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Original Research Article

Assessment of coronary care management and hospital mortality from ST-segment elevation myocardial infarction in the Kazakhstan population: Data from 2012 to 2015

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ABSTRACT

Objective: The aim of this study was to assess and evaluate factors related to coronary care management and hospital mortality in patients with ST-segment elevation myocardial infarction (STEMI) hospitalized in the Kazakhstan County and city hospitals in which percutaneous coronary intervention (PCI) was performed during the period of 2012–2015.

Materials and methods: A total of 22,176 adult patients (18> years) with acute STEMI were hospitalized from January 2012 to December 2015. All the investigated STEMI patients underwent PCI.

Results: The mean age of STEMI patients was 61.52 ± 11.48 years, 72.2% of the patients were male and 75.2% living in the rural regions. The mean time from hospitalization to PCI was 2104.41 ± 5060.68 min (median 95.0 and IQR 1034.5). The mean and median of time from hospitalization to PCI tended to decrease from 2747.7 ± 5793.9 min and 155.0 min in 2012 to 1874.7 ± 4759.2 min and 73.5 min in 2015. Among all STEMI events the percentage of patients from hospitalization to PCI within 0–59 min was up to 39.0% during all study period. From 2012 to 2015, the percentage of STEMI patients with short time (0–59 min) of hospitalization to PCI tended to increase in average by 11.4% per year ($P = 0.09$). Among all STEMI patients hospital mortality from 2012 to 2015 did not change significantly and ranged from 9.0% in 2012 to 8.6% in 2015. By multiple logistic regression analysis, study years (2012), gender (female), age (60> years), time from hospitalization to PCI (60> min) and number of bed-days were statistically significant factors associated with patients' hospital mortality from STEMI with PCI.

Conclusions: The present study demonstrated that hospitalization delay in the treatment of STEMI patients in Kazakhstan population was without significant changes, meanwhile the number of patients perfused within 1 h from hospitalization to PCI tended to increase during

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2012–2015. The higher hospital mortality was associated with study year, female gender, older age, longer-time from hospitalization to PCI and shorter hospitalization.

1. Introduction

Despite the improvement of coronary care and the decline in mortality due to acute ST-segment elevation myocardial infarction (STEMI) in recent years, STEMI remains one of the most fatal diseases in the Kazakhstan population, the same as in other Western and Eastern developed and developing countries [1–5]. Timely reperfusion of the infarct-related artery is the cornerstone of treatment for stopping the progression of myocardium necrosis [6,7]. The outcomes of reperfusion therapy are dependent on the ischemic time from the onset of symptoms to the treatment [8,9]. The strategy of coronary care management involves integrated efforts to shorten the time from the onset of symptoms to hospitalization, to increase the patients' knowledge about ischemic heart disease symptoms, and shorten the time from hospitalization to percutaneous coronary intervention (PCI) and hospital coronary care. The efforts to implement quick myocardial reperfusion as recommended in clinical guidelines have resulted in significant curtailment of hospital time delay to treatment and have improved clinical outcomes [10–12]. In recent population studies, there is little information about the peculiarities of hospital coronary care management and trends in treatment of patients with STEMI and their relevance to hospital mortality. Prehospital and hospital time delay in patients with STEMI has been found to be an important factor of hospital mortality [13–15]. The major factors associated with the peculiarities of hospital coronary care management have not been clearly identified in the Kazakh population with STEMI.

The aim of this study was to assess and evaluate some aspects related to coronary care management and relationship to hospital mortality in patients with STEMI hospitalized in the Kazakhstan County and city hospitals as well as subjected to PCI from 2012 to 2015.

2. Materials and methods

2.1. Study design and subjects

The data on adult patients (18> years) who presented with acute STEMI to the Kazakhstan County and city hospitals from January 2012 to December 2015 were gathered and used for analysis. The data were available from 14 Kazakhstan Counties and 2 cities (Almaty and Astana). During this time, a total of 22,176 consecutive patients were hospitalized.

2.2. Data collection

Sociodemographic factors and other clinical and coronary care management characteristics were extracted from the Kazakhstan Diseases Registration Center Database. Cases without STEMI and PCI were excluded from this study.

