Original Article

Successful Implementation of Primary Percutaneous Coronary Intervention in an Iranian Population: A Single-Center Experience

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ABSTRACT

Background: Primary percutaneous coronary intervention (PPCI) is the gold standard for the treatment of ST-segment-elevation myocardial infarction (STEMI). Guidelines emphasize the importance of STEMI networks in order to facilitate rapid acute reperfusion therapy and improve prognosis. The outcomes of PPCI in a single tertiary university hospital in Hormozgan Province in Iran are reported herein.

Methods: We performed an observational study including all the consecutive STEMI cases admitted to our interventional cardiology department. Symptom to door, door to ECG, door to diagnosis, door to cath lab, door to balloon, and mortality were reported. Descriptive statistics (median, quartile 1-3) and nonparametric tests (Kruskal–Wallis and Mann–Whitney) were used.

Results: Totally, 195 patients were considered eligible for PPCI. The mean age of the patients was 54.90 years old (range =21–91 y). Women accounted for 28.2% of the study population. All the patients successfully underwent PPCI with a 100% rate of stenting. The in-hospital mortality rate was 1.45%. The median time for symptom-to-door, door-to-diagnosis, code-activation, symptom-to-device, and door-to-device times was 167.50, 23, 35, 266, and 60 minutes, respectively.

Conclusions: Our results, in line with previous studies, confirm the role of PPCI as the frontline approach to STEMI. Our results display the continuous efforts provided to reduce the in-hospital procedural times; nevertheless, ongoing efforts are needed to decrease symptom-to-door times. ***(Iranian Heart Journal 2019; 20(4): 46-55)***

KEYWORDS: Primary percutaneous coronary intervention, ST-elevation myocardial infarction, Door to device

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Worldwide, ischemic heart disease is the most common cause of death and its frequency is on the rise. However, in Europe, there has been an overall trend for a reduction in ischemic heart disease mortality over the past 3 decades. [1] Several studies have demonstrated that the implementation of an integrated strategy for the treatment of ST-segment-elevation myocardial infarction (STEMI) by means of a prompt execution of primary percutaneous coronary intervention (PPCI) is effective in reducing time to reperfusion and mortality. According to the European Society of Cardiology (ESC) and the American Heart Association (AHA)/ the American College of Cardiology (ACC) guidelines, the choice therapy for STEMI is PPCI. [5] A reduced time to reperfusion, defined as symptom to device
, is a strong predictor of survival following PPCI. [6] However socioeconomic status and initial treatment at nonspecialized centers are both associated with worse outcomes. These factors are particularly relevant to developing countries. [2] In developed countries, PPCI coverage in urban areas is recorded to be more than 95%, [3] whereas in developing countries, this percentage is very low. [4] Data from the Iranian Ministry of Health and Medical Education show that about more than 40% of deaths are due to cardiac events [10] and the most prevalent cause of death is acute myocardial infarction (MI). [8] For a whole variety of reasons, including the infrastructure status, the main treatment for STEMI in Iran is thrombolytic therapy. An assessment of STEMI management in neighboring countries [4] and similar developing countries [9] reveals similarities with Iran. In order to implement the recommended management strategy for STEMI, we should employ other countries' experiences—especially the countries that practice the Stent for Life (SFL) project in Europe. [7] Thus, we programmed a scientific approach to designing a cardiac disease registry and improving STEMI management. In the first phase, 53 hospitals from different parts of Iran were enrolled in a pilot study aimed at providing 24/7 PPCI in STEMI. This project was termed "Project 247".

Objective

The present study aims to describe the first-year experience of Project 247 and to assess the efficacy of this new STEMI management strategy.

METHODS

Study Design

A national committee for developing Project 247 was created by the Iranian Ministry of Health and Medical Education 3 months before starting. During the first phase, 53 hospitals in 23 cities from different parts of Iran were enrolled in the pilot study. All the hospitals were capable of performing 24/7 PPCI. All the hospitals were equipped as recommended by the guidelines.

