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Barriers To The Implementation Of Primary PCI In The Management Of STEMI In Egypt

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Abstract:
Introduction: Evidence-based guidelines recommend Primary percutaneous coronary intervention (PPCI) to be the mainstay reperfusion strategy for the treatment of STEMI if performed in the proper time window. However, Egypt health care system is still struggling to provide such important service. The aim of the present study, through a quantitative questionnaire, is to explore the current practice of management of STEMI patients in Egypt, and to identify the barriers, opportunities, and potential areas of improvement.
Methods and Results: The questionnaire was conducted in Egypt via face to face qualitative in-depth interviews with cardiologists from 14 PPCI-capable hospitals and 26 non-PPCI-capable hospitals. Participants were selected in view of their experience and knowledge. The study identified potential barriers to the implementation of PPCI among STEMI patients in Egypt. These barriers include among others: the pre-hospital patient and EMS delay, delay in emergency department and patient transfer to CCU, unavailable equipment, Cath lab activation delay, lack of trained interventional cardiologists, lack of regional STEMI networks and hospital policies and insufficient ICU beds.
Conclusion: Limited resources and health care system inadequacies have led to potential barriers that prevent suboptimal implementation of PPCI in Egypt. Efforts from all healthcare providers should be directed to overcome these identified barriers.
Keywords: STEMI, PPCI, Barriers, Egypt

Introduction

Evidence-based guidelines recommend Primary percutaneous coronary intervention (PPCI) to be the mainstay reperfusion strategy for the treatment of STEMI if performed in the proper time window. However, primary PCI is performed in <25% of acute care hospitals (1). Many patients with STEMI present to hospitals that do not have on site PCI capabilities and therefore cannot undergo PCI within the time frames recommended in the guidelines; instead, they receive fibrinolytic as the initial reperfusion therapy (2). Despite the availability and affordability of intravenous thrombolysis, the usefulness of this therapy is greatly limited by a high incidence of failed reperfusion and a substantial rate of re-occlusion (1). In a recent study, the percent of STEMI patients receiving PPCI in Egypt was much less than that among patients in other European countries. (3)

Study Objectives

The aim of the present study is to explore the current practice in STEMI management in EGYPT, to assess the resources and capabilities of governmental hospitals and to identify the most common gaps, barriers and potential areas for improvement to widely provide PPCI in Egypt.

Study design:

This survey was conducted in Egypt in January 2020 via face to face qualitative in-depth interviews that included a previously prepared unified questionnaire. Our team interviewed cardiologists from 14 PPCI-capable hospitals and 26 non-PPCI-capable hospitals in great Cairo, Alexandria, Upper Egypt, Delta & Canal (Table 1). All hospitals were governmental public hospitals which are the main providers of health care service in Egypt. The hospital is considered to be PPCI capable center if it provides PPCI for 24 hours/day and 7 days/week. To include a wide range of hospitals we included hospitals from different geographical locations and with variable ICU/CCU bed capacity: 6-12 beds (43%), 15-29 beds (29%), 31-50 beds (2%) and >100 beds (7%). Also, among participating hospitals, the number of ER doctors ranged from 2-20, ICU doctors from 1-60, interventional cardiologists from 1-90, qualified nurses from 3-60 and cath lab technicians from 1-30.

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Table 1: Type and geographical location of the participating hospitals

	PPCI-capable hospitals	Non PPCI-capable hospitals	Total
Cairo & Giza	*8*	*4*	*12 (30%)*
Alex	*2*	*2*	*4 (10%)*
Delta & Canal	*2*	*12*	*14 (35%)*
Upper Egypt	*2*	*8*	*10 (25%)*
Total	*14(35%)*	*26 (65%)*	*40 (100%)*

Results:

Patient presentation. STEMI patients presenting to PPCI capable hospitals either arrive directly (71%) or are referred from another hospital (29%). The type of reperfusion did not differ significantly between the two groups: primary PCI in 34% of the direct group vs. 31% among the referred patients (p: NS). In non-PPCI centers, only 22% of patients arrive by ambulance while 78% are self-transported. Only 29% of patients arrive to hospital within 2 hours of chest pain onset.

