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ORIGINAL RESEARCH

Effects of Prehospital Traige and Diagnosis of ST Segment Elevation Myocardial Infarction on Mortality Rate

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Introduction: Adverse outcomes and mortality associated with STEMI (ST segment elevation myocardial infarction) are associated with the management and diagnosis time. The aim of this study is to evaluate the outcomes of prehospital diagnosis of STEMI via emergency medical service (EMS) on mortality, in comparison to the patients who did not receive EMS.

Methods: This retrospective study included STEMI patients, who underwent primary angioplasty. The patients were categorized as group A: referred without emergency service, group B: patients who did not receive PPCI and group C: patients referred via ambulance and received telecardiology. Medical records of these patients were evaluated for the diagnosis time, door-to-balloon time, in-hospital, six months, one year and three-year mortality, left ventricular ejection fraction and previous history of cardiovascular conditions and surgeries. The data were recorded and statistically analyzed using SPSS v21.

Results: Of 424 patients studied, 79 were referred without emergency service (group A), 52 patients did not receive PPCI (group B) and 293 patients were referred via ambulance with telecardiology (group C). Door-to-balloon time was least in group C (57.78 min) compared to group A (141.70 min). In-hospital, six months, one year and three-year mortality was least in group C, however, the difference was not statistically significant. The left ventricular ejection fraction was significantly greater in group C.

Conclusion: The results of our study indicate that prehospital diagnosis and telecardiology significantly reduce door-to-balloon time in STEMI patients referred for percutaneous intervention and might have an influence on short-term and long-term mortality rates.

Keywords: prehospital, mortality rates, cardiology, myocardial infarction, STEMI

Introduction

Myocardial infarction is one of the leading causes of morbidity and mortality globally and adds significantly to health and economic burdens. Early management of acute STEMI (ST segment elevation myocardial infarction) can reduce ischemic time duration, morbidity and mortality.[1] Over the past few years, management of STEMI has significantly reduced the mortality rate. Nonetheless, the long-term mortality rate still remains significant.[2]

The time to re-establish blood flow (reperfusion) is closely related to the morbidity and mortality of STEMI patients and is the primary goal of the treatment. The incidence of adverse events during myocardial ischemia with a delay in reperfusion over 30 min is associated with a 7.5% increase in mortality.[7] Other factors associated with increased in-hospital mortality also include greater

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SYNTAX score (evaluation of clinical variable and coronary anatomy),[3] Killip–Kimball class III and IV[4,5] renal failure, thrombolysis in myocardial infarction (TIMI), PCI ≤2, ejection fraction and some biochemical parameters.[6] According to the guidelines, PPCI (primary percutaneous coronary intervention) should be performed in less than or equal to 90 min from the patient's arrival at the hospital, which is known as door-to-balloon time.[7] Door-to-balloon time can, therefore, chiefly influence mortality in STEMI patients.[8,9] To achieve this goal, many interventions have been made to increase the speed of reperfusion treatment. The prehospital phase is critical in minimizing the time delay of first medical contact with the EMS (emergency medical service). Two important aspects in this phase are rapid STEMI detection and transfer time to PCI centers.[10] Ambulances are equipped with a 12-lead ECG (electrocardiography) system that allows trained paramedics to make prompt diagnosis of STEMI and immediate transfer to PCI facilities. Performing 12-lead ECG at this stage is recommended by the Heart Association/American Cardiology College and Canadian Cardiovascular Association.[7,11,12] A number of studies have suggested that these interventions can reduce mortality among STEMI patients.[13]

The aim of this study is to evaluate short-term and long-term mortality rate among patients who were provided with prehospital EMS, including STEMI diagnosis, compared to those who were not referred to our PCI center via the EMS.

Methods

This retrospective study was conducted at Imam Khomeini Hospital, where STEMI patients who underwent primary angioplasty were included. These patients were transferred to the hospitals via EMS and their hospital records were evaluated for demographic information (age and sex) and clinical information such as medical history, history of heart attack and stroke, previous history of angioplasty or heart surgery, smoking, and usage of diuretics. In addition, clinical and paraclinical symptoms of patients, including coronary arteries under angioplasty and involvement, cardiac biomarkers, creatinine levels, blood pressure, heart rate, venous congestion and ECG information, and type of myocardial infarction and respiratory arrest before PPCI were recorded. The questionnaire comprised ofinformation regarding the time of the onset of symptoms, the time of the first contact with the medical team, the time of admission of the patient in the Cath Lab, or the time of admission of patient in the hospital (admission time) and duration of PPCI. The final outcome-based section of the questionnaire comprised of the outcomes such as left ventricular dysfunction after angioplasty, postoperative arterial occlusion, hospital mortality, and one-month mortality based on TIMI (thrombosis in myocardial infarction) score and six-month mortality based on GRACE rating.

