original article

Are acute coronary syndrome patients admitted during off-duty hours treated differently? An analysis of the Saudi Project for Assessment of Acute Coronary Syndrome (SPACE) study

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BACKGROUND AND OBJECTIVES: It is often suggested that acute coronary syndrome (ACS) patients admitted during off-duty hours (OH) have a worse clinical outcome than those admitted during regular working hours (RH). Our objective was to compare the management and hospital outcomes of ACS patients admitted during OH with those admitted during RH.

DESIGN AND SETTING: Prospective observational study of ACS patients enrolled in the Saudi Project for Assessment of Acute Coronary Syndrome study from December 2005 to December 2007.

PATIENTS AND METHODS: ACS patients with available date and admission times were included. RH were defined as weekdays, 8 AM-5 PM, and OH was defined as weekdays 5 PM-8 AM, weekends, during Eid (a period of several days marking the end of two major Islamic holidays), and national days.

RESULTS: Of the 2825 patients qualifying for this analysis, 1016 (36%) were admitted during RH and 1809 (64%) during OH. OH patients were more likely to present with heart failure and ST elevation myocardial infarction (STEMI) and to receive fibrinolytic therapy, but were less likely to undergo primary percutaneous coronary interventions (PCI). The median door to balloon time was significantly longer ($P<.01$) in OH patients (122 min) than in RH patients. No differences were observed in hospital outcomes including mortality between the two groups, except for higher heart failure rates in OH patients (11.1% vs 7.2%, $P<.001$).

CONCLUSIONS: STEMI patients admitted during OH were disadvantaged with respect to use and speed of delivery of primary PCI but not fibrinolytic therapy. Hospitals providing primary PCI during OH should aim to deliver it in a timely manner throughout the day.

A favorable clinical outcome in patients with acute coronary syndromes (ACS) depends on the timely delivery of proven therapies.[1-3] In patients with ST elevation myocardial infarction (STEMI), a short door to needle time (DNT) and a door to balloon time (DBT) are evidence-based quality indicators for optimal reperfusion associated with improved survival.[1,3,4] Hospitals provide routine care during regular working hours (RH), while only providing emergency care during off-duty hours (OH), weekends, and holidays.[5] Previous studies suggest that outcomes are worse in ACS patients presenting to the hospital during OH.[5,6] Such a disparity may be more pronounced in developing countries because of general shortages in health care professionals and poor health care service management.[7]

Despite tremendous improvement in cardiac care in Saudi Arabia, patterns of medical practice and hospital outcomes for ACS patients presenting during OH is still unknown. We sought to evaluate the potential inequality in management and in-hospital outcomes of patients enrolled in the Saudi Project for Assessment of Acute Coronary Syndrome (SPACE) who presented during RH and OH.

PATIENTS AND METHODS

The SPACE study was a prospective, multicenter, observational study of all consecutive acute coronary syndrome (ACS) patients admitted to participating hospitals from the start of December 2005 until the end of December 2007. A full description of the design was previously reported.[8] Seventeen hospitals from five regions of Saudi Arabia participated in the registry. Centers involved were from the following cities: Riyadh, Jeddah, Dammam, Buraidah, Tabuk, Khamis Mushayt, and Al Kharj. All participating hospitals were in urban areas. A total of 70% of these hospitals had cardiac catheterization laboratories, and 60% had on-site cardiac surgery backup. Only two centers had a primary percutaneous coronary interventions (PCI) programs for all STEMI comers; however other centers offered primary PCI sporadically. Where required, ethics approval was obtained from the institutional review board of individual hospitals. The diagnosis of STEMI, non-ST elevation myocardial infarction (NSTEMI), unstable angina, and other adverse endpoints analyzed in this study were based on the definitions of the Joint Committee of the European Society of Cardiology/American College of Cardiology, published in December 2001.[4] Patients with the diagnosis of NSTEMI and unstable angina were grouped in the category of non-ST elevation acute coronary syndrome (NSTEACS).

Data collection was performed using a standardized case report form. Collected data included patient demographics, past medical history, provisional diagnosis on admission and final discharge diagnosis, electrocardiographic findings, laboratory investigations, medical therapy, use of cardiac procedures and interventions, in-hospital outcomes, and overall mortality.