Interhospital transfer. In PPCI centers, 96% of admitted STEMI patients will-not be transferred to another hospital for recovery or further management. In non-PPCI hospitals, only 38% will be transferred to a PCI center and, when transferred, 81% will be self-transported. Regarding level of expertise required by the hospital policy to transfer a STEMI patient, 81% responded that only an EMS paramedic is required and not a nurse or doctor.

Written protocols. Only 21% of PPCI centers reported having written STEMI management protocols in place; it is even less (8%) among non-PPCI hospitals. None of the PPCI centers had a regional STEMI network program. The reperfusion strategy is left to the discretion of the referring hospitals. None of the PPCI centers had written repatriation agreements with the non-PCI centers in the region.

Quality Control Indicators. In PPCI centers, quality control indicators for STEMI diagnosis and management are variably monitored: Door to balloon in 79%, door to ECG in 71%, door to Cath lab activation in 71% while chest pain to device and door to thrombolysis in only 7%. Quality control indicators are less monitored in non-PPCI hospitals; 85% report in-hospital mortality, 50% in-hospital morbidity, 23% readmission rate, 15% 30-day mortality, 73% report patients arriving within 2 hours of chest pain, 50% report patients arriving to hospital by EMS and 19% report door to needle time.

Hospital Resources and Expenses Coverage. A cardiology department was available in 85% of surveyed hospitals, ICU/CCU in 96%, physician availability 24/7 in ED in 96%, ECG in the ED in 92%, defibrillator in 88%, Echocardiography in 73 % and troponin/CK estimation in only 42%. In PPCI centers, 87% of patients were covered by Ministry of Health (MOH) and 6% by the governmental Health Insurance Organization (HIO); in non-PPCI centers, 61% by MOH, 2% by HIO and 28% were covered by out of pocket payment.

STEMI Outcomes and Secondary Prevention. STEMI outcomes were perceived as less complicated by respondents in non-PPCI hospitals compared to respondents in PPCI hospitals: STEMI patients fully recovered in 87% vs 75%, in-hospital mortality 2% vs 3%, in-hospital morbidity 5% vs 13%, readmission 5% vs 6% and 30-day mortality 1 % vs 3%. Secondary prevention strategies were less applied in non-PPCI centers compared to PPCI centers; prescribing ASA upon discharge 88% vs 93%, antiplatelet 88% vs 100%, statins 88% vs 93%, RAS blockers 81% vs 86%, education on risk modification 73% vs 93% and referral to cardiac rehabilitation 27% vs 64%.

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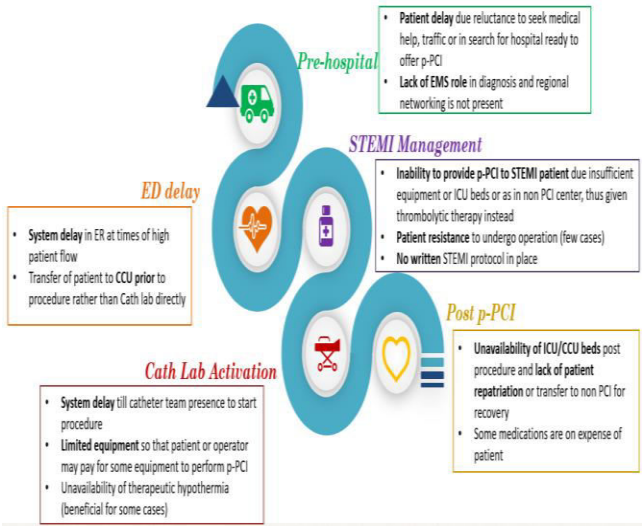

Figure 1: Gaps in STEMI Patient Journey in Egypt

Pre-hospital phase Delay. Pre-hospital delay represents the main obstacle against timely reperfusion due to patients' reluctance to seek medical advice, heavy traffic, searching for available bed in PPCI hospital, lack of EMS role and absence of regional networks. Only an estimated 29% of the patients presenting with STEMI to non-PPCI hospitals will arrive to the hospital within 2 hours of chest pain onset and a similar 24% in PPCI centers. Also, 71% will arrive directly to the hospital, while 29% of them will be transferred from other hospitals (Figure 2). EMS is used only by 35% of patients arriving to PPCI-capable centers and by 51% of patients presenting to non-PPCI capable centers.