Clinical as well as coronary care management variables were investigated with regard to gender, age, location of living and time from hospitalization to percutaneous coronary intervention (PCI), bed-days, myocardial infarction recurrent events and hospital mortality data. Patients were divided into two groups according to the time from hospitalization to PCI (0–59 min and 60> min) [16]. Data on hospital mortality were available from the Kazakhstan Disease Registration Center Database. Data about transportation from the moment of STEMI event to the hospitals were not available. PCI procedures were done in the intensive cardiology care departments at the Kazakhstan PCI-capable hospitals. Up to year 2013 STEMI system in Kazakhstan hospitals was not in accordance with ACCF/AHA and ECS Guidelines algorithm of acute coronary syndrome with ST elevation treatment, but from year 2013 acute coronary syndrome with ST elevation treatment algorithm (Protocol No. 1 of Expert Council at Kazakhstan Republic Health Ministry at 28 06 2013) and 2013 ACCF/AHA, ECS Guidelines for the Management of STEMI were used [17,18].

2.3. Definitions

All STEMI patients with codes I21.0-3 and I22.0-3 according to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) were analyzed. STEMI was defined according to the criteria of the universal definition of myocardial infarction [19]. The definition of the STEMI diagnosis: (1) ST-segment elevation consistent with MI of ≥2 mm in adjacent chest leads and/or ST-segment elevation of ≥1 mm in 2 or more standard leads or new left bundle branch block, and (2) positive cardiac necrosis markers. Time from hospitalization to PCI was the time from patient's arrival in the emergency department of hospitals to PCI. The term ''bed-days'' means the days of staying in the hospital from arrival to discharge. The term of hospital mortality (case fatality) defined the patients who died in hospital due to STEMI. The fatal cases were compared with all the cases of hospitalized patients due to STEMI during study period.

2.4. Statistical analysis

The Kolmogorov–Smirnov test was used to test normality of continuous data distribution. The numeric variables were summarized by their mean, 95% confidence interval (CI), median and interquartile range (IQR); categorical variables by counts and relative frequencies. Differences in patients' sociodemographic status and some clinical characteristics were compared between subgroups with the chi-square test for categorical variables and the Student t test for continuous

variables. The linear regression analysis was performed due to trends over the study period and annual percentage change was calculated. The logistic regression model was employed to identify the significant independent prognostic factors affecting hospital mortality by crude odds ratios (OR) and 95% CI. Differences or relations were statistically significant if $P < 0.05$. All statistical analyses were carried out using SPSS version 20.0 and MS Excel statistical software.

2.5. Ethics statement

The study protocol was reviewed and approved by the institutional review board of Kazakhstan Governmental Registration Center.

3. Results

3.1. Baseline characteristics of the study population

The baseline characteristics of 22,176 study patients are shown in Table 1. The mean age of STEMI patients was 61.52 ± 11.48 years; 72.2% of the patients were male and 75.2% lived in the rural regions. For all investigated STEMI patients the PCI was accomplished.

From 2012 to 2015, the percentage of patients with STEMI by gender and age was without significant changes, meanwhile in STEMI patients living in the urban area a significant decline of 2.8% per year on average was registered ($P = 0.04$) (Table 1).

The mean time from hospitalization to PCI of total 22,176 STEMI patients was 2104.41 ± 5060.68 min (median 95.0 and IQR 1034.5). The mean and median of time from hospitalization to PCI tended to decrease from 2747.7 ± 5793.9 min and 155.0 min in 2012 to 1874.7 ± 4759.2 min and 73.5 min in 2015, respectively (Table 1). The mean of time from hospitalization to PCI did not differ with respect to sex, age, but mean of time from hospitalization to PCI in the rural regions tended to decrease by 14.3% per year ($P = 0.06$) in average during 2012–2015 (Table 2).

Among all STEMI events the percentage of patients from hospitalization to PCI during 0–59 min time period amounted in average up to 39.0% during the study period. From 2012 to 2015, the percentage of STEMI patients with short time (0–59 min) of hospitalization to PCI tended to increase in average by 11.4% per year ($P = 0.09$).

The mean of bed-days for events with STEMI and PCI was 11.7 ± 5.7 days and was without significant changes according to sex, age and living location during study period (Table 3).

3.2. Clinical outcomes according to sociodemographic factors and time from hospitalization to PCI

During 2012–2015, hospital mortality among all STEMI patients was without significant changes and accounted for 9.0% in 2012 and 8.6% in 2015, respectively. Hospital mortality was higher in females (13.8%) compared with males (6.8%) ($P = 0.0001$), in the older (>60 years) patients compared with the younger (≤60 years) ($P = 0.0001$), and in patients, who were living in urban areas in comparison with those in rural areas, respectively 9.2% and 7.3% ($P = 0.01$). Hospital mortality was higher in long time to PCI (60> min) group compared with short time (0–59 min) to PCI group (9.9% vs. 8.0%, $P = 0.0001$). Hospital mortality in the Kazakhstan population did not change significantly according to gender, age, and living place from 2012 to 2015 (Figs. 1–3).

