Original Article

Predictors of Mortality for Patients with ST-Elevation Myocardial Infraction after 2-Year Follow-Up: A ST-Elevation Myocardial Infarction Cohort in Isfahan Study

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Abstract

Background: Mortality of ST-elevation myocardial infarction (STEMI) patients is increasing in world. This study defines predictors of mortality in patients who have STEMI.

Materials and Methods: This study was a part of the ST-elevated myocardial infarction cohort study in Isfahan conducted on 876 acute myocardial infarction (MI) followed for 2 years that 781 patient entered. The effect of predictors of mortality includes demographic, physiological, and clinical characterizes compared in two groups alive and died patients. MACE was defined as nonfatal MI, nonfatal stroke, and atherosclerosis cardiovascular disease-related death was recorded. Univariate and multiple logistic regression analyses were performed. All analyses performed using SPSS 20.0. $P < 0.05$ considered statistically significant.

Results: A total 781 patients, 117 (13%) that 72 (8.5%) was in-hospital died. The mean (standard deviation) age of the patients was 60.92 (12.77) years and 705 (81.3%) patients were males. Significant factors that affected mortality on analysis of demographic and physiological parameters were age ($P < 0.001$), sex ($P = 0.004$), transfusion ($P = 0.010$), STEMI type ($P < 0.001$), number epicardial territories >50% ($P = 0.001$), ventilation options ($P < 0.001$), smoker ($P = 0.003$), and diabetes ($P = 0.026$). Significant clinical factors affected mortality were ejection fraction (EF) ($P < 0.001$), creatinine ($P < 0.001$), hemoglobin ($P < 0.001$), low-density lipoprotein-cholesterol (LDL-C) ($P = 0.019$), and systolic blood pressure ($P < 0.001$). Multiple logistics regression model definition significant predictors for mortality were age ($P < 0.001$), heart rate (HR) ($P = 0.007$), EF (0.039), LDL-C ($P = 0.002$), and preangia ($P = 0.022$).

Conclusion: The set of factors can increase or decrease mortality in these patients. Significant predictors of mortality STEMI patients by 2-year follow up were age, HR, EF, LDL-C, and preangia. It seems that more articles need to be done in different parts of Iran to confirm the results.

Keywords: Logistic regression, mortality, predictors, ST-elevation myocardial infraction

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Introduction

The coronary artery disease and the myocardial infarction (MI) are the fourth major cause affecting the disease burden globally.[1] The yearly rate incidence of MI in the United States estimated 550,000. In 2013, a fatal MI occurred in 57% (with average of age 65.1) and 43% (with average of age 72) in men and women, respectively.[2] The MI mortality rate reported 85/100,000 and age-adjusted incidence of MI was approximately at 73.3/100,000 in Iran.[3,4]

Acute coronary syndrome (ACS) could be a syndrome caused by decreased blood flow within the coronary arteries that including ST-elevation of MI (STEMI), non-STEMI, and unstable angina. STEMI is one of common weakening and growing cardiovascular diseases.[5] STEMI is an occasion during which transmural myocardial ischemia results in myocardial injury or necrosis and remains an important reason behind morbidity and mortality worldwide.[6] According to the Global Registry of Acute Coronary Events follow-up program in 2015, 35% of all ACS presentations accounts for STEMI.[7] Studies reported that up to 40% of all ACS hospital admissions are STEMI patients and mortality in STEMI ranges from 4% to 24%.[8-10]

Previous studies showed that mortality rates at 30 days for patients displaying with STEMI are between 2.5% and 10%.[11-13] The most commonly used scoring framework for 30-day mortality is the TIMI risk score that risk factors consider age older than 75 years, diabetes, hypertension, hypercholesterolemia, smoking, history of angina, systolic blood pressure (SBP) <100 mm Hg, heart rate (HR) >100 beats/min, Killip class II to IV, and body weight <150 lbs.[14-16] Since risk factors and health care vary from country to country for MI patients and few studies on patient mortality of STEMI patients in Eastern Mediterranean Region (EMR) have been discovered especially in Iran. Therefore, it is necessary to identify the effective predictive factors of 2-year mortality.

Materials and Methods

This study is a prospective cohort study: ST-elevation myocardial infarction cohort in Isfahan study on 867 acute coronary heart patients referred to Chamran Hospital, Isfahan, Iran, 781 patients analyzed for this study. It was followed during a 2-year period (2015–2017). The main objective in this analysis is presentation of vital predictors on 2 years' mortality for STEMI patients in Iran.

