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Original Article

Impact of On-Hours Versus Off-Hours Presentation on Mortality in ST-Segment Elevation Myocardial Infarction Patients

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ABSTRACT

Objective: To compare in-hospital mortality rates of ST-Segment Elevation Myocardial Infarction (STEMI) patients based on their admission times, either during on or off hours.
Study Design: Prospective Longitudinal Study.
Place and Duration of Study: Cardiology Department, Ayub Teaching Hospital, Abbottabad Pakistan, from Aug to Dec 2019.
Methodology: This study recruited STEMI patients from a tertiary care hospital. A validated questionnaire was used to collect patient data regarding demographic profiles. Data was collected by consecutive non-probability sampling.
Results: A total of 266 patients were included; 74 were admitted during regular hours, while 192 were admitted during off-hours. There was no significant difference in thrombolysis time between regular and off-hours. In-hospital mortality occurred in 14(18.9%) patients admitted during regular hours and 19(9.9%) patients admitted during off-hours, indicating higher mortality during regular hours (*p*-value =0.040). The door-to-thrombolysis time during either period was not linked to increased mortality. Systolic blood pressure at admission was a significant variable associated with higher mortality (*p*-value =0.001). This suggests that patient disease severity at the time of admission may explain the difference in mortality, rather than the admission time itself.
Conclusion: Mortality difference exists among STEMI patients during on hours and off hours, which is attributed to the severity of disease at admission, and not to the difference in provision of medical care at off time or staff availability. These results suggest that an aggressive treatment protocol should be administered to STEMI patients with hemodynamic compromise.

Keywords: Mortality, Off Hours, On Hours, St-Elevation Myocardial Infarction.

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INTRODUCTION

A major cause of death worldwide is acute ST-elevation myocardial infarction.[1] Reperfusion of the affected vessel with either fibrinolysis or percutaneous coronary intervention (PCI) decreases mortality for ST elevation myocardial infarction (STEMI) patients.[2] There is a greater survival benefit with either therapy when the time from symptom onset to treatment is shorter.[3,4] Therefore, the time from symptom onset to treatment should be considered when choosing between therapies.[5] The open artery theory suggests that rapid achievement of reperfusion of the infarct-related artery with thrombolytic therapy leads to better clinical outcomes.[6] Angiographic studies have supported that there is increased patency of the infarct-related artery and improved survival at 90 minutes but not 180 minutes, suggesting that small differences in reperfusion times cause clinically significant mortality differences.[7]

In most of the hospitals, only emergency services are provided on weekends as compared to weekdays, where routine services are provided. Staffing in hospitals is reduced on weekends and off hours, both in terms of numbers and the availability of expertise.8 This difference in staffing on weekends has an impact on managing patients suffering from acute medical emergencies like myocardial infarction.[9] A delay in providing optimal medical therapy or timely reperfusion to patients during off-hours may contribute to higher mortality.[10]

Given the high incidence and substantial case fatality associated with acute myocardial infarction, even modest increases in mortality during off-hour admissions may meaningfully impact population-level outcomes. Concerns regarding potential delays in care, reduced staffing, and variations in service availability during weekends and nights further underscore the

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need to evaluate temporal disparities in clinical results. Therefore, this study was designed to compare the outcomes of patients presenting with ST-elevation myocardial infarction during off-hours versus regular working hours.

METHODOLOGY

This Prospective longitudinal study was conducted in the Cardiology Department of Ayub Teaching Hospital, Abbottabad Pakistan, a tertiary care, non-primary percutaneous coronary intervention facility hospital. The study was approved by the ethical review committee of the hospital via reference number RC-EA-2023/047. Consecutive patients admitted to the Cardiac Care Unit via emergency department were included in the study from Aug to Dec 2019. The demographic features, clinical characteristics, and outcome of patients who fulfilled the inclusion criteria were recorded on a preformed proforma. The collection of data was stopped after achieving the sample size. The WHO software was used for sample size calculation using the following assumptions: Absolute Precision 5%, Confidence interval 95%, Anticipated population proportion of MI 22.2%,[11] with a sample size of 266. The sample was collected by consecutive non-probability sampling technique.

Inclusion Criteria: Patients of either gender, aged 45 till 65, who experienced chest pain or other symptoms of myocardial ischemia, along with new ECG changes in the ST segment (at least 0.2mv elevation of J point in leads V1, V2, V3, or 0.1 mV in two contiguous leads) or development of a new left bundle branch block were defined as having a ST-segment elevation myocardial infarction.