Table 1 – Baseline sociodemographic and coronary care management characteristics of hospitalized Kazakhstan population with STEMI and PCI during 2012–2015.

Variable	Study years				P for trend
	2012	2013	2014	2015	
Gender, *n* (%)					
Male	3684 (72.2)	4201 (71.8)	4391 (72.5)	3734 (72.3)	>0.05
Female	1420 (27.8)	1651 (28.2)	1666 (27.5)	1429 (27.7)	
Age, years					
≤60	2495 (48.9)	2735 (46.7)	2904 (47.9)	2494 (48.3)	>0.05
>60	2608 (51.1)	3117 (53.3)	3153 (52.1)	2669 (51.7)	
Living location					
Urban	4037 (79.1)	4451 (76.1)	4431 (73.2)	3763 (72.9)	0.04
Rural	1067 (20.9)	1401 (23.9)	1626 (26.8)	1400 (27.1)	
Time from hospitalization to PCI, min					
Mean ± SD	2747.7 ± 5793.9	1975.4 ± 4793.8	1832.4 ± 4729.9	1874.7 ± 4759.2	>0.05
Median [IQR]	155.0 [1755.0]	90.0 [955.0]	85.0 [730.0]	73.5 [712.8]	0.1
Time from hospitalization to PCI, %					
0–59 min	30.5	40.0	41.2	44.1	0.09
≥60 min	69.5	60.0	58.8	55.9	
Bed-days					
Mean ± SD	12.1 ± 5.2	11.2 ± 5.2	11.6 ± 5.9	12.0 ± 6.3	>0.05
Median [IQR]	12.0 [4.0]	11.0 [4.0]	11.0 [5.0]	11.0 [6.0]	
Hospital mortality, %	9.0	8.5	8.9	8.6	>0.05
Recurrent MI, %	21.3	20.1	19.8	18.2	0.03

IQR, interquartile range; PCI, percutaneous coronary intervention; MI, myocardial infarction.

Table 2 – Trends in the mean time from hospitalization to percutaneous coronary intervention for the Kazakhstan population with STEMI and PCI by gender, age, and living place during 2012–2015.

Year	Mean time from hospitalization to percutaneous coronary intervention, min					
	Gender		Age		Living place	
	Male	Female	≤60 years	>60 years	Urban	Rural
2012	2755.3	2565.3	2581.6	2819.0	2515.7	3408.9
2013	2030.7	1859.9	1967.8	1995.4	1762.4	2681.8
2014	1850.7	1813.6	1783.8	1892.6	1686.9	2258.8
2015	2073.0	1668.6	1876.4	2040.2	1857.2	2240.1
2012–2015	2177.4	1976.8	2052.4	2186.8	1955.6	2647.4
APC, %	−9.5	−13.2	−10.6	−10.2	−9.5	−14.3
	$P = 0.3$	$P = 0.1$	$P = 0.2$	$P = 0.3$	$P = 0.3$	$P = 0.06$

PCI, percutaneous coronary interventions; APC, annual percentage change.

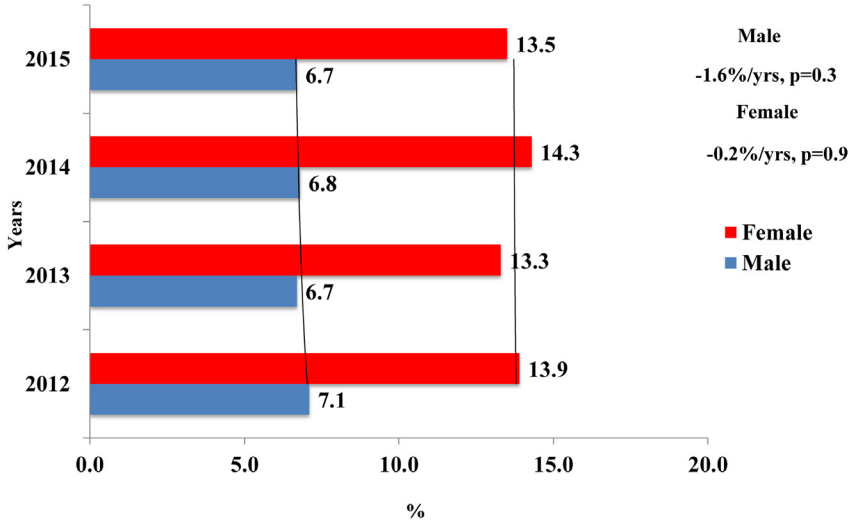
Table 3 – Trends in the mean number of bed-days for the Kazakhstan population with STEMI and PCI by gender, age, and living place during 2012–2015.