Patients accepted with the diagnosis of STEMI during past 24 h in Chamran hospital in Isfahan, Iran, during 2 years were selected. Exclusion criteria were each patient that did not participate completely in 2-year follow-up. All participants filled an informed consent and for more confidentiality all patients form coded. The Ethics Committee of Isfahan University of Medical Sciences approved this study in 2018. The Institutional Ethical Committee at Isfahan University of Medical Sciences approved all study protocols (IR.MUI.Rec. 1396.2.018). The study protocol was explained to the eligible patients, and they were reassured about the confidentiality of their personal information.

The checklists were completed by trained nurses. The nurses who were chosen to collect the data and were given ten initial training courses of 1.5 h and one monthly reeducation gathering. Forms were included demographic factors, clinical factors and some laboratory information, history of underlying disease, and hospital diagnosis (ECG diagnosis, ejection fraction [EF], blood pressure and HR, history of hypertension, diabetes, hyperlipidemia, and atrial fibrillation). Eventually, we yearly follow-up patients and investigated mortality status and other clinical factors of patient after 2-year follow-up.

This study investigated previous angina (preangina). Preangina is defined the presence of any chest pain symptoms before the acute cardiac event.[17]

Sudden cardiac death is an unexpected death from cardiac because which occurs <1 h after symptom onset.[18]

The patients' long-standing annual follow-up was completed over the phone and in person in the event of an event. Patients are served by a trained nurse. We checked blood pressure and serum lipids in patients who came to our centers. If a patient had a MACE (the term "MACE" refers to atherosclerosis cardiovascular diseases [ASCVD] in coronary and cerebral vessels, including nonfatal MI, nonfatal stroke, and ASCV deaths), they were invited to the hospital for an exact diagnosis with their hospital documents.

Statistical analysis

Data are presented as mean ± standard deviation (SD) for continuous variables and counts and percentages for categorical variables. Outcome variable was mortality status (alive and died) and independent variables included of demographic variables, past medical history, clinical and lab variables. Student *t*-test was used for continuous and Chi-square (Fisher exact) test for categorical data. Our outcome was mortality status of patients that it was a bidirectional variable. Univariate and multiple binary logistic regression analyses were performed to define significant factors that affected mortality. We adjusted age, sex, and time (Different of arrival at PCI hospital time and therapy time) in this statistical model. Results are expressed as the odds ratios (ORs) and their 95% confidence intervals per one SD increment of each measure. All statistical analyses were performed using SPSS 20.0 (IBM. Corp., Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

Results

A total of 867 patients were selected for the current analysis that 86 patients had incomplete information. Overall, a total 781 patients enrolled so that the mortality rate of patients was 117 (13%) that 72 (8.5%) was in-hospital mortality. The mean of days to death of patients was 3.27 ± 2.37. The mean (SD)

age of the patients was 60.92 (12.77) years. 705 (81.3%) patients were males. A comparison of demographic and clinical characteristics in nonsurvivors and survivors is provided in Table 1. Compared with patients who survived, died were more likely to be older. Significant factors that affected mortality on analysis of demographic and physiological parameters were age ($P < 0.001$), sex ($P = 0.004$), transfusion ($P = 0.010$), treatment intention ($P < 0.001$), number pericardial territories > 50% ($P = 0.001$), ventilation options ($P < 0.001$), smoker ($P = 0.003$), and diabetes ($P = 0.026$). Significant clinical factors affected mortality were EF ($P < 0.001$), creatinine ($P < 0.001$), hemoglobin (HB) ($P < 0.001$), low-density lipoprotein-cholesterol (LDL-C) ($P = 0.019$), and SBP ($P < 0.001$). Thirty-two (23.2%) and 85 (13.2%) died in female and male, respectively [Table 1]. In the first step, the univariate logistics model was implemented. According to the results, the important factors were age, sex, diabetes, smoker, SBP, number pericardial territories, transfusion, EF, time (different of arrival at PCI hospital time and therapy time), ventilation option, and HB [Table 2]. In the next step, all predictors were entered into the multiple logistics model simultaneously. Significant results were age ($P < 0.001$), HR ($P = 0.007$), EF (0.039), LDL-C ($P = 0.002$), and preangia ($P = 0.022$) [Table 3]. The incidence of the disease was higher in women aged 60–69 years, and the death rate was 40.6% [Figure 1a]. Furthermore, in men shows that the highest incidence of men was 50–59 years and the death rate was 23.5% in this age group and 80 years more patients had more deaths (29.4%) [Figure 1b].