Study patients

Admission date and time information was required for all ACS patients enrolled in the SPACE registry to be included in this analysis. Patients referred from other hospitals were excluded, as their referral was mostly planned and details on their admission times in the referring hospital was not available. Patients were assigned to the RH group if they were admitted during regular duty hours between 8 AM and 5 PM. In the OH group were patients admitted between 5 PM and 8 AM, weekends defined as Wednesday 5 PM to Saturday 8 AM, religious holidays (two Eid holidays), and the national day holiday. This classification was mainly based on differences in staffing between the two time periods. Baseline characteristics, clinical presentations, and in-hospital therapies were compared between groups. Outcome measures included: in-hospital all-cause mortality, reinfarction, heart failure, cardiogenic shock stroke, and major bleeding.

Statistical analysis

Categorical data are presented as frequencies and percentages, and continuous data were summarized using means and SD or medians and interquartile ranges based on satisfying the normality assumption. Statistical comparisons between the RH and OH groups were carried out using chi-square test for categorical variables and independent *t* test or Mann-Whitney U test as appropriate for continuous variables. All analyses were performed using SPSS software (IBM Corp, Armonk, NY USA).

RESULTS

Of the 5055 ACS patients admitted to Saudi hospitals during the study period, 2230 were excluded as they were referred from other centers. Of the remaining patients only 2825 (55.9%) had details on admission times and were included in this study. The majority of patients (1809, 64%) were admitted during off hours, while 1016 (36%) were admitted during regular hours. **Table 1** reports baseline characteristics of both groups. The mean (SD) age of the study population was 57.7 (13.2) years; the population was predominately male and composed of Saudi nationals. Diabetes mellitus and hypertension were highly prevalent (56.8% and 56.3%, respectively). In addition, vascular disease in the form of coronary artery disease, peripheral arterial disease, and cerebrovascular disease were found in at least half of the study cohort.

Baseline characteristics and clinical presentation were similar between patients presenting in RH and those presenting in OH. Differences included a higher baseline creatinine and a lower rate of prior PCI in the OH group. OH patients were more likely to present with heart failure (24% vs 19.1%, P=.002), tachycardia (17.4% vs 10.1%, P<.001), and presented to the hospital earlier following symptom onset (105 min vs 137 min, P<.001). In addition, STEMI patients presented more often in OH than RH (762 [42.1%] vs 377 [37.1%], P=.009, respectively), while NSTACS patients pre-

Table 1. Baseline patient characteristics.

	Overall (N=2825)	Regular hours (n=1016)	Off hours (n=1809)	*P*
Age (mean, SD)	57.7 (13.2)	57.9 (13.2)	57.6 (13.3)	.573
Males (%)	2216 (78.4)	802 (28.9)	1414 (78.2)	.632
Saudi (%)	2197 (77.8)	797 (77.8)	1400 (77.4)	.518
Diabetes mellitus (%)	1603 (56.8)	584 (57.5)	1019 (56.4)	.566
Hypertension (%)	1591 (56.3)	571 (56.2)	1020 (56.4)	.870
Smoking (%)	953 (33.9)	324 (31.8)	629 (34.7)	.115
Dyslipidemia (%)	291 (25.9)	105 (28.2)	186 (24.7)	.456
Waist circumference (median, IQR)	98.0 (18)	99 (19)	98 (18)	.649
BMI (median, IQR)	27.7 (6.3)	27.7 (6.2)	27.7 (6.4)	.681
Symptom to admission time (median, min)	120 (173)	137 (190)	105 (165)	<.001
History of coronary artery disease (%)	482 (47.5)	797 (44.1)	1279 (45.3)	.075
Prior PCI (%)	456 (16.1)	179 (17.6)	277 (15.3)	.009
Prior CABG (%)	183 (6.5)	65 (6.4)	118 (6.5)	.092
History of PAD (%)	124 (4.4)	363 (3.5)	88 (4.9)	.277
History of CVA (%)	179 (6.3)	56 (5.5)	123 (6.8)	.092
Creatinine, µmol/dl (median, IQR)	92.0 (32)	90.0 (26)	92.0 (29)	.001
Hemoglobin g/dL (median, IQR)	14.0 (3)	14 (2)	14 (3)	.721
FBS, µmol/dL (median, IQR)	6.6 (4)	6.6 (4)	6.7 (4)	.516
HR >100 bpm (%)	417 (14.8)	103 (10.1)	314 (17.4)	<.001
SBP ≤90 mm Hg (%)	81 (2.9)	30 (3.0)	51 (2.8)	.631
Heart failure (%)	627 (22.3)	193 (19.1)	434 (24.0)	.002
STEMI <12 hr (%)[a]	927 (81.4)	309 (81.9)	618 (81.1)	.441
Anterior STEMI (%)[a]	623 (56.1)	221 (59.8)	402 (54.2)	.772
ECG to admission time, min (median, IQR)	14 (16.5)	10.0 (16.0)	10.0 (15.0)	.405
LVEF <35% (%)	881 (31.2)	306 (30.1)	575 (31.8)	.359
3V or LM coronary disease (%)	621 (22)	233 (22.9)	388 (21.4)	.360

BMI: Body mass index; IQR: interquartile ranges; SD: standard deviation; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; PAD: peripheral arterial disease; CVA: cerebrovascular accidents; HR: heart rate; SBP: systolic blood pressure; STEMI: ST elevation myocardial infarction; ECG: electrocardiography; LVEF: left ventricular ejection fraction; 3V: three vessel; LM: Left main.

