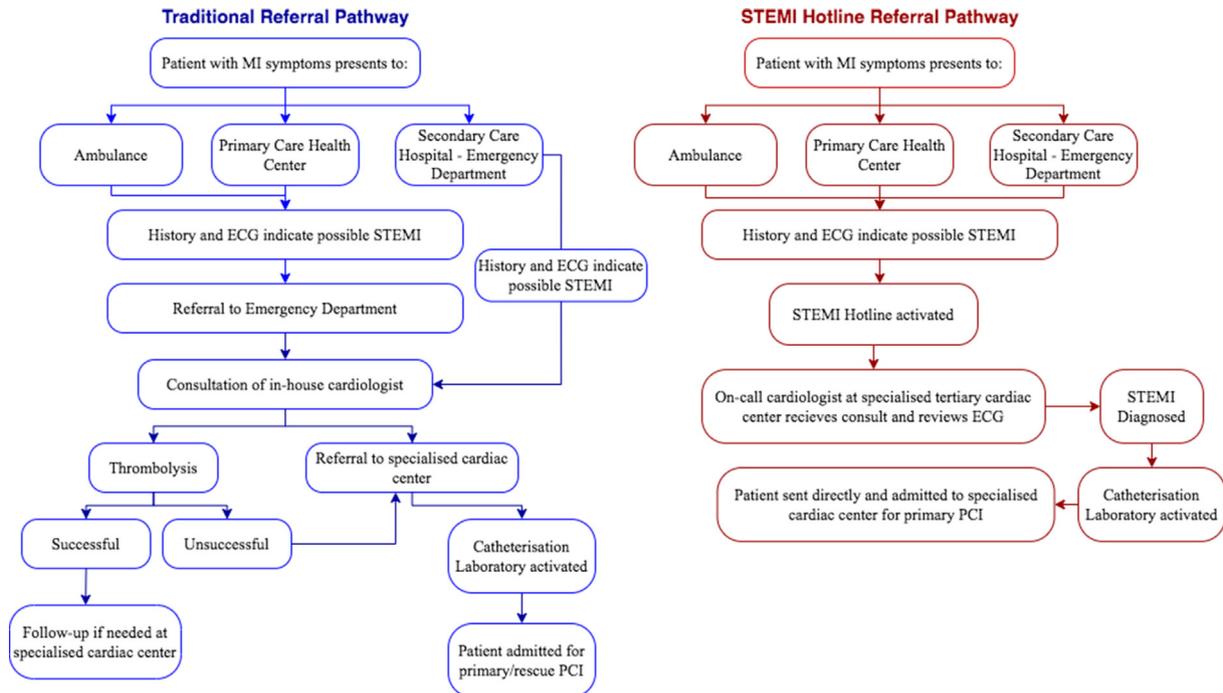


Fig. 1. Flowchart illustrations of the two described referral pathways. MI, myocardial infarction; ECG, electrocardiogram; STEMI, ST-elevated myocardial infarction; PCI, percutaneous coronary intervention.

nationals were a majority (55.2%) for the hotline group.

A known past medical history of diabetes, hypertension and dyslipidemia were more common in the traditional pathway (54.5%, 55.4%, and 49.5% respectively, versus 37.5%, 42.7%, and 36.5%). Smoking status was similar between the two groups with 46.5% of the traditional pathway patients being either current or ex-smokers, compared to 42.7% of the hotline pathway.

More patients in the traditional pathway had a history of PCI compared to the hotline pathway (15.8% vs 6.2%), with this difference being significant at the 0.05 level. Multiple and significant differences were seen in the source of referral for patient in the two groups. There has been an increase in referrals from private clinics/hospitals (14%–41%) and local health centers (3%–12%), after the implementation of the STEMI hotline. Moreover, direct referrals from paramedics in the field were observed in the hotline pathway.

Coronary angiogram findings were significantly different between the two groups. More patients in the traditional pathway had multivessel disease and/or left main coronary artery disease compared to the hotline pathway (45.5% vs 25%). 70% of cases in the hotline pathway had a single vessel disease, compared to 51% in the traditional pathway. Minority of cases had normal or non-obstructive coronary artery disease in both

groups. The use of thrombectomy, intracoronary imaging, and further management were similar in both groups. These results are summarized in Table 2.

Anterior wall MIs were the most common presentation in the hotline pathway (40.6%) while Inferior wall MI were the most common in the traditional pathway (43.6%). Mean HbA1C and LDL levels were not significantly different between pathways.