Table 1: Comparison demographic and physiological characterizes ST-elevation myocardial infarction patients who alive and those who died

Variable	Alive (*n*=664), *n* (%)	Died (*n*=117), *n* (%)	*P*
Demographic variable			
Age (years)	58.89±11.86	68.79±12.76	<0.001*
Sex (male)	558 (84.04)	85 (72.65)	0.004*
Past medical history			
Privous_angia	98 (14.76)	19 (16.24)	0.779
History of MI	78 (11.75)	20 (17.09)	0.107
History of stroke	28 (4.22)	15 (12.82)	<0.001*
Diabetes	180 (27.11)	44 (37.61)	0.026*
Hypertension	217 (32.68)	40 (34.19)	0.749
Hypercholestromia	204 (30.72)	25 (21.37)	0.040
Smoker	279 (42.018)	32 (27.35)	0.003*
Clinical variables			
Time (h)[#]	1.12±2.31	1.69±2.44	0.040*
Location AMI			
Anterior STEMI	349 (52.56)	68 (58.12)	0.271
Other STEMI	315 (47.44)	49 (41.88)	
Number pericardial territories			
1	276 (47.34)	29 (29.90)	0.001*
>1	307 (52.66)	68 (70.10)	
HR	70.99±10.89	68.81±11.50	0.314
EF	38.88±11.53	31.60±11.52	<0.001*
BMI (kg/m^2)	26.54±3.95	25.26±4.29	0.016
SBP (mmHg)	129.13±25.61	112.40±31.50	<0.001*
Ventilation options	19 (2.86)	58 (49.57)	<0.001*
Transfusion	14 (2.11)	8 (6.84)	0.010*
Treatment intention			
Primary PCI	320 (48.56)	80 (68.96)	<0.001*
Thrombolysis	325 (49.32)	32 (27.59)	
No_rperfusion	14 (2.12)	4 (3.45)	
Lab variables			
LDL-C	89.16±33.93	105.70±38.32	0.019*
HB	14.49±1.72	13.44±2.33	<0.001*
Cr	1.17±0.37	1.50±0.61	<0.001*

*Significant is $P<0.05$, [#]Different of arrival at PCI hospital time and therapy time. STEMI: ST-elevation myocardial infarction, PCI: Percutaneous coronary intervention, MI: Myocardial infarction, AMI: Acute myocardial infarction, HR: Heart rate, EF: Ejection fraction, BMI: Body mass index, SBP: Systolic blood pressure, LDL-C: Low-density lipoprotein-cholesterol, HB: Hemoglobin, Cr: Creatinine

Discussion

The results of the present study show that multiple predictors affected occurrence of mortality for STEMI patients. Results show that the incidence of the disease was higher in women 60–69 years with death rate 40.6% and incidence of this disease was 50–59 years in men with death rate of 23.5%. Incidence rate of this disease is more in male than female. The mean of age in died patients was higher than who survived, with a difference about 10 years. This result is similar to the result of other study, although age of died patients was 77 years.[9] The follow-up time was longer and the sample size of our study was larger. It should be noted that the mean age of patients in our study was lower (69 years). Although in our study, gender was not statistically significant, we found that percentage of mortality is increasing for female. A study shows that the