Prehospital emergency registration time was also noted by the means of GPS (global positioning system).

Exclusion criteria included patients with comorbidities, duration of symptoms and angioplasty greater than 12 h, patients with normal vascular angiography after the surgery in whom PPCI was not performed, absence of medical records of the patients, patients presented with other life-threatening disease, normal-ECG, patients admitted to intensive care unit and those transferred to another hospital, following PPCI.

The outcomes from the questionnaire were computerized and analyzed using R software.

The Kruskal–Wallis test was used to compare variables. Fisher's exact test was also used to compare the percentage (frequency) of qualitative variables. A p-value <0.05 was considered to be statistically significant.

Results

The patients were divided into three groups: referral to emergency without (group A, n=79), patients who did not receive PPCI (group B, n=52) and patients referred via ambulance and received telecardiology (group C, n=293).

The three groups did not differ in terms of age and gender, $p=0.089$ and $p=0.3$. The history of previous angioplasty was significantly different among the three groups, $p=0.016$. In addition, bypass surgery of left circumflex artery $p=0.016$, obtuse marginal $p=0.029$, posterior descending artery, right coronary artery, left anterior descending artery and three diseased vessels $p<0.001$, respectively, also differed significantly among the three groups, Table 1.

During the hospital admission, the three groups did not differ in the mortality rate, $p=0.4$. The six-month, one, and three-year mortality rates were not significantly different in these groups, $p=0.2$, $p=0.13$ and $p=0.2$. The mean and standard deviation of left ventricular ejection fraction (LVEF) is recorded in Table 2. Kruskal–Wallis test showed that LVEF was significantly higher in group C compared to group A, $p=0.019$.

According to the Kruskal–Wallis test, the time interval between the onset of symptoms in a STEMI patient and

Table 1 Descriptive Statistics Related to Demographic and Clinical Information

Characteristic	n	115, n=293	No PCI, n=52	Personal, n=79	*p*-value
Age	423	58.92 (12.41)	58.85 (15.91)	62.19 (12.23)	0.089
Sex	424				0.3
Female		51 (17%)	9 (17%)	20 (25%)	
Male		242 (83%)	43 (83%)	59 (75%)	
CHF	424				0.9
Neg		285 (97%)	51 (98%)	78 (99%)	
Pos		8 (2.7%)	1 (1.9%)	1 (1.3%)	
CAD	424				0.8
Neg		289 (99%)	52 (100%)	79 (100%)	
Pos		4 (1.4%)	0 (0%)	0 (0%)	
IHD	424				0.4
Neg		238 (81%)	39 (75%)	67 (85%)	
Pos		55 (19%)	13 (25%)	12 (15%)	
Hypertension	424				0.7
Neg		183 (62%)	35 (67%)	52 (66%)	
Pos		110 (38%)	17 –(33%)	27 (34%)	
Diabetes_mellitus	424				0.14
Neg		225 (77%)	34 (65%)	55 (70%)	
Pos		68 (23%)	18 (35%)	24 (30%)	
History_of_HLP_and_DLP	424				>0.9
Neg		251 (86%)	45 (87%)	68 (86%)	
Pos		42 (14%)	7 (13%)	11 (14%)	
Chronic_kidney_disease	424				0.5
Neg		285 (97%)	50 (96%)	75 (95%)	
Pos		8 (2.7%)	2 (3.8%)	4 (5.1%)	
Cerebral_vascular_disease	424				0.2
Neg		292 (100%)	51 (98%)	78 (99%)	
Pos		1 (0.3%)	1 (1.9%)	1 (1.3%)	
Chronic_lung_disease	424				0.060
Neg		283 (97%)	48 (92%)	72 (91%)	
Pos		10 (3.4%)	4 (7.7%)	7 (8.9%)	
Previous_stroke	424				0.2
Neg		283 (97%)	52 (100%)	74 (94%)	
Pos		10 (3.4%)	0 (0%)	5 (6.3%)	
Previous_myocardial_infarction	424				0.4
Neg		281 (96%)	52 (100%)	76 (96%)	
Pos		12 (4.1%)	0 (0%)	3 (3.8%)	
Previous_angioplasty	424				0.016
Neg		262 (89%)	52 (100%)	70 (89%)	
Pos		31 (11%)	0 (0%)	9 (11%)	
Previous_bypass_surgery	9				
Death		8 (100%)	0 (NA%)	1 (100%)	