3.1. Disease outcomes

In the traditional pathway, the primary outcome (use of inotropes/Intra-aortic Balloon Pump (IABP)/ Mechanical Ventilation and/or cardiac arrest and/or death) occurred in 22.8% of patients (n = 23) as compared to 11.5% (n = 11) in the hotline group (Fig. 2).

When comparing the traditional pathway to the hotline pathway respectively, more patients required inotropes (19.8% vs 9.3%), IABP (7.9% vs 4.2%), and mechanical ventilation (7.9% vs 2.1%). Patients in the traditional pathway were also more likely to develop arrhythmias (18% vs 14%) and require an ICD device (3% vs 0%). Overall, 7.9% developed cardiac arrest and 3% died in the traditional group as opposed to 4.2% and 2% in the hotline group, respectively.

The unadjusted odds ratio for the STEMI hotline patients developing in-hospital cardiovascular

Table 1. Baseline characteristics of included cases stratified by referral pathway.

Factor	Level	Traditional Pathway	STEMI Hotline Pathway	p-value
Number of patients		101	96	
Average cases per week		5.01	12.44	
Age, mean (SD)		53.1 (11.2)	53.6 (11.3)	0.79
Male		88 (87.1%)	85 (88.5%)	0.76
Bahraini		54 (53.5%)	43 (44.8%)	0.22
Diabetes		55 (54.5%)	36 (37.5%)	0.017
Hypertension		56 (55.4%)	41 (42.7%)	0.074
Dyslipidemia		50 (49.5%)	35 (36.5%)	0.065
Smoking Status	Nonsmoker	54 (53.5%)	55 (57.3%)	0.83
	ExSmoker	8 (7.9%)	6 (6.2%)	
	Current smoking	39 (38.6%)	35 (36.5%)	
Previous PCI		16 (15.8%)	6 (6.2%)	0.033
previous CABG		1 (1.0%)	1 (1.0%)	0.97
Origin	BDF	11 (11%)	13 (14%)	<0.001
	CPC	21 (22%)	0 (0%)	
	Field	0 (0%)	3 (3%)	
	KHUH	26 (27%)	8 (8%)	
	LHC	3 (3%)	12 (12%)	
	Private	14 (14%)	39 (41%)	
	SMC	22 (23%)	21 (22%)	
MI Presentation	Anterio-Lateral	2 (2.0%)	8 (8.3%)	0.12
	Anterior	41 (40.6%)	39 (40.6%)	
	Inferio-Lateral	3 (3.0%)	1 (1.0%)	
	Inferio-Posterior	8 (7.9%)	7 (7.3%)	
	Inferior	44 (43.6%)	31 (32.3%)	
	LBBB	1 (1.0%)	2 (2.1%)	
	Lateral	0 (0.0%)	3 (3.1%)	
	Posterior	2 (2.0%)	5 (5.2%)	
HbA1C, mean (SD)		7.5 (2.4)	7.2 (2.1)	0.46
LDL, mean (SD)		3.4 (0.9)	3.7 (1.0)	0.005
Hb, mean (SD)		14.2 (1.9)	14.0 (2.3)	0.37

STEMI, ST-elevated myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; BDF, Bahrain Defense Force Hospital; CPC, Chest pain Clinic; KHUH, King Hamad University Hospital; LHC, local health center; SMC, Salmaniya Medical Center; MI, myocardial Infarction; LBBB, Left bundle branch block; HbA1C, Hemoglobin A1C; LDL, low-density lipoprotein; Hb, hemoglobin.

complications was 0.43 (95% CI: 0.2–0.95; $p = 0.036$). Upon adjusting for confounders in the multivariate model, we found the odds ratio to be 0.39 (95% CI: 0.17–0.9; $p = 0.028$). This denotes a 61% reduction in the odds of developing the outcome of in-hospital cardiovascular complications upon adoption of the STEMI hotline referral pathway. Tables 3 and 4 summarizes these results. Additional details on the statistical models are available in the Appendix.

4. Discussion

The results of this study demonstrate that the introduction of the STEMI hotline has successfully reduced in-hospital cardiovascular complications. The primary outcome (i.e. use of inotropic support, IABP, mechanical ventilation, cardiac arrest and death) has significantly decreased from 22.8% in the traditional referral pathway to 11.5% in the STEMI hotline referral pathway (Fig. 2).

Analysis of the demographics of our studied sample showed that there were some important differences between patients in the two pathways.