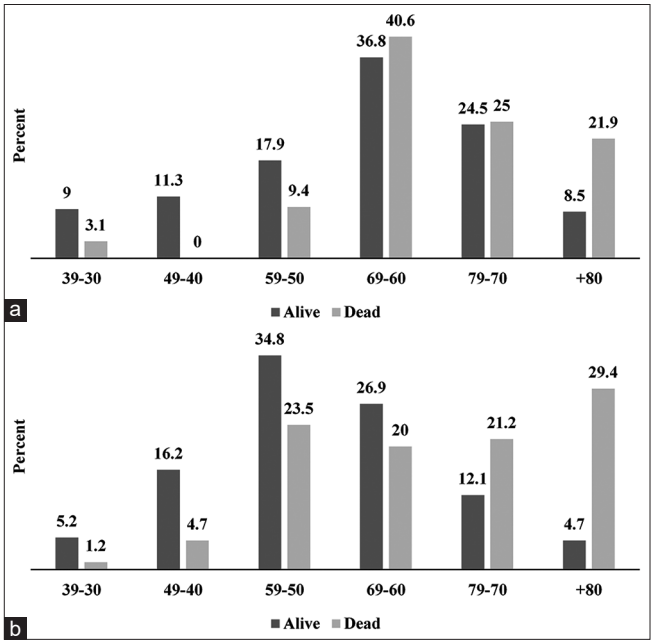

Figure 1: (a) Percent of final status in female patients in each age groups. (b) Percent of final status in male patients in each age groups

Table 2: Univariate logistic regression model of predictors of mortality for ST-elevation myocardial infarction patients

Variables	Estimate	SE	OR	95% CI	*P*
Age	0.068	0.009	1.071	1.052-1.090	<0.001*
Sex (male)	−0.342	0.116	0.710	0.565-0.892	0.003*
Preangia	−0.057	0.137	0.945	0.723-1.236	0.679
Diabetes (yes)	0.121	0.052	1.128	1.018-1.251	0.021*
Smoker (yes)	−0.327	0.11	0.721	0.580-0.896	0.003*
Time[#]	0.086	0.042	1.089	1.002-1.184	0.044*
Location AMI (STEMI)[†]	−0.225	0.203	0.798	0.536-1.188	0.267
Number epicardial territories[$]	0.746	0.237	2.108	1.325-3.353	0.002*
HR	−0.020	0.020	0.980	0.943-1.019	0.314
EF	−0.057	0.012	0.944	0.922-0.967	<0.001*
SBP	−0.025	0.004	0.975	0.967-0.983	<0.001*
Ventilation option	−3.510	0.297	0.030	0.017-0.054	<0.001*
Transfusion	−1.220	0.455	0.294	0.121-0.718	0.007*
Treatment intention (primary PCI)[‡]	−0.725	0.156	0.485	0.357-0.658	<0.001*
LDL-C	0.003	0.004	1.003	0.994-1.011	0.534
HB	−0.301	0.057	0.740	0.662-0.829	0.001*
Cr	1.357	0.242	3.886	2.417-6.249	0.688

*Significant is *P*<0.05, [$]References: >1, [†]References: Other STEMI, [‡]References: Thrombolysis, [#]Different of arrival at PCI hospital time and therapy time. STEMI: ST-elevation myocardial infarction, PCI: Percutaneous coronary intervention, AMI: Acute myocardial infarction, HR: Heart rate, EF: Ejection fraction, SBP: Systolic blood pressure, LDL-C: Low-density lipoprotein-cholesterol, HB: Hemoglobin, Cr: Creatinine, SE: Standard error, CI: Confidence interval, OR: Odds ratio

Table 3: Multiple logistic regression model defining significant predictors of mortality for ST-elevation myocardial infarction patients

Variables	Estimate	SE	OR	95% CI	*P*
Age	0.122	0.036	1.130	1.052-1.214	0.001*
Sex (male)	0.541	0.604	1.718	0.526-5.610	0.370
Preangina	−0.954	0.483	0.385	0.159-0.936	0.035*
Diabetes (yes)	0.359	0.191	1.432	0.984-2.083	0.061
Smoker (yes)	0.098	0.370	1.103	0.535-2.276	0.791
Time[#]	−0.052	0.146	0.949	0.713-1.264	0.721
Location AMI (STEMI)[†]	0.611	0.772	1.508	0.332-6.851	0.595
Number epicardial terriroteis[$]	−0.691	0.749	0.501	0.116-2.173	0.356
HR	−0.114	0.043	0.892	0.820-0.970	0.008*
EF	−0.62	0.031	0.940	0.880-0.997	0.048*
SBP	0.013	0.013	1.014	0.988-1.040	0.310
Ventilation option	−1.251	1.283	0.286	0.023-3.537	0.330
Transfusion	−1.330	2.239	0.135	0.003-21.31	0.552
Treatment intention (primary PCI)[‡]	−0.281	0.741	0.755	0.177-3.277	0.705
LDL-C	0.033	0.010	1.033	1.012-1.054	0.002*
HB	−0.104	0.219	0.901	0.587-1.385	0.636
Cr	−0.218	0.544	0.804	0.277-2.337	0.688
Constant	1.109	6.329	3.033	–	0.861