Our hospital, Shahid Mohammadi Hospital, was selected for the project. Shahid Mohammadi Hospital is an important university hospital affiliated with Hormozgan University of Medical Sciences. Shahid Mohammadi Hospital is a cardiology training center and is an important referral hospital in Hormozgan Province. Based in Bandar Abbas City, which is the capital of the province, Shahid Mohammadi Hospital is located in the center of the province and has a distance of about 400 km from the farthest city in the east and about 600 km distance from the farthest city in the west. The Bandar Abbas district has an approximate population of 599 000 people, 469 000 of whom live in urban areas and the rest reside in the rural parts of the district (Fig. 1). Hormozgan Province is one of the 31 provinces of Iran. It is in the south of the country facing Oman and the United Arab Emirates. Its area is 70 697 km^2, and its capital is Bandar Abbas with a distance of 1300 km from Tehran. The

province has 14 islands in the Persian Gulf, more than 1000 km of coastline, 13 major cities, 21 counties, and a population of 1.7 million people. [11]

A data registry was designed (247 Code Registry) and became mandatory for all the cases. The project was commenced on 09/23/2015.

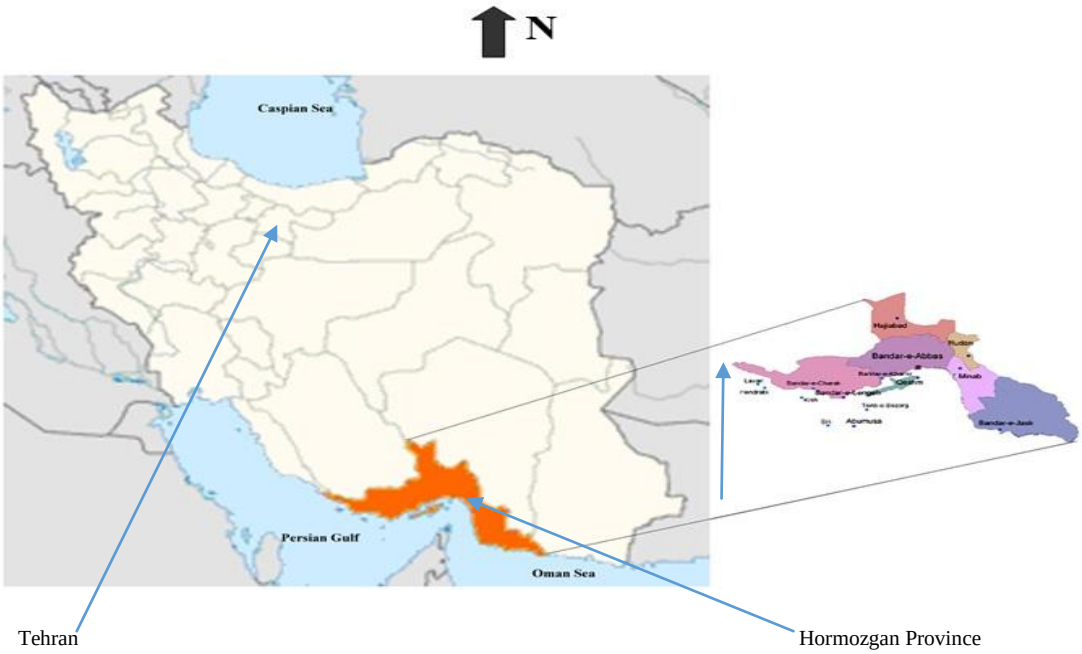

Figure 1. Location of Hormozgan Province

STEMI diagnosis

The diagnosis of STEMI was made based on the presence of ischemic symptoms and persistent (> 20 min) ST-segment elevation in at least 2 contiguous leads, a new left bundle branch block, or a true posterior MI confirmed by the posterior leads. All STEMI cases referred to our emergency department were prepared for PPCI and the 247 code was activated immediately after the diagnosis. All the patients received as soon as possible 325 mg of aspirin and 600 mg of clopidogrel, followed by a daily administration of 75 mg of clopidogrel for 6 to 12 months and 80–100 mg of acetylsalicylic acid indefinitely.