Year	Mean number of bed-days					
	Gender		Age		Living place	
	Male	Female	≤60 years	>60 years	Urban	Rural
2012	12.1	12.1	12.1	12.0	12.1	12.1
2013	11.3	11.0	11.3	11.1	11.2	11.3
2014	11.7	11.4	11.8	11.5	11.6	11.7
2015	12.3	11.7	12.2	12.1	12.0	12.3
2012–2015	11.8	11.5	11.9	11.7	11.7	11.9
APC, %	+0.8	−0.7	+0.7	+0.6	+0.2	+0.9
	$P = 0.7$	$P = 0.8$	$P = 0.7$	$P = 0.8$	$P = 0.9$	$P = 0.7$

PCI, percutaneous coronary intervention; APC, annual percentage change.

3.3. *Factors related to hospital mortality due to STEMI with PCI*

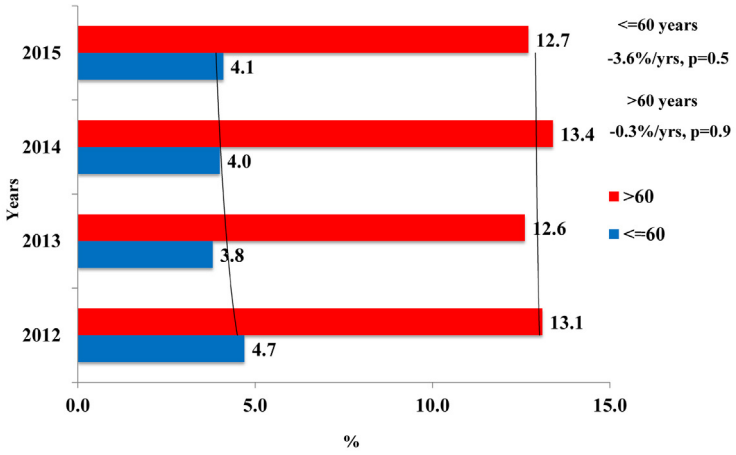
By multiple logistic regression analysis, study year (2012), gender (female), age (>60 years), longer time from hospitalization to PCI (60> min) and fewer bed-days were statistically significant factors associated with patients hospital mortality from STEMI with PCI (Table 4). Logistic regression analysis revealed that the likelihood of dying among STEMI patients with PCI was around 1.5 times lower in 2013, 2014, and 2015 than in 2012. During study period, female hospital mortality in average was 1.5 fold more often in comparison with male hospital mortality. Age >60 years was increasing odds of dying in the hospital due to STEMI with PCI in average by 2.7 fold in



$y=-0.265\ln(x)+7.0356$; $R^2 = 0.7087$ – assumption of linear regression for males

$y=-0.05\ln(x)+13.79$; $R^2 = 0.0046$ – assumption of linear regression for females

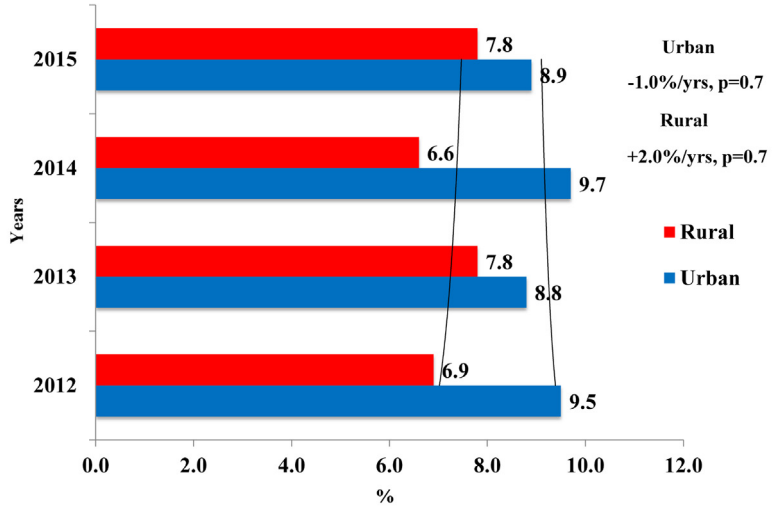
Fig. 1 – The trends in hospital mortality (%) among Kazakhstan male and female patients due to STEMI and PCI during 2012–2015.