For instance, the nationalities of patients referred before and after STEMI hotline implementation differed. Earlier, the majority of cases received through the traditional pathway were Bahraini nationals (53.5%); in contrast, 55.2% of the cases received after the initiation of STEMI hotline pathway were non-Bahraini residents. Moreover, this difference is expected to further increase, as the first week of the STEMI pathway was considered as a “soft opening” and only a few hospitals were included.

This demonstrates that the current STEMI pathway has been able to reach more effectively into a population demographic (non – Bahrainis) prior to which they were managed medically in peripheral health centres.

To understand how the effect of nationality affects outcome it's important to understand the

Table 2. Angiographic details and management of included cases.

Factor	Level	Traditional Pathway	STEMI Hotline Pathway	p-value
Number of patients		101	96	
Coronary Artery disease on CAG	Normal/Non obstructive	3 (3%)	5 (5%)	0.005
	SVD	50 (51%)	67 (70%)	
	DVD	33 (33%)	10 (10%)	
	TVD	10 (10%)	9 (9%)	
	SVD + LM	0 (0%)	3 (3%)	
	DVD + LM	1 (1%)	1 (1%)	
	TVD + LM	2 (2%)	1 (1%)	
MVD or LM Thrombectomy		46 (45.5%)	24 (25.0%)	0.003
Intracoronary Imaging		32 (32%)	30 (31%)	0.87
IVUS		10 (9.9%)	12 (12.5%)	0.56
OCT		3 (3%)	10 (10%)	0.039
Management	Medical	9 (9%)	2 (2%)	0.034
	PCI	5 (5.0%)	4 (4.4%)	0.98
	Surgery	95 (94.1%)	86 (94.5%)	
		1 (1.0%)	1 (1.1%)	

STEMI, ST-elevation myocardial infarction; CAG, coronary angiogram; SVD, Single Vessel disease; DVD, Double vessel disease; TVD, Triple vessel disease; MVD, Multivessel disease; LM, left main; IVUS, intravascular ultrasound; OCT, optical coherence tomography; PCI, percutaneous coronary intervention.

demographics in Bahrain. The population of Bahrain is 1,501,611 including 677,506 Bahraini (45%) and 823,610 non-Bahraini (55%) [13]. The majority of non-Bahrainis in our study were composed of migrant workers. This subpopulation represents a lower socioeconomic status and behave differently than Bahraini Nationals [14]. Generally,

Table 3. Outcomes of cases stratified by referral pathway.

Factor	Level	Traditional Pathway	STEMI Hotline Pathway	p-value
Number of patients		101	96	
EF, mean (SD)		40.0% (10.6)	41.9% (9.0)	0.187
Inotropes		20 (19.8%)	8 (8.3%)	0.021
IABP		8 (7.9%)	4 (4.2%)	0.27
Mechanical Ventilation		8 (7.9%)	2 (2.1%)	0.062
Mechanical Complications		4 (4.0%)	1 (1.0%)	0.19
LV clot		3 (3%)	3 (3%)	0.97
Arrhythmias	Atrial	7 (7%)	4 (4%)	0.66
	Ventricular	11 (11%)	10 (10%)	
	None	81 (82%)	82 (85%)	
ICD device		3 (3.0%)	0 (0.0%)	0.089
Cardiac Arrest		8 (7.9%)	4 (4.2%)	0.27
Death		3 (3.0%)	2 (2.1%)	0.69
Primary Composite Outcome		23 (22.8%)	11 (11.5%)	0.036

STEMI, ST-elevation myocardial infarction; EF, ejection fraction; IABP, intra-aortic balloon pump; LV, left ventricular; ICD, implantable cardioverter defibrillator.

patients from poor social and educational backgrounds are at risk of poor risk factor screening and control [15]. This status has also been associated with increased risk of CVD death [16].