Intervention Procedure

PPCI was performed from the right femoral or the radial route at the operator's discretion. Unfractionated heparin (100 UI/kg) was administered intraprocedurally in all the cases. In the case of large thrombi, 180 µ/kg of intracoronary eptifibatide was administered, followed by (if required) manual thrombus aspiration. Drug-eluting stents (DESs) were used in all the cases. Interventions were applied only on the culprit lesion in the majority of the PPCI cases. After the procedure, the patients were transferred to the coronary care unit (CCU). If uncomplicated progress was noted, the patients were transferred to the post-CCU department after 48 hours and discharged in the next 24 hours.

Data Collection

Demographic and clinical characteristic data were collected from the 247 Code Registry Database. The collected times were comprised

of symptom to door, door-to-code activation, code activation to device, symptom to device, and door to device. All the timings from admission to angioplasty were registered in specific forms. Another outcome was in-hospital mortality. Data from the previous year were extracted from clinical records.

Statistical Interpretation

The data were analyzed using descriptive statistics (median, quartile 1-3) and nonparametric tests (the Wilcoxon–Mann–Whitney *U* test and the Kruskal–Wallis test) with SPSS, version 16.

RESULTS

During the study period, 206 STEMI cases were admitted to our hospital (mean age = 54.9 y). Of these patients, 71.8% (148) were men at a mean age of 54.76 years. The mean age of the enrolled women was 62.22 years (Table 1). The youngest patient was a 21-year-old man and the oldest was a 90-year-old man. Totally, 147 patients presented to the hospital in private vehicles or taxis. Twenty-four patients were transferred by ambulances from other hospitals, and 5 patients were admitted from the different wards of the hospital. Only 30 (14.5%) patients were transferred by EMS (Iranian Emergency Services, which is known as “115”). The median duration of symptom to door was 167.50 minutes, and the median duration of door to device was 60 minutes. The median time of ECG recording until diagnosis, interpretation, and decision-making by emergency physicians and the activation of the 247 code was 23 minutes. The median time for code activation to device was 35 minutes, and the mean symptom-to-device time was 266 minutes (Table 2).

Angiography was performed via the femoral access in 66.9% (n = 138) of the study population and in 23.1% (n = 68) via the radial access. A total of 195 patients had undergone PPCI. The success rate of PPCI was 100% with stenting in all the patients. Two patients had a history of coronary artery bypass graft surgery (CABG) that needed PPCI on saphenous vein grafts. Five (2.4%) patients were referred for CABG; 1 of these patients had undergone angioplasty with balloons for the restoration of the flow in the culprit artery before the operation. Two (0.97%) patients had severe slow flow, which was managed medically. Four patients had no significant flow-limiting lesions; 2 of them were admitted with suspected new left bundle branch block. Two patients required the deployment of intra-aortic balloon pumps, and thrombus aspiration catheters were used in 71 (36%) cases. In nearly 78% of the patients, intracoronary GP IIb/IIIa inhibitors were injected, and intravenous infusions of GP IIb/IIIa inhibitors were continued for the next 24 or 48 hours in 40%. An 89-year-old patient presented with cardiac arrest (thrombotic left main). Totally, 109 (52.9%) patients were diagnosed as anterior MI, 75 (36.4%) were treated as inferior MI, and 18 were diagnosed as the other types of MI. Approximately 45% of the patients had undergone echocardiography before PPCI. In the study period, the STEMI cases had equal monthly distributions. Two cases had a simultaneous double-vessel thrombotic involvement and PPCI with stenting was done on both thrombotic coronary arteries: 1 case of the left anterior descending and the right coronary artery and 1 case of the left anterior descending and the left circumflex artery. Interestingly, both of the cases were substance users. One case was complicated with massive femoral bleeding, which was controlled, and the patient survived.