Emergency Department Delay. A delay is also observed in the ED due to high patient numbers. According to the surveyed non-PPCI centers, as many as 13% of patients presenting to the ED have STEMI. On the other hand, 5% of patients presenting to the ED of PPCI capable centers have STEMI. Among non-PPCI hospitals, only 42% of STEMI patients are transferred to PPCI centers. The barriers are (table 2): Long estimated time for patients transfer, limited availability of EMS, an accompanying physician and vacant CCU beds at the PPCI hospital. The transfer of patients to CCU prior to procedure rather than Cath lab directly also add more delay in STEMI management.

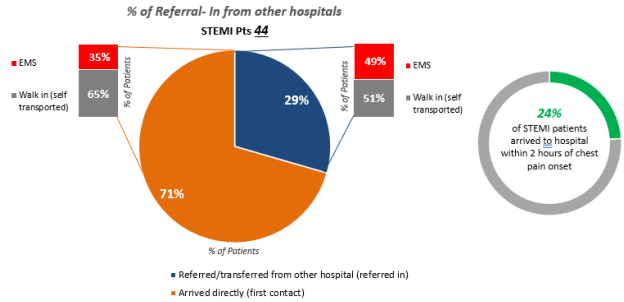

Figure 2: Representations of patients presented to ED with STEMI

Cath Lab Delay. Most non-PPCI hospitals have Cath labs but its operating hours are <12 hours in 84% and 36% of patients arrive after the operating hours. This highlights the underutilization of the limited yet available resources. Even during Cath lab operating hours, only 23% of the questionnaire respondents will perform PPCI. This may point to other obstacles such as unavailability of essential equipment or lack of expertise for PPCI. Moreover, the time for Cath lab activation and the time till catheter team arrival may add more delay to the process (Figure 4). In 79% of cases, the Cath lab is activated by the cardiologist and not the ER doctor. Some essential PPCI equipment may not be available and patients may pay for some

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items. Thus, 24% of cases presenting directly to PPCI capable centers may end up given thrombolytic therapy (figure 3).

Table 3: barriers in transferring patients from non-PCI-capable centers to PCI-capable centers

