Day of admission and risk of myocardial infarction mortality in a cardiac care unit in Basrah, Iraq

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Abstract

Background: Among many factors that may affect the in-hospital mortality among acute myocardial infarction (AMI) patients admitted to the cardiac care unit (CCU), the day and time of admission have been reported to play some role, but such relationship is controversial.

Objective: The objective of the following study is to assess the effect of the day and time of admission on in-hospital mortality of patients with AMI.

Subjects and Methods: Retrospective analysis of data of all patients with AMI who were admitted to the CCU in Al-Sadr Teaching Hospital, Basrah, Iraq during 2010 was conducted.

Results: A total of 419 patients were included in this analysis. The mean age of patients was 62.4 ± 11.6 years, 64.9% of them were men. Admission during weekdays was greater than that during weekends (63.2% vs. 36.8%). Admission during off hours was greater than that during regular-hours (59.9% vs. 41.1%). Weekend admissions were more likely to be presenting with ST elevation myocardial infarction, complications and hypotension. A likewise pattern of baseline characteristics was found among patients admitted at the off-hours time.

The overall in-hospital mortality rate was 16.5%. The weekend admission was associated with a higher unadjusted hospital mortality rate than that for weekday admission (23.4% vs. 12.5%, respectively; odds ratio [OR], 2.14; 95% confidence interval [CI], 1.27-3.61; $P = 0.004$). In multivariate analyzes, no statistically significant difference in mortality was found between weekend and weekday admissions (OR, 0.658; 95% CI, 0.311-1.392). Whereas, off-hours admission was significantly associated with a higher mortality (25.5% vs. 3%; $P < 0.001$), adjusted OR, 12.178; 95% CI, 3.846-38.442.

Conclusion: Of predictors for the in-hospital outcome of AMI, day of admission had no significant influence on mortality, whereas off-hour admission was associated with an increased risk of AMI in-hospital mortality.

Key words: In-hospital mortality, myocardial infarction, weekend

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Introduction

Acute myocardial infarction (AMI) is a major cause of death world-wide. Effective therapies can improve its associated morbidity and mortality.[1] Despite the efforts of health care providers to improve the consistency and timely delivery of effective health care and treatments, many studies demonstrated quality gaps in AMI care in routine clinical practice.[2]

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Many studies have reported that patients with myocardial infarction (MI) who were admitted to hospitals on weekends or during "off-hours" (weekday nights, weekends and holidays) have worse outcomes than patients admitted during the other week days.[3-6] The reasons for these variations have not been well-defined. Lower staffing levels (both in terms of number and expertise) in hospitals on weekends than on weekdays, diagnostic and therapeutic

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procedures might take longer or are postponed until office hours, or patients admitted at such times were with severe illness and were less likely to receive guideline-based medications had been claimed as causes for such weekend effect.[7-13] Therefore, to improve outcomes, identification and estimation of increased weekend mortality may promote the redesign of health care services.[13]

However, this increased mortality outside office hours has been questioned by several other studies,[14-18] suggesting that the association was confounded by differences in the definition of office hours, differences in the study population, sample size, health care organization or insufficient correction for case mix and severity of illness. As a result of these methodological and organizational differences between countries, it remains unclear whether there is a relationship between increased in-hospital mortality and day or time of admission.

No study had been conducted in Basrah concerning such issue. Therefore, this study was conducted to determine whether day and time of admission to the cardiac care unit (CCU) increase the risk of death from AMI or not.

Subjects and Methods

Study design

This was a retrospective hospital-based study carried out for the period from 1st January 2012 to 30th September 2012.

Study population

The study included patients admitted to the CCU in Al-Sadr Teaching Hospital during the period from 1st of January to 31st of December 2010 with proven AMI as the primary reason for admission. AMI diagnosis was based on European Society of Cardiology/American College of Cardiology definition of MI.[19] Patients with valvular heart diseases, history of coronary bypass surgery, coronary angioplasty and patients with congenital heart diseases were excluded from the study.

Data collection and study variables

Data for this study were drawn from CCU and inpatient hospital discharge records available from the hospital archive department. For each discharge episode, we obtained the patient's age, sex, date of admission and discharge, outcome (discharged alive or dead). Admissions on Friday or Saturday were classed as weekend admissions and admissions during Sunday to Thursday were classed as weekday admissions.

Time of admission, was dichotomized into regular or office hours (8 am-2 pm h during weekdays; Sunday-Thursday) and off-hours (2 pm-8 am h during weekdays; Sunday-Thursday, 8 am-8 am the following morning hours during Friday-Saturday and holidays). Additional patient covariates included baseline socio-demographic and medical history factors and characteristics of the clinical presentation including the presence or absence of coexisting conditions (such as diabetes, hypertension) and the presence or absence of complications including mechanical (such as heart failure and cardiogenic shock), arrhythmic, embolic (central nervous system or peripheral embolization), or inflammatory (pericarditis).