This is clearly demonstrated in the results of this study, as the reported history of diabetes in patients in the STEMI hotline pathway was significantly less than the traditional pathway. However, measured HbA1C levels on admission were similar between the two groups. Similarly, patients in the STEMI

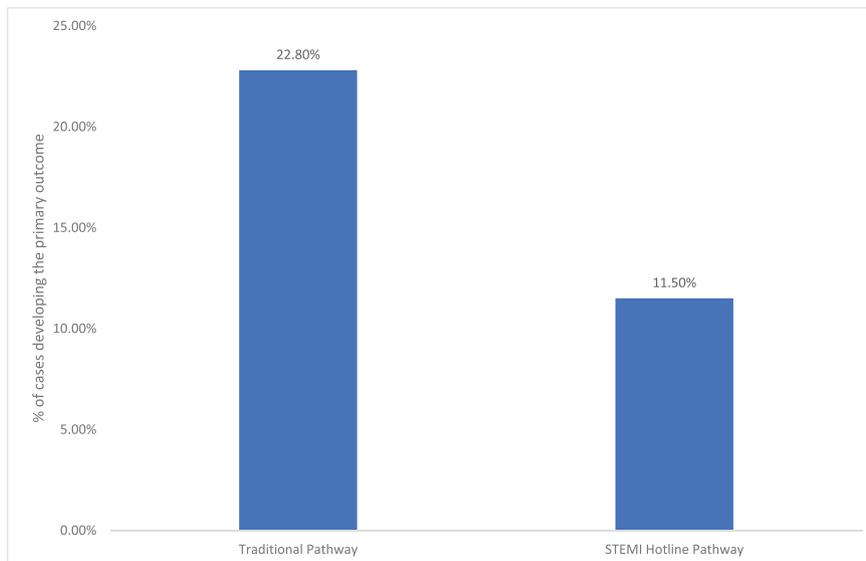


Fig. 2. Bar chart showing percentage of cases developing the primary composite outcome in each group. STEMI, ST-Elevated Myocardial Infarction.

Table 4. Primary outcome analysis.

Analysis	Value	P value
Number of events/number of participants at risk (%)	34/197 (17.3%)	–
Traditional Pathway	23/101 (22.8%)	–
STEMI Hotline Pathway	11/96 (11.5%)	–
Crude analysis – Odds ratio (95% CI)	0.439 (95% CI: 0.2–0.95)	P = 0.036
Multivariate analysis – Odds ratio (95% CI)	0.39 (95% CI: 0.17–0.9)	P = 0.028

Adjusted for: Nationality, History of PCI, Number of diseased vessels.

STEMI, ST-Elevated Myocardial Infarction; PCI, percutaneous coronary intervention.

hotline pathway had less reported history of dyslipidemia; however, the LDL levels were higher than the traditional pathway. This shows that the newly reached subpopulation have not been diagnosed with these diseases until the development of the STEMI, demonstrating lower access to risk factor screening and control.

In the traditional pathway, all the non-Bahraini patients presenting at peripheral centers underwent thrombolysis and were not referred for primary PCI. They were only referred for rescue PCI in case of failed thrombolysis.

The STEMI Hotline pathway has allowed us to reach more patients who had poor access to routine medical checks. A large portion of the non-Bahraini population have vastly benefitted from this program by obtaining prompt PCI for STEMI management.

Another significant difference between the two groups is the higher prevalence of coronary artery disease and history of PCI in the traditional pathway. We believe this difference is due to the traditional pathway having more Bahraini nationals and thus entitled patients who would have undergone PCI previously, while the STEMI hotline allowed access to newer patients who previously wouldn't have followed up in our center. This could also explain the higher prevalence of multivessel disease in the traditional pathway.

We also noted significant differences in the origin of referral for patients. There has been a significant increase in referrals from private hospitals in the STEMI Hotline Pathway (41% vs 14%). Private hospitals usually refer STEMI cases to the biggest governmental Accidents and Emergencies department in SMC and KHUH, where patients undergo fibrinolysis there. Since the introduction of the STEMI hotline these cases were referred directly to the hotline for primary PCI, hence increasing referral from private hospitals. This should have led to an expected decrease in SMC and KHUH referral

to the hotline; however, referral from SMC remained high. This may be due to stopping fibrinolysis in SMC and KHUH, as all patients are directly referred to the hotline for PCI. Cases referred from local health centres have also risen from 3% to 12%. Field activation by paramedics has also begun taking place at higher rates, increasing from 0 to 3%. This demonstrates that the STEMI hotline pathway has widened the reach of our ACS programme and has helped to identify and treat more STEMI cases who otherwise would have arrived at a peripheral center and received thrombolysis or been referred from there with an increased ischemia time.

Anterior wall MI was the most common presentation of STEMI in the STEMI hotline pathway, while Inferior wall MI was the most common in the traditional pathway. Patients with acute anterior myocardial infarction (AMI) typically suffer greater left ventricular (LV) systolic dysfunction and hemodynamic compromise compared to those with inferior myocardial infarction [17]. Hence, it's possible that a significant portion of AMI in the traditional pathway were referred late and developed complications prior to arrival, and hence were excluded from this study.