Three (1.5%) deaths were recorded as in-hospital mortality. The year before, 189 STEMI cases had been admitted and 21 deaths had been recorded.

Table 1. Characteristic of the STEMI patients

Demographic	
total mean age, y	56.90
male n (%)	148 (71.8)
mean age of male patients, y	54.76
female n (%)	58(28.2)
mean age of female patients, y	62.22
Source of Referral, n (%)	
private vehicles or taxis	147 (71.35)
Interhospital transfer	24 (11.65)
Intrahospital transfer	5 (2.42)
EMS transfer	30 (4.56)
Type of MI, n (%)	
anterior MI	109(52.91)
inferior MI	75(36.40)
other types of MI	18(8.73)
Management, n(%)	
thrombosuction	71(34.46)
IABP	2(0.97)
intracoronary GPIIb/IIIa	161(78)
IV infusion (post PCI GpIIa/IIIb)	45(48)
Access, n%	
radial	68(33.1)
femoral	138(66.9)
In-hospital Mortality, n(%)	3(145)
Success Rate, n(%)	196(100)
LBBB, n (%)	4(1.94)
slow flow	2(0.97)
pre-PCI echocardiography	93(45)

MI, Myocardial infarction; IABP, Intra-aortic balloon pump; LBBB, Left bundle branch block; PCI, Percutaneous coronary intervention; IV, Intravenous

Table 2. Management time in the enrolled patients classified by age and gender

		Symptom to Door	Door to Code Activation	Code Activation to Device	Symptom to Device	Door to Device
Total		167.5 (75.0-376.3)	23.0 (11.0-48.0)	35.0 (25.0-50.0)	266.5 (160.0-479.5)	60.0 (45.0-101.0)
Gender	male	155.0 (75.0-370.0)	20.0 (11.0-40.0)	35.0 (25.0-47.5)	250.0 (155.0-440.0)	60.0 (45.0-88.5)
	female	250.0 (95.0-510.0)	30.0 (11.0-80.0)	32.5 (25.0-50.0)	345.0 (170.0-650.0)	70.0 (47.0-135.0)
	P value	0.154	0.141	0.995	0.144	0.170
Age (y)	20-29	250.0 (164.0-540.0)	15.0 (5.0-22.0)	36.5 (20.0-53.0)	227.5 (130.0-325.0)	50.0 (25.0-75.0)
	30-39	90.0 (57.0-390.0)	20.0 (15.0-48.0)	35.0 (27.0-50.0)	230.0 (110.0-450.0)	65.0 (45.0-80.0)
	40-49	139.0 (70.0-210.0)	22.5 (10.0-40.0)	30.0 (23.0-40.0)	182.5 (130.0-342.5)	55.0 (40.0-93.0)
	50-59	160.0 (70.0-328.0)	25.0 (13.0-40.0)	35.0 (25.0-45.0)	252.5 (155.0-430.0)	60.0 (45.0-105.0)
	60-69	233.0 (55.0-375.0)	29.0 (10.0-84.0)	36.5 (25.0-52.5)	347.5 (170.0-515.0)	68.0 (40.0-130.0)
	70-79	350.0 (75.0-450.0)	29.0 (15.0-55.0)	36.5 (25.0-57.0)	448.0 (205.0-545.0)	70.0 (50.0-125.0)
	>80	174.0 (105.0-365.0)	20.0 (11.0-40.0)	40.0 (20.0-52.0)	305.0 (215.0-420.0)	63.5 (45.0-85.0)
	P value	0.421	0.702	0.834	0.169	0.781

* All recorded times are in minutes.