MI type was divided into ST elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (NSTEMI). STEMI was defined by the presence of ST segment elevation $\geq$ 1 mm ($\geq$2 mm in V1-V3) in two or more adjacent leads. Whereas NSTEMI was defined by the presence of ST depression, T wave inversion, or non-significant ST-T changes.[20] As far as treatment strategies are concerned, all patients had nearly the same conservative treatment strategy on admission. Coronary interventional therapy is not available in this hospital. This study was approved by the Ethics and Human Research Committee of Basrah Medical College.

Statistical analysis

Categorical variables were presented as numbers and percentages and compared by Chi-square test. While continuous variables were presented as mean $\pm$ standard deviation and compared using *t*-test or ANOVA. Observed differences are expressed as *P* value. Logistic regression analysis was used to predict the independent risk factors of in-hospital mortality. $P < 0.05$ was considered to be statistically significant.

All analyzes were performed with SPSS (Statistical Package for Social Sciences) version 19, (IBM, Chicago, Illinois, USA).

Results

Of the 419 admissions, 64.9% were men. The mean age was 62.4 years ($\pm$11.6), 47.7% of the patients were aged 65 years or more.

Differences in baseline characteristics of the patients between the weekday and weekend, regular hours and off-hours admission are shown in Table 1. Although fewer MI admissions on weekends when compared with weekdays (36.8% vs. 63.2%), there was no significant difference in most of the socio-demographic and clinical characteristics of the two groups.

In general terms, weekend admissions were more likely to be presenting with STEMI, complications and hypotension, but had nearly similar proportions of previous MI. A likewise pattern of baseline characteristics was also found among patients admitted at off-hours time.

Table 1: Baseline patients' characteristics for admissions on weekdays versus weekends and during regular hours versus off-hours

Characteristic	All (n=419)	Weekdays (n=265) (63.2%)	Weekends (n=154) (36.8%)	P value	Regular hours (n=168) (40.1%)	Off-hours (n=251) (59.9%)	P value
Socio-demographic							
Age, mean (SD), year	62.4±11.6	61.8±11.8	63.4±11.3	0.156	61.7±12.1	62.8±11.3	0.335
Male, n (%)	272 (64.9)	175 (66)	97 (63)	0.528	113 (67.3)	159 (63.3)	0.410
Smoker, n (%)	122 (29.1)	75 (28.3)	47 (30.5)	0.890	47 (28)	75 (29.9)	0.867
Medical history, n (%)							
Diabetes mellitus	156 (37.2)	97 (36.6)	59 (38.3)	0.727	62 (36.9)	94 (37.5)	0.910
Hypertension	229 (54.7)	136 (51.3)	93 (60.4)	0.072	87 (51.8)	142 (56.6)	0.335
Previous MI	200 (47.7)	125 (47.2)	75 (48.7)	0.762	77 (45.8)	123 (49)	0.524
Complications	112 (26.7)	57 (21.5)	55 (35.7)	0.002[a]	33 (19.6)	79 (31.5)	0.007[a]
Clinical characteristics							
STEMI diagnosis, n (%)	259 (61.8)	152 (57.4)	107 (69.5)	0.014[a]	94 (56)	165 (65.7)	0.043[a]
Pre-hospital delay>12 h	186 (44.4)	124 (46.8)	62 (40.3)	0.194	83 (49.4)	103 (41)	0.091
SBP (mean±SD) mmHg	132.3±36.2	135.3±35.9	127.1±36.2	0.025[a]	137.4±35.3	128.9±36.5	0.018[a]
DBP (mean±SD) mmHg	81.2±22.0	82.9±21.7	78.3±22.2	0.037[a]	84.6±20.8	78.9±22.5	0.009[a]

[a]Significant difference. SD=Standard deviation; n=Number; MI=Myocardial infarction; STEMI=ST elevation myocardial infarction; SBP=Systolic blood pressure; DBP=Diastolic blood pressure

Table 2 shows the effects of certain variables on in-hospital mortality. Mortality was significantly higher in the following patients: Elderly (25.0% vs. 8.7%; $P < 0.001$); females (28.6% vs. 9.9%; $P < 0.001$); patients with complications (42.0% vs. 7.2%; $P < 0.001$); and those with past history of diabetes mellitus (21.8% vs. 13.3%; $P < 0.05$).

A total of 259 patients (61.8%) had STEMI. Of those, only 73 patients (28.2%) received thrombolytic therapy. The in-hospital mortality rate among those who did not receive thrombolytic treatment was 20.8% versus 13.4% among those who received thrombolytic treatment (odds ratio [OR] =1.69; 95% confidence interval [CI], 0.77-3.71; P = 0.183).