[a]Proportions were out of the total STEMI patients.

Table 2. Hospital therapies.

	Overall (N=2825)	Regular hours (n=1016)	Off hours (n=1809)	*P*
Aspirin (%)	2775 (98.5)	991(97.9)	1784 (98.8)	.075
Clopidogrel (%)	2458 (87.3)	879 (86.9)	1579 (87.5)	.635
Beta-blockers (%)	2369 (84.1)	869 (85.9)	1500 (83.1)	.050
Statins (%)	2722 (96.6)	980 (96.8)	1742 (96.5)	.592
ACE I (%)	2002 (71.0)	727 (71.8)	1275 (70.6)	.486
ARB (%)	179 (6.4)	57 (5.6)	122 (6.8)	.238
Heparin (%)	2544 (90.1)	887 (87.5)	1657 (91.6)	<.001
GP 2b 3a inhibitors (%)	838 (29.7)	303 (29.9)	535 (29.6)	.864
Fibrinolytic use (%)[a]	653 (70.4)	199 (64.4)	454 (73.5)	.004
ECG to admission time, min (median, IQR)	14 (16.5)	10.0 (16.0)	10.0 (15.0)	.405
DNT (median, IQR)	54 (60)	50.0 (52.5)	54.5 (67.2)	.336
DNT <30min (%)[b]	94 (14.4)	26 (13.2)	68 (15.0)	.553
Fibrinolytic short fall (%)	208 (14.4)	81 (7.9)	127 (7)	.352
Primary PCI (%)[a]	158 (17)	66 (21.4)	92 (14.9)	.014
DBT Median, min (IQR)	110.5 (72.8)	96 (49)	122 (92)	.002
DBT <90 min (%)	46 (31.1)	24 (39.3)	22 (25.3)	.069
Hospital length of stay, days (median, IQR)	5 (5)	5 (5)	5 (5)	.802

ACEI: Angiotensin-converting enzyme inhibitor; ARB: Angiotensin receptor blocker; GP 2b 3a inhibitors: glycoprotein 2b 3a inhibitors; DNT: door to needle time; DBT: door to balloon time; Fibrinolytic short fall: eligible for fibrinolytic therapy but did not receive it; IQR: interquartile ranges; SD: standard deviation.

[a]Proportions were out of the STEMI patients presenting within 12 hours of chest pain onset; [b]Proportions were out of STEMI patients receiving fibrinolytic therapy.

Table 3. In-hospital outcomes.

Outcome	Overall (N=2825)	Regular hours (n=1016)	Off hours (n=1809)	*P*
Overall death (%)	92 (3.3)	32 (3.2)	60 (3.3)	.234
Death in STEMI	57 (5)	17 (4.5)	40 (5.2)	.590
Overall re-infarction	30 (1.1)	11 (1.1)	19 (1.1)	.935
Major bleeding	36 (1.3)	17 (1.7)	19 (1.1)	.157
Stroke/TIA	23 (0.8)	9 (0.9)	14 (0.8)	.751
Heart failure	273 (9.7)	73 (7.2)	200 (11.1)	<.001
Cardiogenic shock	125 (4.4)	35 (3.4)	90 (5.0)	.058

STEMI: ST elevation myocardial infarction; TIA: transient ischemic attacks.

sented more often during RH than OH (637 [62.8%] vs 1047 [57.8%]), *P*<.001, respectively). The predominant STEMI location was anterior (56.1%) (**Table 1**).

Hospital therapies

Distribution and frequencies of in-hospital therapies dispensed to patients were similar between groups with the exception of beta-blockers, heparin, and fibrinolytic agents (**Table 2**). Heparin and fibrinolytic agents were given more frequently and beta-blockers were given much less frequently to patients presenting during OH. No significant differences were observed between the two groups with regard to DNT or the proportion of patients meeting a DNT <30 min. Primary PCI was performed in only 17% of the study cohort; however it was performed less in STEMI patients presenting during OH. In addition, the DBT was significantly longer. A DBT ≤90 minutes was achieved in only 31.1% of the overall cohort, with a statistical trend toward a lower proportion of patients meeting this quality indicator if admitted during OH periods (**Table 2**).