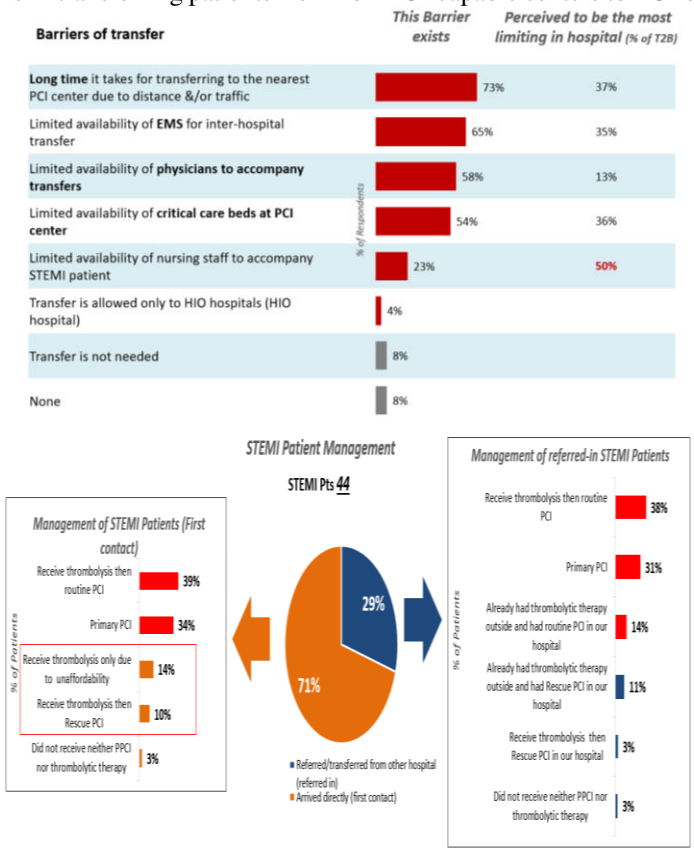

Figure 4: STEMI patients management

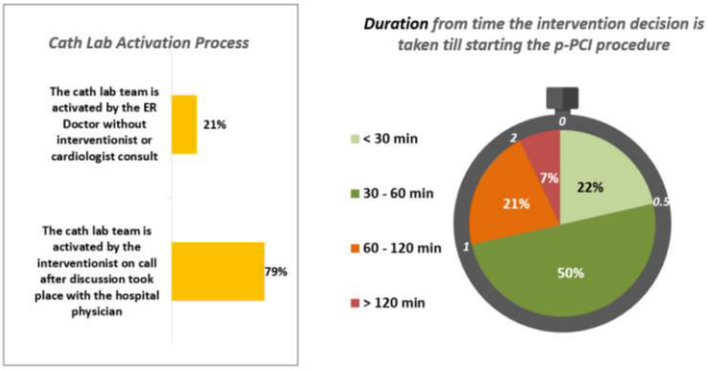

Figure 5: Cath Lab activation process

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Post Procedural Barriers. Among PPCI hospitals, the most common place for immediate recovery after PPCI is the CCU/ICU in 93% of hospitals. Unavailability of ICU/CCU beds post procedure and absence of repatriation policy are barriers to PPCI implementation in some cases. In this study, 64% of respondents do not use early discharge for STEMI patients post procedure.

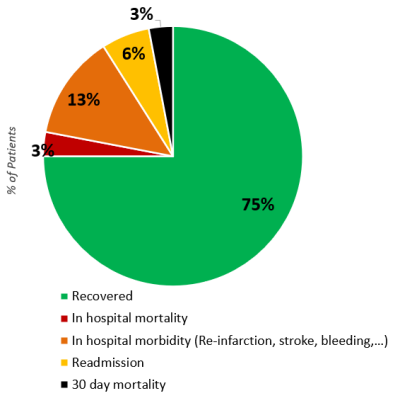

Table 6: The summary of barriers in non PPCI-capable centers

The barriers for providing the best medical service for patients presented with STEMI in Egypt can be summarized in table 3 and 4 for PPCI-capable centers and non-PPCI-capable centers, respectively. Limited resources, lack of trained interventional cardiologists, insufficient numbers of CCU beds, lack of regional STEMI networks and hospital policies are among the main barriers in the management of STEMI patients in Egypt

Table 7: The summary of barriers in PPCI-capable centers

Barriers at p-PCI centers	This barrier exist at hospital	Perceived to be the most limiting in hospital (% of T2B)
Limited/unstable Physical resources, e.g stents, balloons	93%	54%
Limited number of cardiologist/interventionist	64%	11%
Rules and regulations of hospital	64%	22%
Availability of back up cardiac surgery in hospital	64%	56%
Lack of ICU capacity	57%	25%
Limited Calibers/training	50%	
Poor condition of Cath device/s in hospital	50%	14%
Limited number of nurses in typical shift	43%	17%
Limited number of technicians involved in cath lab in typical shift	43%	17%
Lack of repatriation agreements (returning back patients) with Non-PCI hospitals	43%	50%
Lack of hospital administration support	36%	40%
Limited cath lab rooms to operate p-PCI	21%	
Unaffordability and lack of financial support	7%	100%
None	7%	

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Figure 8: Management outcome of patients with STEMI of the present study