Exclusion Criteria: The patients who did not receive fibrinolytic therapy or who were referred to our hospital after thrombolysis were excluded from the study.

The door-to-thrombolysis time was defined as the time from when the patient arrived at the hospital ER till the start of fibrinolysis in the CCU (door to drug time). Admissions from Monday to Saturday (8:00 AM to 2:00 PM) were marked as on-hour admissions, while off-hour admissions were during evenings (2:00 PM to 8:00 PM) and night shifts (8:00 PM till 8:00 AM), weekends (Sundays), and public holidays.

The recorded data of patients included demographic features like age, gender, past medical history, disease severity at admission, time from onset of symptoms to arrival at the hospital, and discharge outcome. The indicators of severe disease at admission were hypotension (S.B.P.<90mmHg), hypertension (S.B.P.>180mmHg), tachycardia (H.R.>100 beats/min), or bradycardia (H.R.<60 beats/min). The primary endpoint was all-cause mortality during hospital stay.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Continuous variables were reported as median (IQR), and the Mann-Whitney U test was used to compare age, heart rate, door-to-thrombolysis time, and systolic and diastolic blood pressure between patients. The Chi-square test and Fisher's exact test were used for comparison of categorical variables like gender, diagnosis, past medical history, time of admission, and outcome. The significance level of p was taken to be ≤0.05.

RESULTS

A total of 266 patients were recruited in our study. The median age of the patients was 58.0 years, with the age range between 25–90 years. The number of female patients was 80(30.1%), and male patients was 186(69.9%). The median time from door to thrombolysis was 55.0 minutes, with earliest thrombolysis within 3 minutes, and maximum time for thrombolysis was 307 minutes. The patients admitted were further subdivided according to their disease severity at admission, factors attributed to disease severity included hypotension (systolic blood pressure <90mmhg) or hypertension (>180mmHg). Tachycardia (H.R.> or =100 beats/min) or bradycardia (H.R.<60 beats/min).

Of the total 266 patients enrolled, 192(72.2%) patients presented during the off hours, while 74(27.8%) patients were received during on hours. The average door-to-drug time was prolonged during off hours [55.00(39.02) minutes] compared to the regular hours [53.50(44.00) minutes]. However, the comparison of door-to-thrombolysis times during off hours and on hours came out to be non-significant (p-value =0.928).

During regular hospital hours, 74 patients were treated with fibrinolytic therapy, out of which 14(18.9%) patients died. Of the 192 patients who received care during off-hours, 19(9.9%) patients died. The mortality was higher during on hours compared with off hours (p=0.040). There was no significant association of mortality with door-to-thrombolysis time (p=0.330).

Table-I: Demographic and Clinical Characteristics of Patients Admitted with ST Elevation Myocardial Infarction (n=266)

Parameters	Regular hours (n=74)	Off Hours (n=192)	Total (n=266)
Gender			
Male	48(25.8%)	138(74.2%)	186(100%)
Female	26(32.5%)	54(67.5%)	80(100%)
Diagnosis			
AWMI	39(28.1%)	100(71.9%)	139(100%)
IWMI	22(34.9%)	41(65.1%)	63(100%)
IPWMI	6(27.3%)	16(72.7%)	22(100%)
IWMI+RV	3(18.7%)	13(81.3%)	16(100%)
Others	4(15.3%)	22(84.6%)	26(100%)
Medical History			
Normal	17(22.6%)	58(77.3%)	75(100%)
Hypertension	20(31.7%)	43(68.2%)	63(100%)
Diabetes	03(21.4%)	11(78.5%)	14(100%)
CVA	00(0.00%)	01(100%)	1(100%)
Smoking	06(42.8%)	08(57.1%)	14(100%)
IHD	05(20.8%)	19(79.1%)	24(100%)
Others	07(58.3%)	05(41.6%)	12(100%)
HTN+DM	12(27.2%)	32(72.7%)	44(100%)
HTN+CVA	02(40.0%)	03(60.0%)	5(100%)
HTN+ Smoking	0(0.00%)	04(100%)	4(100%)
HTN+IHD	02(20.0%)	08(80.0%)	10(100%)
Age (years)	56.50(16)	58.00(15)	
Systolic B.P (mmHg)	135.0(34)	140.0(39)	
Diastolic B.P (mmHg)	90.0(21)	90.0(29)	
Heart Rate (bpm)	80.0(23)	83.5(30)	