*Significant is *P*<0.05, [$]References: >1, [†]References: Other STEMI, [‡]References: Thrombolysis, [#]Different of arrival at PCI hospital time and therapy time. STEMI: ST-elevation myocardial infarction, PCI: Percutaneous coronary intervention, AMI: Acute myocardial infarction, HR: Heart rate, EF: Ejection fraction, SBP: Systolic blood pressure, LDL-C: Low-density lipoprotein-cholesterol, HB: Hemoglobin, Cr: Creatinine, SE: Standard error, CI: Confidence interval, OR: Odds ratio

crude rates of in-hospital death were 3.2% in men and 8.4% in women and it is similar to our result.[19]

Our data confirm that age, HR, preangina, EF, and LDL-C are as significant risk factors of post-MI mortality. Our findings are consistent with the results of previous investigators.[20] Numerous studies have shown that the risk of patient mortality is highest in the 1st year following MI.[20-22] Patients with accompanying conditions such as hypertension, diabetes, peripheral artery disease, or history of stroke are known to have significantly higher rates of mortality.[21-23]

Low EF after MI remains is an important risk factor for mortality of STEMI patients so that a study showed that,

among 82,558 patients 65 years or older, mortality of patients with EF <35% is more than who EF >55%.[24] More recent studies confirm this association so that patients with LVEF of 35%–50% had a relative risk of 2.5 for cardiac mortality compared with patients with LVEF >50%.[25-27] Therefore, low EF increased risk of mortality. In Our study, mean of EF was lower in died patients, and the current study shows that EF is one of important predictors, and it had conservative effect on mortality STEMI patients (OR = 0.888).

A study reported that discharge HR was significantly related to mortality at 1 year by hazard ratio 1.13, but it was not dangerous for later years. In acute MI, patients with HR >75 beats/min are at higher risk of death during the 1st year after discharge.[28,29]

The other study in western Romania reported that HR and SBP on admission of STEMI patients can provide valuable information on the risk of in-hospital death after primary PCI. Thus, in study, HR ≥80 bpm and SBP ≤105 mmHg increased risk of death, while HR <80 bpm and SBP >159 mmHg are associated with a better prognosis.[30] Furthermore, Gevaert *et al*.'s study reported that SBP less of 100 mmHg increased mortality.[31] In a population-based study in elderly patients after acute MI, they showed that low aSBP within 48 h after admission was strongly associated with an increased risk of cardiovascular death occurring after hospital discharge.[32] In our study, low SBP increased risk of mortality that mean of SBP in dead group was 112.40 mmHg, but it did not show statistically significant in logistic regression model.

Shock index (SI) is a simple index, defined as the ratio of HR and SBP that known as hemodynamic stability predictor. Many studies demonstrated that SI of 0.7 or greater (other some studies SI of 0.8 or more) is a strong predictor for short- or long-term outcomes in patients with STEMI.[33-35]

In Northern Taiwan study reported to lower HB level increased risk of 1-year mortality in the anemic group.[36] Our study shows that HB level is significant different in both group survival and nonsurvival in univariate analysis.

STEMI patients with diabetes are a high-risk group and they had an increased long-term mortality when compared to patients without diabetes.[37] In our study, 224 patients had diabetes and 44 (19.64%) patients died. Multiple logistic regression did not show significant effect.

Majority of our patients were brought to the ED by ambulances that similar to other studies.[9]

One of the factors that decreased mortality of STEMI patients is early PCI that suggested that door to balloon time <90 min.[38-40] Our study considered time interval between arrival at PCI hospital and reperfusion therapy. We found longer mean of this time in our patients who died.

Limitation and strength

One of the limitations was a lack of access to all patients because the number of patients were managed at home or died before reaching the hospital. Another one of limitation of the current study was limited to a central area of Iran and also single-center. Therefore, it is better to do a multicenter study because mortality rate of this disease different from region to other region.

Most impressive strength of our study is its cohort conduction as the most reliable type of study design and its large population with long-term follow-up.

Conclusion

Patients with STEMI are high-risk group that require more attention for risk factors and prevented of their premature mortality. The set of factors can increase or decrease mortality in these patients. In our study, significant predictors of mortality STEMI patients by 2-year follow-up were age, HR, EF, LDL-C, and preangina.

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Conflicts of interest

There are no conflicts of interest.

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