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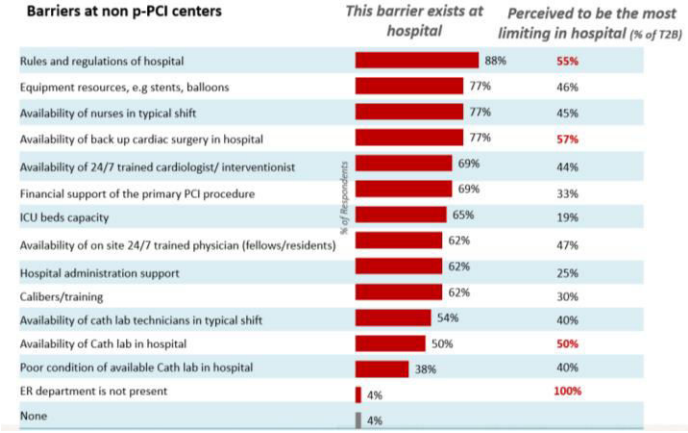

Discussion:

Rapid myocardial reperfusion is the cornerstone of treatment for patients with STEMI. For every 30 minutes delay in treatment of patients with STEMI there is an increase the risk of death by 7.5%. Therefore, minimizing delay is crucial. (4)

In the present study, according to the questionnaire respondents, only 22% of patients arrive in ambulance while 78% walk in (self-transported). Only 29% of patients arrive to hospital within 2 hours of chest pain onset and only 38% of patients are admitted to non-PCI hospitals transferred to a PCI center.

Shaheen et al. (2020) (3)evaluated data from 19 Egyptian centers (with and without PCI facilities) with 1356 patients who were compared to 7420 patients from other ESC countries to describe the characteristics of patients with STEMI, to assess STEMI management patterns, to evaluate the organization of STEMI networks across Egypt, to evaluate in-hospital patient outcome, and to compare Egyptian patients with other ESC countries. Compared to other ESC countries, Egyptian patients had longer median pain-to-first medical contact time 120 (60.0; 240.0) vs.100 min (50.0; 240.0) $p < 0.001$. This is due to both patients and system delays. Self-presentation rather than EMS presentation was the mode of admission in 86.06% in Egypt vs. 25.83% in EU countries ($p < 0.001$). Initial reperfusion therapy was 49.12%, 43.07%, and 7.26% for primary PCI, thrombolytic therapy, and no reperfusion in Egypt vs. 85.42%, 7.26%, and 7.82% for EU countries, respectively. Thrombolytic therapy is still the common reperfusion strategy in patients with STEMI in Egypt. They stated that there is an urgent need for public awareness and patient education campaigns to instruct patients with chest pain to seek medical advice as early as possible together with improving the EMS performance in Egypt to become a dependable and efficient mode of STEMI patients transfer. Moreover, the number of primary PCI/ per million populations is very small due to the limited number of primary PCI centers which is also not connected by a regional STEMI network. Pharmaco-invasive approach might be a practical way of treating STEMI patients as a temporary solution until the development of STEMI referral network.

China STEMI Care Project (CSCAP) was started in 2011 to evaluate the problems of insufficient reperfusion and delay in treating patients with STEMI in China. A total of 4191 patients with STEMI with symptom onset within 12 or 12–36 h was enrolled from 53 tertiary PCI hospitals in 14 provinces in China. Among them, 49% were self-transported, 26.5% by calling the EMS directly, and 24.5% were transferred from other hospitals. About 83.2% of patients received PPCI, 5.9% thrombolysis and 10.9% conservative treatment. The median door-to-balloon time was 115 (85–170) min and the median door-to-needle time for

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in-hospital thrombolysis was 80 (50–135) min. They concluded that, although a long treatment delay and a high proportion of patients transporting themselves to the hospital were observed, trends were positive with greater adoption of primary PCI and lower in-hospital mortality in tertiary hospitals in China. Therefore, these results provide an important information for the need for future integrated STEMI network construction in China. (5)

Yin et al. (2020) (6) conducted a study to understand the current STEMI treatment process in Guangdong Province in China to provide recommendations for improvement. Data were collected using face-to-face interviews from 32 participant including patients with STEMI, cardiologists and nurses from hospitals, ED doctors, primary healthcare providers, local health governors, and coordinators at the emergency medical system (EMS). The patients' barriers are un-awareness of STEMI symptoms and self-transfer rather than calling EMS. The main system barriers are the limited capacity of health professionals in hospitals and lack of coordination between hospitals They advised 5 important recommendations to improve the STEMI care in Guangdong Province: (1) Public education; (2) strengthen primary healthcare workforce; (3) increase EMS capacity; (4) establish an integrated care model; and (5) harness government's responsibilities.