**AWMI – Anterior Wall Myocardial Infarction*
IWMI – Inferior Wall Myocardial Infarction
IPWMI – Inferoposterior Wall Myocardial Infarction
IWMI + RV – Inferior Wall Myocardial Infarction with Right Ventricular Involvement
CVA – Cardiovascular Accident
HTN – Hypertension
DM – Diabetes Mellitus
IHD – Ischemic Heart Disease
B.P – Blood Pressure

Table-II: Door-to-Thrombolysis Time (minutes)

Parameters	Time Of Admission		*p*-value
	Off Hours (n=192)	Regular hours (n=74)	
Door to thrombolysis time [Median (IQR)]	55.00(39.02)	53.50(44.00)	0.928

Table-III: Regular Versus Off Time Outcomes

Time of Admission	Outcome		*p*-value
	Expired (n=33)	Discharged (n=233)	
Regular Time	14(18.9%)	60(81.1%)	0.040
Off Time	19(9.9%)	173(90.1%)	

DISCUSSION

In our study, the incidence of STEMI among male patients was nearly twice that observed in females, and approximately two-thirds of all cases presented during off-hours. Participants were diagnosed with anterior wall, inferior wall, lateral wall, or inferior wall STEMI with right ventricular involvement, each carrying distinct clinical implications. Most patients either had no significant comorbidities or reported a history of hypertension, diabetes mellitus, ischemic heart disease, or previous cerebrovascular accident. However, neither the type of STEMI nor the presence of past medical conditions demonstrated a significant association with in-hospital mortality. Likewise, patient age and gender did not show a meaningful impact on mortality outcomes in this cohort.

Table-IV: Comparison of Mortality with Baseline and Clinical Characteristics (n=266)

Characteristics	Expired (n=33)	Discharged (n=233)	*p*-value
≤50	10(11.6)	76(88.3)	0.195
>50	23(12.7)	157(87.2)	
Gender			
Male	19(10.2)	167(89.7)	0.076
Female	14(17.5)	66(82.5)	
Door to Thrombolysis time (mins)	60.0(53)	55.0(38)	0.330
Diagnosis at Admission			
AWMI	19(13.6)	120(86.3)	0.679
IWMI	8(12.6)	55(87.3)	
IPWMI	1(4.5)	21(95.45)	
IPWMI + RV	3(18.7)	13(81.2)	
Others	2(7.6)	24(92.3)	
Heart Rate (bpm)	90.0(41)	81.0(26)	0.327
<60	7(23.3)	23(76.6)	
60-110	19(9.45)	182(90.54)	
>110	7(20.*00*)	28(80.00)	
Medical History			
Normal	10(13.3)	65(86.6)	0.572
Hypertension	8(12.6)	55(87.3)	
Diabetes mellitus	4(28.5)	10(71.4)	
CVA	0(0.0)	1(100)	
Smoking	1(7.14)	13(92.85)	
IHD	1(41.6)	23(95.8)	
Others	0(0.0)	12(100)	
HTN+DM	8(18.1)	36(81.8)	
HTN+CVA	0(0.0)	5(100)	
HTN+Smoking	0(0.0)	4(100)	
HTN+IHD	1(10)	9(90)	

AWMI – Anterior Wall Myocardial Infarction
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IWMI + RV – Inferior Wall Myocardial Infarction with Right Ventricular Involvement
CVA – Cardiovascular Accident
HTN – Hypertension
DM – Diabetes Mellitus
IHD – Ischemic Heart Disease
Bpm – Beats per minute

Previous studies, like Hall *et al.*, have demonstrated that advancing age, male gender, and underlying comorbidities are important predictors of mortality in STEMI patients.[13] Additionally, Kwok *et al.*, confirmed that there is a small weekend effect for admission with acute coronary syndrome that has persisted over time.[14] In contrast, our findings did not show these factors to significantly influence in-hospital mortality within our cohort. Vital parameters, including heart rate and non-invasive blood pressure at admission, were systematically recorded, along with the symptom-to-door time. Notably, all patients except one presented within 24 hours of symptom

onset, which may partly explain the lack of association between baseline characteristics and mortality when compared with earlier reports.