DISCUSSION

Key Results

The mean age of the patients was 56.9 years: 54.7 years in the men and 62.2 years in the women, which is in line with other studies from Iran, [12] India, [13] and Taiwan; [14] nonetheless, age for both genders is younger than what is recorded in the South Korean MI registry [15] and other Western countries. [16] In the study period, most of the patients presented to Shahid Mohammadi Hospital (directly in their private vehicles, taxis, or ambulances). Unfortunately, only a few patients were transferred by ambulance (14%), indicating that hospital transport by ambulance is not popular in our community, which is shown in other studies [17] in some developing countries [18,19] in contrast to developed countries. [16] Currently, there are 6 active EMS centers in Bandar Abbas urban areas and 6 active centers in Bandar Abbas rural areas and the farthest rural EMS center is 70 km away from Shahid Mohammadi Hospital. There are 21 rural healthcare centers in the Bandar Abbas District; all of these rural healthcare centers have at least 1 general physician and are equipped with ECG recorders and a 24/7 active ambulances. EMS in Iran is free of charge. Educational campaigns are needed to increase population awareness of the early recognition of heart attacks and quick EMS calls. If a patient seeks help from 115 (EMS), according to law and national guidelines, the patient should be transferred to the nearest hospitals, which are probably most of the time not Shahid Mohammadi Hospital. Hence, a large number of patients are often referred to 2 hospitals in the east and west of the city, where STEMI is managed by thrombolysis, which is one of the most important ways of discovering all MI patients in Bandar Abbas. In phase 2, it is necessary to provide all the ambulances with ECG recorders and facilitate the ECG transfer of suspected STEMI patients to this hospital. Additionally, training EMS staff can facilitate the transfer of more cases of STEMI to Shahid Mohammadi Hospital in the future.

Patient Management Timings

The main problem in the treatment of patients with STEMI is the delay from the beginning of symptom to door, which is unfortunately more than the elapsed symptom-to-door time in comparison with European countries. [20] Nevertheless, this amount of time does not differ from some other developing countries. [14,21,22]

According to Table 2, the main remarkable time intervals are symptom to door, door to the 247 Code activation (ECG, interpretation, and diagnosis), and the activation of the 247 Code to device interval.

The most important and challenging interval is the symptom-to-door time with a median of 167.50 minutes (155 min for men and 250 min for women, which is nonsignificant) in our study (P = 0.154) (Table 2). This time interval is shorter than what is recorded in some countries like Pakistan, [4] India, [13] and Egypt [22] and longer than what is recorded in European countries. [23] In our previous studies, delayed presence of patients with STEMI was observed and the most important cause was unawareness of these patients regarding MI symptoms. [17]

In cities such as Bandar Abbas, the distance between home and the hospital or traffic is not a major issue. Indeed, in Bandar Abbas, the farthest point of the city to the hospital is 15–20 minutes. Still, unfortunately, the time interval from symptom onset to decision-making for seeking medical help is currently very long. Local public awareness of MI symptoms and treatment importance should be increased, mainly by local media, in order to shorten the symptom-to-door time.

The median door-to-247 Code activation time consists of the request for and the performance of ECG and its primary interpretation by emergency specialists; it takes approximately 23 minutes. Regrettably, unacceptable delays are seen (75 percentile), mainly due to delays in

decision-making by emergency specialists in activating the 247 Code and the poor patient transport system to the cath lab. The median time (Table 2) from door to 247 Code activation is about 23 minutes, and this interval could be reduced by setting up a chest pain unit managed by cardiology residents rather than emergency specialists in the emergency department. [24] Although in the first year, emergency specialists were authorized to activate the 247 Code, in practice, emergency specialists tried to consult a cardiologist, resulting in unacceptable delays in the door-to-device time. Consequently, 3 months prior to the writing of this report, there was a small alteration to the program and currently, cardiology residents in the emergency ward activate the 247 Code instead of emergency physicians.

Another time interval that can be reduced is the time from activation of the 247 Code until arrival to the cath lab (a median of 35 minutes). This delay, which can be seen in many hospitals in developing countries, [25] can be reduced by improving hospital logistical and transportation systems. Another solution is to equip EMS with devices such as EMS electrocardiographs and to transfer patients directly with EMS to the cath lab. In comparison with the French registry (FAST-MI 2010), which reported a median time from ECG to PCI of about 110 minutes, [26] our door-to-balloon time interval is favorable (Table 2).

