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Comparison of Outcomes for Non-ST Elevation Acute Myocardial Infarction in Weekday vs Weekend Admissions: The Weekend Effect

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Abstract

Background: Recent literature shows that reduced staffing over the weekends in hospitals may compromise patient care with acute conditions like acute coronary syndrome (ACS).

Objective: Our study evaluated differences in the outcomes between patients presenting with non-ST segment elevation acute coronary syndrome (NSTEMI-ACS) on weekends versus those coming on weekdays.

Methods: A single-center retrospective study was performed on NSTEMI-ACS patients. Data were analyzed using SPSS version 22 to calculate an independent sample t-test value for significance between the two groups.

Results: The mean DTB time for patients admitted over the weekend was significantly higher than those admitted over weekdays ($p = 0.000$). The mean peak troponin level and length of stay (LOS) for patients admitted over the weekends vs. weekdays was significantly higher by 5 ng/dL (9.71 ± 5.23 vs. 4.194 ± 2.60 , $p = 0.0001$) and 24 h (72 ± 10 vs. 48 ± 6 h, $p = 0.003$), respectively. While the mean left ventricular ejection fraction (EF) of patients on discharge was lower by 5% for patients admitted over the weekend compared to patients admitted on weekdays ($p = 0.001$).

Conclusion: NSTEMI-ACS patients admitted over the weekends have a significantly higher myocardial injury evidenced by an increased LOS, higher peak troponin levels, and reduced EF due to delayed PCI compared to weekday admissions.

Keywords: NSTEMI-ACS (Non-ST segment Elevation acute coronary syndrome), STEMI (ST-Segment elevation myocardial infarction), Acute coronary syndrome (ACS), Ejection fraction (EF), Door to balloon time (DTB)

1. Introduction

Although ACS is a major cardiovascular disease with a high mortality rate, the timely medical intervention has proven beneficial effects. A DTB within 90 min of ST-segment elevation myocardial infarction (STEMI) presentation is the standard recommendation, but no such protocol is in place for NSTEMI-ACS.¹ There has been a paucity of evidence regarding the optimal timing of PCI for these patients, especially for patients presenting over the weekend.^{2,3} The average wait time for

percutaneous intervention in patients presenting over the weekend has been longer compared to weekdays admission, potentially putting these patients at risk of complications.^{2,3} Some recent studies have also identified higher mortality in patients due to variations in the intensity of diagnostic and therapeutic interventions associated with weekend vs. weekday admissions.⁴ However, there has been no concrete data to identify the outcomes and burden of these patients. This study sought to determine to compare the cardiovascular outcomes of patients treated on the weekends compared to weekdays.

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2. Methods

2.1. Data acquisition

A retrospective observational chart review of patients admitted to Abington Hospital – Jefferson Health was performed from January 2014–October 2016 with a primary diagnosis of NSTEMI-ACS. The study population was divided into weekday and weekend groups. The measured outcomes included peak troponin levels, door to balloon time (DTB), and length of hospital stay (LOS). Patients were retrospectively stratified by looking at patients charts. Both groups were matched with respect to their anginal pain scale and response to the medications. The two groups were also matched based on the major risk factors. There was no significant difference in the weekend vs. weekdays groups in terms of baseline characteristics, hypertension (85% vs. 84%), diabetes mellitus (51% vs. 50%), prior MI (17% vs. 18%), hyperlipidemia (73% vs. 76%) and prior history of smoking (12% vs. 10%), respectively. Logistics, data collection form was used to compare different variables.

All data were recorded in a de-identified manner. All patients selected for the study were assigned a unique study identification number. This study identification number was not linked back to identifiable information about the subject. The medical information gathered during the study was treated with confidentiality except as may be required by the law. If requested, information will be provided to the Institutional Review Board and the U.S. Food and Drug Administration. All data collected for the study were stored on a password-protected network hard-drive and will be destroyed after five years.