(*Continued*)

Table 1 (Continued).

Characteristic	n	115, n=293	No PCI, n=52	Personal, n=79	*p*-value
Diagonal	424				0.6
Neg		284 (97%)	52 (100%)	77 (97%)	
Pos		9 (3.1%)	0 (0%)	2 (2.5%)	
LCX	424				0.016
Neg		263 (90%)	52 (100%)	67 (85%)	
Pos		30 (10%)	0 (0%)-	12 (15%)	
OM	424				0.029
Neg		270 (92%)	52 (100%)	70 (89%)	
Pos		23 (7.8%)	0 (0%)	9 (11%)	
PDA	424				0.4
Neg		282 (96%)	52 (100%)	76 (96%)	
Pos		11 (3.8%)	0 (0%)	3 (3.8%)	
PLB	424				>0.9
Neg		290 (99%)	52 (100%)	79 (100%)	
Pos		3 (1.0%)	0 (0%)	0 (0%)	
Left_main	424				0.5
Neg		292 (100%)	52 (100%)	78 (99%)	
Pos		1 (0.3%)	0 (0%)	1 (1.3%)	
Ramus	424				0.7
Neg		286 (98%)	52 (100%)	78 (99%)	
Pos		7 (2.4%)	0 (0–%)	1 (1.3%)	
RCA	424				<0.001
Neg		190 (65%)	52 (100%)	61 (77%)	
Pos		103 (35%)	0 (0%)	18 (23%)	
LAD	424				<0.001
Neg		142 (48%)	52 (100%)	36 (46%)	
Pos		151 (52%)	0 (0%)	43 (54%)	
SVD	424				<0.001
Neg		219 (75%)	52 (100%)	65 (82%)	
Pos		74 (25%)	0 (0%)	14 (18%)	
2VD	424				<0.001
Neg		195 (67%)	52 (100%)	46 (58%)	
Pos		98 (33%)	0 (0%)	33 (42%)	
3VD	424				<0.001
Neg		182 (62%)	52 (100%)	49 (62%)	
Pos		111 (38%)	0 (0%)	30 (38%)	
HB	424				>0.9
Neg		291 (99%)	52 (100%)	79 (100%)	
Pos		2 (0.7%)	0 (0%)	0 (0%)	
Anterior myocardial infarction	275				0.5
Neg		101 (51%)	0 (NA%)	43 (57%)	
Pos		98 (49%)	0 (NA%)	33 (43%)	

(*Continued*)

Table 1 (Continued).

Characteristic	n	115, n=293	No PCI, n=52	Personal, n=79	*p*-value
Systolic blood pressure, mmHg	351	124.46 (20.72)	NA (NA)	124.73 (18.50)	0.9
Diastolic blood pressure, mmHg	147	79.85 (14.61)	NA (NA)	79.95 (12.51)	0.8
Heart rate, beats/min	349	79.45 (15.26)	NA (NA)	82.97 (12.28)	0.017
Creatinine clearance, mL/min	291	1.42 (0.78)	NA (NA)	1.58 (1.14)	>0.9

Table 2 Comparison LVEF in Different Groups

Characteristic	n	115, n=293	No PCI, n=52	Personal, n=79	*p*-value
LVEF (%)	294	39.84 (11.22)	NA (NA)	36.58 (10.83)	0.019

Table 3 Comparison Door-to-balloon in Different Groups

Characteristic	n	115, n=293	No PCI, n=52	Personal, n=79	*p*-value
Door to balloon time (min)	296	57.78 (127.74)	NA (NA)	141.70 (237.64)	<0.001

the time of angioplasty did not differ significantly between groups, p=0.074.