In the present study, only 21% of PCI centers reported having STEMI management protocols in place; It is even less (8%) among non-PCI hospitals. None of the PCI centers had a regional STEMI network program. None of the PCI centers had written repatriation agreements with the non-PCI centers in the region. One of the reasons cited by participants for non-delivery of PPCI is that there was no medical code for the procedure post thrombolytic therapy. This prevented the participating centers from seeking reimbursement, which translated into underutilization of post thrombolytic PPCI. Logistical issues were cited as another reason for the under implementation of PPCI, such as lack of written protocols for EMS interhospital transfer. Operational gaps exist, and a multidisciplinary approach to the continuum of care between EMS and hospitals remains a major challenge in Egypt. The absence of prehospital ECG recording and interpretation in EMS vehicles add to the problem of diagnosis delay. Furthermore, EMS paramedics are not trained to perform, interpret or send ECGs to receiving centers. Other obstacles include insufficient number of trained interventional cardiologists, nurses and/or technicians to cover 24/7 service of PPCI and the non-sustained flow of availability of consumed equipment like stents, guide wires, balloons, contrast agents and others. These limitations are especially apparent outside the capital Cairo.

Dakota et al. (2020) evaluated the door-in to door-out (DIDO) delays as a routine performance measure of the metropolitan STEMI network. Data from 1,076 patients with acute STEMI who were transferred by ground ambulance to a PPCI center demonstrated that the median DIDO time was 180 minutes (120–252 minutes) that in-term led to significant increase in total ischemia time ($r = 0.4$, $p < 0.001$). The median door-to-device time was 70 minutes (58–88 minutes). They concluded that, to improve the overall performance of primary PCI in the region, interventions aimed at improving the DIDO time at the initial hospitals are the best efforts in improving the total ischemia time. (7)

Although most of efforts have been made to reduce the in-hospital delays, pre-hospital delays account to the major factor in total delay in STEMI reperfusion. Patient education especially symptom awareness programs is the most important step in delay reduction. It is mandatory to educate the publics about ischemic symptoms and the importance of immediate contact of EMS once they have any suspicious symptoms of myocardial ischemia. In the present study, the pre-hospital phase delay represents the main obstacle to timely reperfusion due to patients' reluctance to seek medical help, heavy traffic, searching for hospital ready to offer p-PCI, lack of EMS role and lack of regional networks. Long time of patients transfer, and limited availability of EMS, accompanying physician and CCU beds at the PPCI center represents the major obstacles to patient transfer from non-PCI-capable centers to PCI-capable centers.

The American heart association conducted the (PreAct STEMI algorithm) to be applied to patients with ischemic symptoms and/or EMS suspicion of STEMI. The AHA recommends 3 modes of prehospital ECG interpretation: paramedic interpretation, computerized algorithm diagnosis, and ECG transmission for remote interpretation. Patients who fulfill the STEMI criteria will be directly transported to the nearest PPCI-capable center while those who not fulfill the criteria will be transported to the ED for further management. Prehospital identification of STEMI has been successfully implemented in many regions by training EMS personnel to make STEMI-focused interpretations of 12-lead ECGs. funding to train and equip EMS personnel to acquire, interpret, and transmit the prehospital ECG. (8)