In this study, the primary parameter evaluated in relation to in-hospital mortality was the interval from arrival in the emergency department to initiation of thrombolysis in the CCU. This door-to-drug time showed no meaningful variation between off-hour and regular-hour presentations, averaging 67.8 minutes and 66.8 minutes, respectively. Consequently, timing of admission did not emerge as a limiting factor influencing mortality in our cohort. These findings align with report of Lin *et al.,* demonstrating comparable treatment times across different admission periods and similarly showing no excess mortality during off-hour presentations, despite a greater proportion of patients being treated during those times.[15]

The mortality rates reported by Alrawashdeh *et al.,* were higher among patients receiving reperfusion during regular hours. This challenges the idea that mortality is greater during off-hours due to delays in receiving treatment, which are caused by less staff availability and reduced staff performance from sleep deprivation and fatigue.[16] Similar findings have been reported by Thiele *et al.,* conducted at different centers.[17] Further logistic regression analysis showed that most of the excess deaths in patients could be attributed to the severity of their condition at admission, mainly cardiogenic shock, rather than the medical treatments themselves. Patients with cardiogenic shock face additional delays in both emergency departments and inpatient services, as they need extra time to stabilize before reperfusion therapy. This high mortality associated with cardiogenic shock has been confirmed by Namdar *et al*.[18] To improve outcomes, early and aggressive treatment should be provided to patients with STEMI complicated by cardiogenic shock.

As time is an important factor in the management of STEMI, various methods can be adopted to prompt STEMI treatment. One such method is the design of a "STEMI code." It was shown in a study by Scholz *et al.,* that if a "STEMI code" is applied, it aids in early treatment by preventing time wastage due to contemporary work and decreasing the patients' waiting time before initiation of treatment.[19] Another study by Scholz *et al.,* showed that field triage of STEMI patients reduced treatment delays, improving outcomes. It also showed that patients with STEMI complicated by cardiogenic shock showed considerable benefit with rapid reperfusion. An ECG is obtained by the ambulance staff and sent to an expert doctor at an invasive care center for evaluation.[20] Upon suspicion of a STEMI, the patient is directly field-triaged to the nearest invasive care center, bypassing the local hospital and minimizing the transfer time. By bypassing the Emergency department, there was a gain in survival, especially in patients complicated by cardiogenic shock.

Similarly, Henry *et al.,* determined that the SHOCK trial (SHould we emergently revascularize Occluded Coronaries for Cardiogenic shock) confirms the fact that early revascularization plays a vital role in the management of STEMI patients with cardiogenic shock.[21] Therefore, prompt reperfusion of STEMI patients complicated by cardiogenic shock is a key feature of management; therefore, special attention should be paid to such patients under treatment in Coronary care units.

Mortality differences between STEMI patients admitted during on-hours and off-hours are primarily linked to the severity of the disease at presentation rather than variations in medical care or staff availability during off-hours.[22] This indicates that patients arriving during off-hours often have more advanced hemodynamic compromise, requiring heightened clinical vigilance. Therefore, an aggressive treatment protocol tailored to address the hemodynamic instability in STEMI patients should be prioritized regardless of admission time to improve survival outcomes.

LIMITATION OF STUDY

The authors could not demonstrate that admission time independently affected STEMI mortality. Our cohort included all-comer patients, from stable cases to those in cardiogenic shock, across all shifts, which may have diluted any shift-based differences. We also did not account for the quality or success of resuscitative efforts, and patients admitted during on-hours continued to receive care during off-hours, potentially balancing any staffing-related effects. Pre-hospital factors, such as time since onset of pain, were not further stratified and may have determined outcomes before hospital care became relevant, though these factors likely influenced both groups similarly. Finally, the unequal group sizes reflected real-world admission patterns, with more patients presenting during off-hours; this reduced the likelihood of bias from smaller off-hour numbers.

CONCLUSION

Mortality difference exists among STEMI patients during on hours and off hours, which is attributed to the severity of disease at admission and not to the difference in provision of medical care at off times or staff availability.

These results suggest that an aggressive treatment protocol should be administered to STEMI patients with hemodynamic compromise.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SQM & FQ: Data acquisition, data analysis, critical review, approval of the final version to be published.

IK & SA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

SIK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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