2.2. Selection criteria

The detailed selection criteria are given in [Table 1](#) below. Patients were matched based on their baseline characteristics, as shown in [Table 2](#).

Table 1. Inclusion and exclusion criteria.

Inclusion Criteria	
•	All patients above the age of 18 admitted with the diagnosis of NSTEMI-ACS (NSTEMI)
•	Weekend group (Friday 17:00 to Sunday 00:00)
•	Weekday group (Sunday 00:00 to Friday 17:00)
Exclusion Criteria	
•	Misdiagnosis
•	Patients who were transferred to another acute care hospital
•	Patients who left against medical advice on index admission
•	Readmission for elective Percutaneous coronary intervention (PCI) and Coronary artery bypass graft (CABG)

Table 2. Demographic and clinical characteristics of population.

Variable	Weekdays Group	Weekends Group
Male (%)	78%	79%
Risk factors		
HTN	85%	84%
DM	51%	50%
Prior MI	17%	18%
HLD	73%	76%
Smoking	12%	10%

2.3. Data analysis

Data were summarized using descriptive statistics such as means, standard deviations, medians, and frequencies. Inferential statistics such as receiver operating characteristic curve (ROC), analysis of variance, t-tests, and chi-square analysis were performed where appropriate. All p-values were two-tailed, and a level of <0.05 was considered significant. The analysis was performed using SPSS version 22.

3. Results

The mean DTB was stratified into less than 12 h, 12–24 h, and greater than 24 h. About 92% of weekday's patients had PCI within 12 h of admission compared to 0% of patients admitted over the weekends ($p = 0.000$). Among the weekend group, 78% had intervention done within 12–24 h, and 22% had PCI after 24 h. These timings were significantly delayed compared to weekdays admissions with a p-value of $p = 0.001$ and $p < 0.001$, respectively. The peak means troponin level of patients admitted over the weekends was 9.71 ± 5.23 (95% CI, 8.22–11.20), significantly lower ($p = 0.001$) compared to weekdays patients (4.194 ± 2.60 , 95% CI 3.45–4.93). The mean left ventricular ejection fraction of patients on discharge was 48.10 ± 8.50 (95% CI 45.68–50.52) for patients admitted over the weekend compared to 53.8 ± 6.74 (95% CI 51.88–55.72) on weekdays. This mean difference between the EF also reached a statistical significance ($p = 0.001$). The mean LOS for patients admitted over the weekends was significantly higher ($p = 0.003$), which is $72 \text{ h} \pm 10$ compared to $48 \pm 6 \text{ h}$ for weekday patients. The detailed values are given in [Table 3](#).

4. Discussion

Many hospitals typically operate with significantly reduced staffing over the weekends. According to some authors, this results in a shortage of available expertise, leading to a lower use of invasive cardiac procedures.⁵ This effect is mostly seen in patients

Table 3. Comparison of weekday vs. weekend admissions outcomes.

Variable	Weekday (N = 50) Mean ± SD (CI)	Weekend (N = 50) Mean ± SD (CI)	P value
Age	68.64 ± 10.04 (65.78–71.50)	62.32 ± 11.15 (59.15–65.49)	0.08
Peak Troponin	4.19 ± 2.60 (3.45–4.93)	9.71 ± 5.23 (8.22–11.20)	0.001
LV function	53.80 ± 6.74 (51.88–55.72)	48.10 ± 8.50 (45.68–50.52)	0.001
LOS	48 ± 6 h	72 ± 10 h	0.003
Door to Balloon Time (hours)	46	0	0.000
<12			
12–24	4	39	0.001
>24	0	11	<0.001
30-day MACE Risk			
Ventricular arrhythmias	0	1	–
CHF	0	1	–
MI	0	0	–
Death	0	0	–