The lengthiest time was seen in a 65-year-old patient with STEMI. This patient was transferred to the emergency department, where after the admission and subsequent management of a few injured patients, the STEMI patient was overlooked by emergency physicians and was transferred to the cath lab after a 10-hour delay. These types of cases can be prevented by setting up a chest pain unit in the emergency department supervised by cardiologists. More favorable results require a reduction in the door-to-balloon time regardless of the symptom-to-door interval, as was shown by Peterson et al, [27] which clearly affects mortality rates after acute MI.

As an ongoing project in its first phase, the current plan—if supported financially—could prove to be an efficacious management system inasmuch as not only can it easily involve health care workers but also it can augment the demand for this type of treatment by patients.

Approximately 45% of the patients in the current study had undergone echocardiography before PPCI, which appears to be inadequate. Echocardiography offers very important information such as the left ventricle ejection fraction, wall motion abnormalities, presenting pericardial effusion, and any valvular involvement and could guide the interventionist to determine the culprit artery. Accordingly, equipping the cath lab with echocardiography instruments could be helpful in this regard.

Thrombus aspiration was used in 71 (36%) of the cases, almost all of whom had total thrombotic occlusion (TIMI Thrombus Grade 5) with good results in most cases. Sanjit et al [28] published a meta-analysis of studies on the pros and cons of thrombus aspiration.

All the stents used in this project in the first year were DESs, which are expensive. The rate of the DES use for PPCI was 42.5% in Pakistan [4] and 19.3% in Egypt. [22] A Study from the United States of America showed that in 79.2% of the cases, the stents used were DES in New York hospitals. [29] If a specific protocol taking into account the current condition is designed for cath labs, bare-metal stents can be used instead in some patients with a view to reducing costs. In Iran, the costs are covered by the Iranian Ministry of Health and Medical Education. In fact, every Iranian has mandatory medical insurance (4 main governmental insurance companies) that covers about 95% of the costs for the urban population in governmental hospitals and 97.5% of the costs for the rural population.

The most valuable achievement in the current project is that data recording has become mandatory. The hospital mortality rates are currently lower than the rates when the project was started. PPCI is the most efficient approach to the management of STEMI, and Iran has taken great strides forward in this regard in the past 2 years. To make PPCI more effective, we recommend that more efforts be made to raise awareness about MI signs and symptoms. Of note, general awareness will be increased significantly with the cooperation of several organizations such the state-run radio and television, municipalities, schools, and educational institutions.

In other cities, pharmacoinvasive treatment is recommended as the treatment of choice for STEMI patients. These patients should be referred to PCI-capable centers as soon as possible after thrombolysis. This approach has been suggested in several developing countries. [30]

CONCLUSIONS

The first phase of Project 247 was very effective in implementing PPCI as a routine strategy for all the STEMI patients admitted to Shahid Mohammadi Hospital. Regular data recording helps us to identify specific barriers to the implementation of the guidelines for these patients in the regional health care systems. The prehospital period is an important part of the management strategy that needs further attention. Efforts should be made to equip EMS ambulances with electrocardiographers with a view to making better and more precise diagnoses of STEMI patients and offering them a rapid transfer to a hospital. Increasing general physicians' knowledge and awareness about the new treatments for acute MI with regular CMEs (medical education) could also prove useful.

Limitations

The major limitation of this study is that it could not include all STEMI patients from the city.

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Conflict of Interest

None.

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Author Contributions

HF: developed the concept, designed, and conducted the study; prepared the draft; and performed intervention on the patients; AA: performed intervention on the patients; AB: performed intervention on the patients; SM: conducted patient management; MN: conducted patient management; MA: conducted statistical interpretation; TEE: prepared and edited the draft

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