y=-0.44ln(x)+4.4993; R^2 = 0.4658 – assumption of linear regression for patients of age <=60 years

y=-0.087ln(x)+13.019; R^2 = 0.0202 – assumption of linear regression for patients of age >60 years

Fig. 2 – The trends in hospital mortality (%) among Kazakhstan <=60 years and >60 years patients due to STEMI and PCI during 2012–2015.



y=-0.206ln(x)+9.3886; R^2 = 0.0783 – assumption of linear regression for urban patients

y=0.3229ln(x)+7.0184; R^2 = 0.0985 – assumption of linear regression for rural patients

Fig. 3 – The trends in hospital mortality (%) among Kazakhstan urban and rural patients due to STEMI and PCI during 2012–2015.

comparison with age ≤60 years. Longer time (60> min) from hospitalization to PCI increased odds of dying in the hospital due to STEMI with PCI in average by 1.2 fold in comparison with shorter time (0–59 min) from hospitalization to PCI. Every bed-day after hospitalization decreased hospital mortality in average by 38%. Living location was not associated with patients' hospital mortality.

4. Discussion

The result of this study showed that among patients hospitalized in the Kazakhstan PCI-capable hospitals due to STEMI, the time from hospitalization to PCI was still too long as compared with STEMI ACCF/AHA and ECS Guidelines [17,18]. On the other hand, in 2012 STEMI system in Kazakhstan PCI-capable hospitals was not in accordance with ACCF/AHA and ECS Guidelines algorithm of acute coronary syndrome with ST elevation treatment; therefore, from 2013 to 2015 acute coronary syndrome with ST elevation treatment algorithm by Expert Council at the Ministry of Health the Republic of Kazakhstan and 2013 ACCF/AHA and ECS Guidelines for the Management of STEMI were used [17,18].

The study results showed that the mean time from hospitalization to PCI in the Kazakhstan population was 2104.41 ± 5060.68 min (median 95.0 min) and exceeded the

Table 4 – Multivariable analysis for predictors of in hospital mortality (backward stepwise logistic regression model).

Variable	Odds ratio (95% CI)	P
Study years		
2012	1	
2013	0.622 (0.520–0.744)	0.0001
2014	0.670 (0.561–0.801)	0.0001
2015	0.676 (0.561–0.814)	0.0001
Gender		
Male	1	
Female	1.464 (1.280–1.675)	0.0001
Age, years		
≤60	1	
>60	2.738 (2.381–3.149)	0.0001
Living location		
Urban	1	
Rural	0.934 (0.805–1.083)	0.365
Time from hospitalization to PCI, min		
0–59	1	
60>	1.232 (1.085–1.400)	0.001
Bed-days	0.621 (0.611–0.632)	0.0001

PCI, percutaneous coronary intervention.
Model entered: study year, gender, age, living location, time from hospitalization to PCI, number of bed-days, $R^2 = 0.52$ (Nagelkerke).

goal of total ischemic time 120 min [17,18]. In this study, the mean time from hospitalization to PCI was very different in comparison with time of hospitalization to PCI median. This suggests that in different regions of Kazakhstan PCI-capable hospitals, time from hospitalization to PCI is very different. This is mainly due to a PCI-capable hospital management, patients' flow, hospital staff capabilities, personnel working conditions in intensive coronary care departments, the time of day, the time locking precision in database, etc. Unfortunately, the above-mentioned variables were not investigated in this study. We also did not have the possibility to set the time from onset of symptoms to hospitalization of patients. As we see in this study, the time from hospitalization to PCI median was even bigger than the recommended coronary care algorithm. During 2012–2015, the mean time from hospitalization to PCI among Kazakhstan population with STEMI tended to decline, especially in the population of rural regions by the 14.3% ($P = 0.06$). Results from other investigators collected by nationwide registries are similar [14,20–22]. The data of acute coronary syndrome analysis of the Slovak registry revealed that total ischemic time was shortened by 26 min in patients treated by PCI during 2007–2008 [23]. Data from the Polish acute coronary syndrome registry showed that for STEMI patients in-hospital delays in initiation of reperfusion treatment were shorter. Three-fourths of patients treated with PCI waited even up to 85 min from admission to the first balloon inflation (median 50 min) [24]. Nighttime onset and arrival via other hospitals were factors, which were related to hospital delay [21,25]. Pre-hospital management by the emergency medical service should be encouraged because it is associated with a shorter time to treatment and more favorable clinical outcomes [25].