In-hospital outcomes

Table 3 shows hospital outcomes of the two groups. No significant differences were observed in hospital outcomes except for significantly higher heart failure events in the OH group (11.1% vs 7.2%, *P*<.001). A marginal trend for a higher occurrence of cardiogenic shock was observed in OH patients compared to those admitted during RH.

DISCUSSION

The results of this analysis provide insights into "real world" management of ACS patients in Saudi Arabia according to the time and day of admission. We found that higher risk ACS presentations, namely, STEMI and heart failure, were seen more frequently during OH. These findings are concordant with some previous reports[6,9,10] but disagree with others.[11-13] Additionally, although PCI was not used frequently in this ACS cohort as a whole, primary PCI was used less in OH patients; when performed, significant delays in DBT were observed both in absolute time and in the proportion of patients achieving a target of less than 90 minutes. Only 2 hospitals out of the 17 participating hospitals offered primary PCI as a default reperfusion strategy for all STEMI comers. This explains to a large extent why this study included a small number of patients receiving primary PCI. Numerous reports showed similar delays in the performance of primary PCI.[6,10,12] Despite the higher risk profile of patients admitted during OH and delays in the performance of primary PCI in STEMI patients in OH patients, no difference in hospital outcomes was observed, except for a significantly higher heart failure rates and a trend toward more cardiogenic shock among patients presenting during OH. The higher in-hospital heart failure rate seen in OH patients is potentially due to the higher rate of heart failure on initial hospital presentation. Data on hospital outcomes in ACS patients admitted during off-hour periods is conflicting. Magid et al showed that patients presenting during OH had significantly higher adjusted in-hospital mortality than patients presenting during RH.[6] A similar finding was demonstrated using the Myocardial Infarction Data Acquisition System, which analyzed 231 164 AMI patients. Both short- and long-term mortality was higher in patients admitted on weekends compared to those admitted on weekdays.[5] On the other hand, our study confirmed the findings of numerous other reports that did not show any difference in adverse outcomes.[9-12] The more frequent administration of fibrinolytic agents in the OH group most likely stems from the fact that STEMI was the predominant presentation in that time period; however, it is unclear why heparin was utilized more frequently in the OH group. Although no differences in DNT were observed between the two groups, it must be stated that the absolute DNT in both groups was significantly longer than the standard DNT of less than 30 minutes. This is a significant care gap that needs to be narrowed by training and empowering emergency care physicians, the first responders to STEMI patients, to administer fibrinolytic agents in a timely manner.

An intriguing finding in this study was that the symptom onset to admission time was shorter in patients presenting during OH times. The reasons behind this observation are unclear; a possible explanation is that STEMI and heart failure, both seen more in OH patients, generally present with more severe symptoms than with NSTEACS patients, leading to a greater urgency in presenting to the emergency room. Another possible explanation is easier access to care during OH owing to less traffic or pressure on the emergency rooms in off hours, weekends, or holidays. Woman are not permitted by law to drive in Saudi Arabia. This may have been a potential factor in delays seen in hospital presentation, or presentation during OH when a male family member is available after work hours for transportation.

Our study suffers from several limitations. This is an observational study; therefore selection bias inherent in the study design could not be avoided. Although we found disparities in the utilization and rapidity of delivering primary PCI between the 2 groups, this did not seem to have an impact on hospital mortality; this

might be because of the small sample size. In addition, data on post-discharge outcomes were not available, and we could not assess the impact of hospital therapeutic disparities on long-term outcomes. A considerable number of patients had missing admission times, which produces potential bias in either direction that might impact study results.

In conclusion, our findings suggest that ACS patients who presented during OH were likely to have a higher risk profile on admission but were generally treated equally to their counterparts presenting during regular hours, except for a lower utilization of primary PCI and longer delays in DBT when primary PCI was performed. Patients presenting in off hours suffered from higher rates of heart failure, but were no different with respect to other hospital outcomes compared to patients admitted during regular hours. These findings highlight existing disparities in health care services delivery in Saudi Arabia, and are potentially related to inadequate staffing and/or staff fatigue during off hours. Moreover, although primary PCI has been shown to be more efficacious in achieving reperfusion in STEMI patients, only a few centers offered it. Future research should address the root causes for such care gaps, and explore the clinical impact for implementing quality initiatives to improve these management shortfalls.

Acknowledgments and Conflict of Interest

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