Door-to-balloon time was significantly less in group C compared to group A, p<0.001, Table 3.

Discussion

The aim of this study was to evaluate the mortality rate among STEMI patients who were provided emergency service and were referred for coronary angioplasty. The results of our study showed that the mortality rate among the patients who were provided emergency service and those who were not, did not differ significantly. Prehospital ECG is associated with reduced reperfusion time, and the diagnosis of STEMI by paramedic staff. In addition, it is associated with reduced mortality and better hospitalization outcomes.[14] Timely referral of these patients directly to PPCI centers, compared to those who are indirectly transferred, can reduce mortality rate significantly by most likely effecting call-to-balloon time.[15] An increase in ECG-to-decision time for PCI also increases the risk of 30-day mortality among STEMI patients.[16] Transmission of ECG by paramedic staff to emergency physician increases the odds of positive prediction of STEMI and eases the decision-making process.[17] A recent study reported that prehospital diagnosis can also provide data regarding pathologic Q wave in STEMI patients, which is associated with a risk of mortality and adverse outcomes.[18] Prehospital factors can increase the time to PCI, which is associated with increased mortality.[19]

The results of our study indicated that indirect referral and emergency referral had a difference in in-hospital, six-months, one, and three-year mortality rates in STEMI patients, however, the difference was not statistically significant. Patients who were referred to our PPCI center via emergency service had a significantly lower door-to-balloon time. The findings of our study are in parallel with those provided by Savage et al.[20] The study reported that prehospital diagnosis of STEMI was associated with a decrease in door-to-balloon time and a statistically non-significant reduction in one and six-month mortality rates. The outcomes from the study by Yeoh et al also reported that prehospital diagnosis and notification for STEMI can reduce door-to-balloon time, nonetheless, it may not influence short-term mortality rates.[21]

A meta-analysis by Nam et al[22] concluded that prehospital ECG diagnosis is associated with a reduction in short-term mortality along with first medical contact–to-balloon, door-to-balloon, and door-to-needle time. A study by Chan et al[23] conducted on 167 patients referred to the PCI center with prehospital triage and 427 patients admitted by inter-hospital transfer, 90-min door-to-balloon time was greater in prehospital triage group along with postprocedural thrombolysis. In addition, 30 days and one-year mortality were also significantly lower in this group, therefore, prehospital triage was concluded to improve survival rates. Similarly, Jerónimo Sousa et al[24] reported that first medical contact to ECG was associated with the best performance. Prehospital emergency patient service significantly reduces ischemic time and ECG-to-PCI, ECG-to-balloon center time. Nonetheless, short FMC-to-device time <90 min is dependent on the distance to the PCI center and the use of protocol-driven EMS ground transportation.[25] In another retrospective study by Farshid et al,[26] prehospital Cath Lab examination significantly reduced ischemic time and 12-month mortality rate compared to emergency department examination among STEMI patients. The study concluded that ischemic time and mortality rate can be reduced, as a result of prehospital diagnosis, by greater than 50%. Compared to these studies, the outcomes from our study do not differ significantly. These discrepancies can be the result of sample sizes in the two groups (emergency and nonemergency referral), the expertise for paramedic staffs in the diagnosis of STEMI, PPCI-expert skills, difference in the protocols and other health-associated factors. A wide range of variations among the outcomes of STEMI patients have been reported globally as a result of hospital care, clinical profile and mortality.[27] Moreover, our study does not include other cardiovascular parameters such as hyperlipidemia that can increase the risk of mortality among these patients. Distance and availability of PCI center have not been considered in this study, as well. Our study included a greater number of male patients and mortality following PCI in STEMI patients might be influenced based on gender.[28] Overall, a significant reduction in door-to-balloon time and nonsignificant reduction in mortality rate among emergency and nonemergency service referral of patients to our PCI center suggest that prehospital triage can improve intrahospital and posthospital outcomes in STEMI patients.

Human and Animal Rights

No animals were used in this research. All human research procedures followed were approved and were in accordance with the ethical standards of the committee responsible for human experimentation (Tehran University of Medical Sciences), and with the Declaration of Helsinki 1975, revised in 2013.

Data Sharing Statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Consent for Publication

Informed consent was obtained from each participant.

Author Contributions

ZA and RA conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. MS and PH designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. PS coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content. All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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