Among all STEMI patients of Kazakhstan population the percentage of patients from hospitalization to PCI during 0–59 min amounted in average up to 39.0% during study period and tended to increase in average by 11.4% per year during 2012–2015. The STEMI patients in the short (0–59 min) and long (60> min) time from hospitalization to PCI groups were not different with respect to the gender, age and living location. Other studies revealed, that treatment delay is a critical determinant of outcomes after primary PCI [26]. Several studies, mostly observational, have suggested that the time from admission to PCI did not influence hospital mortality data [20,27]. Some investigators in a recent cohort of 8771 patients presented with STEMI over a 5-year period, noted that reduction of time from hospitalization to PCI did not decrease mortality [28]. However, the expectation is that physicians should strive for reduced transfer time to the catheterization department [29]. One reason could be the ''system'' delay (time for activating catheterization department personnel and obtaining consent) and ''non-system'' delays (the severity of the patients' condition, catheterization hardware failures, lack of medicines, etc.) [30].

In this study, hospital mortality was without significant changes from 2012 to 2015 and was 9.0% in 2012 and 8.6% in 2015, respectively. Hospital mortality was significantly higher in females, the older (>60 years) patients, patients who were living in urban areas, and among patients with long time (60> min) to PCI. In our survey, hospitalized patients with STEMI and PCI from urban regions, who died in the hospital, might have had more complications and other chronic non-communicable diseases as compared with the patients from rural regions. Results of RECORD study in Russia revealed that in-hospital mortality in patients with STEMI in invasive hospitals was bigger than within our data [30]. In other cohorts in-hospital mortality rates due to STEMI with PCI are similar [22,24,31,32]. In studies of Arabian Gulf countries and Thailand in-hospital mortality among patients with STEMI was lower [33,34].

Multivariate logistic regression revealed that study years, female gender, older age, longer time from hospitalization to PCI and fewer bed-days were statistically significant factors associated with patients' biggest hospital mortality from STEMI with PCI. These findings were similar in previous reports and showed that female gender, older age, diabetes, hypertension, previous history of coronary heart disease or coronary intervention were associated with prolonged pre-hospital and hospital delay and increased hospital mortality [22,32]. Relatively big sized study population, and high enough incidence of recurrent myocardial infarction in the present study may have increased the power to differentiate the risk among the patients.

Patients enrolled in our study were older than those included in ACCESS South Africa study (62 vs. 58 years) and had the same age as the patients included into other Western observational studies, but percentage of men was equal with ACCESS South Africa and other Western observational studies [32,35].

Our study has several limitations. Firstly, this study was retrospective, based on information of the hospital medical records, which could have affected validity of data. Secondly, initial means of transportation, distance to hospital and times between visiting first hospital and arriving in cardiology department were not evaluated because of inaccurate information from registration database. Thirdly, the data of

hospital mortality could have been affected by other harmful lifestyle factors, such as smoking, alcohol abuse, other modifiable factors, such as arterial hypertension, dyslipidemias, chronic diseases, such as diabetes, stroke, other clinical variable, and other sociodemographic factors, such as level of education, socioeconomic status, marital status, previous histories of coronary heart disease or coronary intervention, which were not evaluated in this study. Despite these limitations, the present study could provide the descriptive data showing the current status of coronary care management among STEMI patients and impact on hospital mortality.

5. Conclusions

The present study demonstrated that hospital delay in the treatment of STEMI patients in Kazakhstan population was without significant changes, meanwhile the proportion of patients perfused within 1 h from hospitalization to PCI tended to increase during 2012–2015. The biggest hospital mortality among STEMI patients was associated with study year, female gender, older age, longer time from hospitalization to PCI and fewer bed-days. Coronary care management improvement is needed to raise the health care personnel awareness of STEMI and the efforts to improve door-to-balloon time results that should prompt to seek immediate medical attention for patients' outcomes declining.

Conflict of interest

The authors declare no conflict of interest.

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