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Hoedemaker et al. (2020) evaluated the transfer time by ambulance to primary PCI centers in Netherlands and the impact of expansion of off-site PCI centers (PCI centers without surgical back up). They used data from EMS records to estimate the ambulance driving time from each postal code on each route. There were 14 off-site and 16 on-site PCI centers. The median time to on-site PCI centers was 18.8 min (12.2–26.3) compared to 14.9 min (8.9–20.9) to any PCI center ($p < 0.001$). In areas that were impacted by the initiation of off-site PCI, the median driving time significantly decreased from 25.4 (18.2–33.1) to 14.7 min (8.9–20.9) ($p < 0.001$). Based on a computational model, timely ambulance transfer to a PCI center within 120 min is available to all postal codes in the Netherlands. Expansion of off-site PCI has significantly reduced the driving time to PCI centers. (9)

The Health Professions Council of South Africa approved the use of prehospital thrombolysis for emergency care practitioners in 2009. (10) However, since its approval, prehospital thrombolysis has failed to reach a level of systematic uptake indicative of successful implementation. Lynch et al. (2020) (10) conducted a study to explore the barriers to pre-hospital thrombolysis within a South Africa. They demonstrated that the cost, logistics, inter-professional collaboration, leadership engagement, and beliefs or skepticism associated with pre-hospital treatment are the most important barriers in preventing delay in STEMI management. They concluded that, a lack of strategic implementation has resulted in a poor introduction of evidenced-based prehospital cardiac care, affecting vulnerable populations who may have otherwise benefited from receiving this level of care.

In the present study, a delay in performing revascularization in STEMI patients is observed in the ED due to high patient flow. A recent study using the Korean PCI registry demonstrated a median pain-to-door time of 94 minutes and door-to-balloon time of 62 minutes. (11) Lee et al. evaluated 4,874 patients with STEMI from the Korean acute MI registry. They found that older age, female sex, and avoiding using the EMS were associated with a longer pain-to-door time. (12)

In the present study, the transfer of patients to CCU prior to procedure rather than Cath lab directly also add more delay in STEMI management. The time for Cath lab activation and the time till catheter team arrive may add more delay to the process. A recent study found that using smartphone led to significant decrease in total-ischemia-time in patients with STEMI because of rapid communication that led to decrease time needed to transfer from non-PPCI-capable to PPCI-capable centers. Patients using smartphone had shorter first medical contact-to-device time than others (102.5 minutes vs. 129.5 minutes, $p=0.031$). Pre-hospital triage via telemedicine led to effective reduction of pain-to-reperfusion time. (13)

The STEMI-India task force writing committee for management of STEMI in low- and middle-income countries recently published the essential components of an effective STEMI care program. This include 5 important items: 1) developing a personalized care strategy that targets therapies in a uniquely specific manner which include rapid mobilization to a reperfusion center or pharmaco-Invasive strategy when PCI is not available, 2) create a STEMI system of care involving the governments, 3) introduce performance measures for STEMI care which should be educational, 4) create an easily accessible system of paying for care at any approved STEMI care facility, both public and private; this should eliminate upfront out-of-pocket payments, 5) have a strong component of program evaluation, performance measures and outcomes. (14)

A limitation of this study is that only governmental hospitals were included in this questionnaire. Private hospitals might have different obstacles and limitations as regard PPCI implementation among STEMI patients. However, most of the discussed obstacles in this study are common among most health care sectors in Egypt. Future research is warranted to further explore the still lagging obstacles and whether there has been any system improvement in the health care system in this regard.

Recommendations

The following actions are needed to optimize STEMI management in EGYPT: Public awareness campaigns and patient education, improving EMS service in number of vehicles, call centers, trained personal and equipment on board, increasing the number of PPCI capable centers starting from those centers with already Cath labs that only provide elective non-emergency services, building regional STEMI networks with written protocols for interhospital transfer, extending reimbursement for PPCI to first 24 hours post thrombolytic therapy and finally endorsing training courses for interventional cardiologists and other health care professionals for better diagnosis and management of STEMI patients.

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Conclusion:
Limited resources and health care system inadequacies in Egypt has led to insufficient implementation of PPCI. The potential barriers include, lack of trained interventional cardiologists, insufficient numbers of CCU beds and lack of regional STEMI networks and hospital policies. Governmental efforts should be directed towards these barriers to ensure the best quality of management for patients presenting with STEMI.

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