whose medical condition is thought to be of less urgent attention, such as NSTEMI-ACS, compared to STEMI, potentially putting these patients at higher risk of grave cardiovascular outcomes.⁵ Our results showed that patients admitted over the weekend were inappropriately delayed to undergo PCI by more than 12–24 h compared to a matched cohort of patients with a similar disease and symptoms presenting on the weekdays. This delay had a detrimental effect on the myocardial necrosis, as evidenced by a substantial increase in the mean overall increase in the troponin level and reduced ejection fraction. According to the 3rd universal definition of MI, the degree of troponin leak corresponds directly with severity NSTEMI-ACS. This effect was most remarkable in the weekend group and the loss of myocardial function was reflected as a remarkable loss of ejection fraction in the weekend group. The mechanism of myocardial injury and increased troponin leak in the weekend group was prolonged ischemia and unnecessary delay of PCI. This also resulted in a mean net increase of LOS by about 24 h in patients admitted over the weekend, putting a high financial burden on the health care resources.

CAD is the number one cause of mortality in the western world. According to the World Health Organization (WHO) report, worldwide CAD-related mortality in 2012 peaked up to 7.4 million. The estimated annual incidence of ACS in the United States is projected to be more than 780,000 people by year.⁶ NSTEMI-ACS contributes to the majority of ACS cases, comprising about 70% of the total ACS cases (more than 625,000 cases annually). Despite a substantially higher burden of NSTEMI-ACS, the level of care provided to these patients has traditionally been less aggressive. Studies have shown that the prognosis of NSTEMI-ACS patients in the long-run has been poor if treated conservatively compared to

patients who had PCI.⁷ The mortality in the conservative group was around 30% compared to 2% in the invasive management at long-term clinical follow-up.⁷ Similarly, NSTEMI-ACS patients who had PCI later during hospitalization are shown to do worse compared to patients who were treated in a timely and more urgent manner. Studies have identified logistical challenges in terms of lower onsite staffing and unavailability of experts over the weekends as a major cause of delayed PCI in NSTEMI-ACS.⁸ Agarwal et al. reported higher in-hospital mortality in these patients by 5.9% if admitted over the weekend compared to 5.3% in patients admitted over weekdays.⁸ Our study compared a wide range of cardiovascular outcomes beyond mortality, such as the LOS, troponin rise, and loss of cardiovascular function between these patients and patients admitted on weekdays.

We highlighted that a delayed PCI in patients with NSTEMI-ACS has more troponin leak indicating a more severe cardiovascular injury and on-going necrosis. This effect was further elucidated by a significant drop in the mean left ventricular function of weekend patients at the time of discharge. One can rightly argue that decisions about PCI timing in NSTEMI-ACS patients is primarily based on the hemodynamic instability, electrical instability, or refractory ischemia and not on the timing of presentation. To adjust for these confounding factors, we have matched the two groups based not only on their risk factors but also on their demographics and presentation. This resulted in the exclusion of 70 patients out of the initially 170 screened patients. The primary reason for exclusion was that patients were not sick enough to undergo PCI or had unmatched risk factors.

This study is subject to several limitations. The main limitation of this study is a relatively small sample size due to a stringent matching criterion. To

avoid detection bias due to inter-institutional differences in PCI techniques and anti-thrombotic agents, only a single study center data was analyzed. The patient enrollment was confined only to patients who underwent PCI, and hence, the results cannot be extrapolated to patients treated medically or with CABG. Furthermore, we could not do randomization and allocation concealment of the included population due to the retrospective nature of the study. This potentially could have introduced some selection bias, but the matching of the two groups reduced this risk. Our study was underpowered to compare the major adverse cardiovascular event rate and mortality. A large-scale prospective analysis or randomized controlled trial is needed to further clarify these outcomes.

5. Conclusion

NSTE-ACS patients, if admitted over the weekends, have a higher risk of myocardial injury (raised troponin and reduced EF) and increased hospital stay due to delayed PCI compared to patients admitted on weekdays. Efforts should be made to enable adequate staffing and emergent cardiac catheterization facilities for NSTE-ACS patients over the weekends.

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Conflict of interest

None.

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