The overall in-hospital mortality rate of AMI was 16.5%. The observed mortality rate of patients admitted to the CCU on weekends was 23.4% compared with 12.5% of patients admitted on weekdays. Unadjusted analysis of mortality on weekends versus weekdays demonstrated a significant relationship between weekends and increased death rates (OR, 2.145; 95% CI, 1.273-3.614; P = 0.004). When adjusted for the confounding variables, weekend admission was not found to be independently associated with increased hospital mortality (OR, 0.658; 95% CI, 0.311-1.392; P = 0.273). However, total mortality was significantly increased in patients admitted at off-hours compared with office working (regular) hours even after adjusting for other confounding factors (OR, 12.178; 95% CI, 3.846-38.442; $P < 0.001$) [Table 3].

The multivariate analysis by logistic regression showed also that the significant predictors of in-hospital mortality were; age ≥65 years, female gender, time of admission, history of

Table 2: Univariate analysis of variables affecting the MI in-hospital mortality

Variable	No.	Mortality no. (%)	OR (95% CI)	χ^2; P value
Age (years)				
<65	219 (52.3)	19 (8.7)	3.509 (1.986-6.199)	20.250; <0.001
≥65	200 (47.7)	50 (25)		
Sex				
Male	272 (64.9)	27 (9.9)	3.630 (2.126-6.169)	24.116; <0.001
Female	147 (35.1)	42 (28.6)		
Smoking				
Non-smoker	297 (70.9)	56 (18.9)	0.513 (0.269-0.978)	4.227; 0.040
Current smoker	122 (29.1)	13 (10.7)		
History of diabetes mellitus				
Negative	263 (62.8)	35 (13.3)	1.815 (1.079-3.056)	5.127; 0.024
Positive	156 (37.2)	34 (21.8)		
History of hypertension				
Negative	190 (45.3)	28 (14.7)	1.262 (0.747-2.132)	0.757; 0.384
Positive	229 (54.7)	41 (17.9)		
Past history MI				
Negative	219 (52.3)	38 (17.4)	0.874 (0.520-1.468)	0.261; 0.610
Positive	200 (47.7)	31 (15.5)		
Complications				
Negative	307 (73.3)	22 (7.2)	9.367 (5.279-16.622)	72.238; <0.001
Positive	112 (26.7)	47 (42)		
Type of MI				
NSTEMI	160 (38.2)	20 (12.5)	1.633 (0.931-2.866)	2.962; 0.085
STEMI	259 (61.8)	49 (18.9)		
Duration of chest pain				
≤12 h	233 (55.6)	35 (15.0)	1.265 (0.754-2.122)	0.798; 0.427
>12 h	186 (44.4)	34 (18.3)		
Total	419	69 (16.5)		

OR=Odds ratio; CI=Confidence interval; MI=Myocardial infarction; NSTEMI=Non-ST elevation myocardial infarction; STEMI=ST elevation myocardial infarction

Table 3: Weekend versus weekday and off-hours versus regular hours MI mortality

Time of admission	Patient numbers	All deaths	Mortality rate (%)	Unadjusted OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Weekend	154	36	23.4	2.145 (1.273-3.614)	0.004	0.658 (0.311-1.392)	0.273
Weekday	265	33	12.5				
Off-hours	251	64	25.5	11.16 (4.384-28.392)	<0.001	12.178 (3.846-38.442)	<0.001
Regular hours	168	5	3				

CI=Confidence interval; MI=Myocardial infarction; OR=Odds ratio

diabetes mellitus, low diastolic blood pressure on admission and complications [Table 4].

Table 4: Multivariate analysis of predictors of in-hospital mortality of AMI patients

Predictors	Adjusted OR (95% CI)	*P* value
Age≥65 years	1.045 (1.010-1.081)	0.001
Female gender	4.672 (2.263-9.647)	<0.001
Time of admission	12.178 (3.846-38.442)	<0.001
History of diabetes	2.553 (1.236-5.274)	0.029
Low diastolic BP on admission	1.1 (1.03-1.23)	0.045
Complications	7.973 (3.911-16.252)	<0.001

AMI=Acute myocardial infarction; OR=Odds ratio; CI=Confidence interval; BP=Blood pressure

Discussion

The baseline clinical characteristics of the patients were similar, except for the higher prevalence of hypotension, complications and STEMI type of AMI during weekends and during off-hours. This might be due to that, during regular (office) hours, patients with mild and less specific symptoms can more easily attend the hospital for assessment.[16]

There was a shorter pre-hospital delay at the weekend as well as off-hours admissions, possibly due to the more intense symptoms among patients admitted during such times or due to the influence of significant others such as family members or peers.[21]