The average number of cases per week has increased significantly in the STEMI hotline, demonstrating the ability of the hotline to reach and treat more cases with PCI. Prior to the hotline, thrombolysis was the main reperfusion therapy for patients of non-Bahraini nationality. These patients were managed in peripheral hospitals and hence thrombolysed at those centers and not referred for PCI. The STEMI hotline facilitates early transfer of patients with STEMI from any site, and hence a larger proportion of patients were referred for primary PCI. Furthermore, this number is expected to continue increasing in the future with the additional training being deployed to the paramedics.

Despite the differences within the patients across the two groups, the odds ratio for primary outcome decreased significantly in the STEMI hotline compared to the traditional pathway even after adjusting for confounding factors. We believe this is due to two main reasons:

First, the reduction of thrombolysis practice in Bahrain. It is well known that PCIs have improved outcomes when compared to thrombolysis [5,18]. It is noteworthy that with the initiation of this STEMI hotline pathway, there has been zero cases of rescue PCI.

Second, the reduction in ischemia time. The simple and prompt referral system via the STEMI hotline, patients are referred quicker and were

transferred directly to the cardiac center, bypassing any setbacks which reduces ischemia time by minimizing door to balloon time. These reductions thus lead to reduction in complications [19–21].

The beneficial effects of regional STEMI programs and networks have been widely described in literature and advised through various STEMI guidelines [5,8–12]. Our program is unique in its simplicity to implement and allows rapid referral and discussion with the cardiologist from any referring hospital, health center, or ambulance.

4.1. Strengths

Given that MKCC is the only PCI center which provides emergency PCI services, all emergency PCI in the studied time frame were collected and analyzed. This restriction in center allowed controlling for confounding caused by treatment regimens and equipment availability and minimized operator differences. Moreover, the manual revision of the electronic medical records ensured high quality data collection. The use of regression models allowed adequate confounding of the measured variables.

4.2. Limitations

The study conducted was an observational study and most of the limitations stem from the design of the conducted study. Some variables were undocumented and hence not analyzed, leaving room for potential bias. The unavailability of time data (door to balloon, chest pain to balloon) remains one of the main limitations of the study. This didn't allow for a comparison of ischemia time between the two pathways, which could have further helped in analyzing the differences.

The benefit provided through the STEMI program could also be underreported, as we were not able to include complications of thrombolysis in the traditional pathway. If included, this could lead to a greater benefit from the use of the STEMI Hotline. Future research, which involves multiple hospitals

in Bahrain and broader follow-up periods, is required to further study and analyze the STEMI program.

5. Conclusion

The described STEMI hotline pathway is a simple to use method which allow quick communication with the invasive cardiology service, in order to promptly refer STEMI cases without delay. This pathway, when compared to traditional pathways in Bahrain, showed a 61% reduction in the primary outcome of in-hospital cardiovascular complications (inotrope/IABP/MV use, cardiac arrest, or death). The reduction of in-hospital complications probably stems from the reduction in ischemia time and the use of PCI instead of thrombolysis to treat STEMI patients. Further research with broader follow-up and the inclusion of multiple centers would help further analyze and improve the STEMI program.

Ethics approval

The study was approved by MKCC Research and Ethics Committee.

Funding

No funding was received to perform this study.

Author contributions

FB, AH, OK, FB, KA, SM collected the data. AA analyzed and interpreted the data. AA, AH, OK, KA, MF, FB wrote the manuscript. SIM, AA, MK edited the manuscript. All authors reviewed and approved the final version of the manuscript. FB is the guarantor of this work.

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Appendix. Multivariate regression model

Logistic regression							
Primary Outcome	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]		Sig
Hotline	0.399	0.167	−2.20	0.028	0.176	0.905	**
Bahraini	0.579	0.231	−1.37	0.170	0.265	1.265	
Previous PCI	0.379	0.296	−1.24	0.214	0.082	1.753	
No. of diseases vessels	0.980	0.122	−0.16	0.870	0.768	1.250	
Constant	0.452	0.229	−1.57	0.116	0.168	1.218	
Mean dependent var		0.169		SD dependent var			0.376
Pseudo r-squared		0.045		Number of obs			195.000
Chi-square		8.067		Prob > chi2			0.089
Akaike crit. (AIC)		179.252		Bayesian crit. (BIC)			195.617

***p < 0.01, **p < 0.05, *p < 0.1.

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