The overall in-hospital mortality of MI patients at the CCU was 16.5% which is similar to that reported in Baghdad Teaching Hospital in 2011 which was 16.1%,[22] but it was higher than that reported in Saudi Arabia (3.0%),[23] Iran (9.4%),[24] Italy (7.4%),[25] Pakistan (Rawalpendi) 9.2%[26] and Kosovo (10.25%).[27]

Mortality among patients admitted during weekends was higher than in those admitted during weekdays, but after adjusting for other variables, no significant increase in overall mortality was noticed in patients admitted at the weekend compared with those admitted on weekdays. A result which is consistent with that reported by others.[18,28] However, the mortality was increased significantly in patients admitted at the off-hours time when compared with those admitted in the official working hours even after adjustment for other factors. This result agrees with that of other studies,[3,29,30] but it contradicts that of some studies which showed no significant effect of time of admission on mortality.[14-16] Temporal and methodological influences may account for such differences.[16]

Several explanations are possible for the association between weekend, time of admission and increased in-hospital mortality. Differences in the delivery of care in hospital during weekend periods, reduced overall staffing levels, less senior doctors and less experienced staff, cross cover for other clinicians' patients, discontinuity of care, reduced availability of certain procedures and less supervision have all been considered as possible explanations for the 'weekend effect'.[11] All of these factors also apply at off-hours, as well as a possible average increase in time to first consultant review.[31] Patients may have greater physical activity, alcohol use and emotional stress when at home on nights and weekends. Later waking times and presumptive later medication administration which could contribute to such increase in proportion of patients with AMI presented at these times.[21]

Pathophysiologic factors may affect the timing and type of acute coronary syndrome. The complex interaction of plaque disruption, thrombosis, fibrinolysis and endothelial function are not completely understood and may differ on nights and weekends. Circadian changes in catecholamines, cortisol, blood pressure and pulse have been described, potentially altering coronary artery wall shear stress.[32] An increase in platelet aggregation has been described in the morning[33] and the fibrinolytic system has marked circadian pattern or variation.[34]

Furthermore, it was suggested that patients who initially present to hospital at weekends and off-hours times may on average be more severely ill, compared with those with lesser emergencies who wait or have been planned for next-day normal daytime assessment.[29]

Advanced age was significantly associated with higher in-hospital mortality, a result which agrees with that of others.[35,36] A study by Gurwitz *et al*., showed that although in-hospital death after AMI has declined for patients less than 65 years of age but improvements have not been realized for old age group.[37]

Female gender was another characteristic which was associated with higher mortality in patients with AMI. This study is consistent with previous studies which showed that women had a higher adjusted in-hospital mortality than men.[38,39] This may be due to the fact that females are usually older than males at presentation and also females were more likely to have a higher prevalence of other risk factors such as dyslipidemia and diabetes mellitus.[26]

In univariate analysis, smoking was found to be inversely associated with MI, a result which seems to be contradictory. It is in agreement with that of others.[24,40,41] Younger age and lower comorbidity, more frequently men than women and probably a better clinical profile in smokers might partly account for this "smoking paradox".[40,42-44] However, after adjustment for other variables, no significant effect of smoking on in-hospital mortality was observed.

Diabetes mellitus is another factor which significantly increased risk of mortality in patients with AMI. This result is in agreement with that of other researchers.[24,45] Diabetic patients have increased platelet aggregation and coagulation activity leading to increased probability of thrombus formation.[46] They develop cardiomyopathy more frequently than those without diabetes.[47] Left ventricular dysfunction and heart failure as complications of MI are more frequent in diabetic than in non-diabetic patients.[48] Furthermore, disturbed autonomic tone consequent to diabetic neuropathy may be a direct cause of fatal arrhythmias.[49] These factors may explain the increased MI mortality in diabetic patients.

Patients who were hypotensive on admission (particularly low diastolic blood pressure) had a higher risk of mortality, a result which had been reported by others.[50]

The results of this study should be interpreted in the context of several limitations. This study was carried out in a single hospital, which is a multispecialty teaching hospital and the particular way in which health care services may be quite different and not representative of other locations. There may be some lead-time bias, since the time of admission as recorded in the hospital episode statistics is not necessarily the same as the time of arrival in hospital, if patients have been assessed in the emergency department before being admitted to the acute cardiac unit. This study is a retrospective one; the data of some patients were not complete due to lack of medical records. Despite these limitations, the results of our study are still comparable to published findings.

Conclusion

The overall mortality of MI in CCU in Basrah is not significantly increased at weekends, but appears to be significantly greater on off-hours time. Therefore, persons responsible for staffing and treatment requirements in CCUs should be aware of the possible increase in mortality in patients with MI admitted during "off hours" and health care providers should continue to work to enhance the health care system during regular and off-hours.

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