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Clinical paper

Out of hospital cardiac arrest outcomes: Impact of weekdays vs weekends admission on survival to hospital discharge



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Abstract

Background: Cardiac arrests are a leading cause of mortality with survival of only 12%. In the United States, cardiac arrests were significantly more likely to occur on Saturdays. Hospitals experience a decrease in staffing on weekends. This study aims to assess the relationship between weekend vs weekday admission and outcomes of patients presenting with out of hospital cardiac arrests (OHCA) in the United States.

Methods: This retrospective study utilized the 2014 US National Emergency Department Sample (NEDS) database. Patients who sustained out of hospital cardiac arrests were included using ICD-9-CM codes. Descriptive analysis was conducted, followed by bivariate analysis to compare the collected variables by admission day. Multivariate analysis was done to assess the impact of weekday vs weekend admission on survival of cardiac arrests patients after adjusting for confounders.

Results: A total of 145,774 patients with cardiac arrest were included in this study. Mean age was 65.9 years with male predominance of 61.8%. Almost 71% of cardiac arrests took place on a weekday. As an overall outcome, only 5.7% patients survived to hospital discharge. After adjusting for significant confounders, patients presenting on weekends were less likely to survive compared to those admitted on weekdays (OR = 0.833, 95% CI: 0.727–0.954).

Conclusion: In this study, patients with OHCA admitted to the ED on weekends had slightly lower survival compared to those admitted on weekdays. Modifiable factors should be identified in future studies to reduce outcome discrepancies and improve survival in this patient population.

Keywords: Out of hospital cardiac arrest, Weekend, Weekday, Survival, Outcome

Introduction

Cardiac arrest is a leading cause of mortality in the United States affecting over 350,000 persons per year, with an overall reported survival of only 12%.¹ Previously reported poor predictors of outcomes include older age, longer time from collapse to Cardiopulmonary Resuscitation (CPR), and from collapse to the first defibrillation.² On the other hand, factors that lead to better outcomes and increased survival include witnessed cardiac arrests, in addition to ventricular fibrillation or tachycardia as initial cardiac rhythms.³

The difference in frequencies of out of hospital cardiac arrest (OHCA) by day of the week has been previously examined. In the United States, cardiac arrests were significantly more likely to occur on Saturdays.⁴ This is important since hospitals tend to experience a decrease in staffing on weekends and holidays compared to weekdays which usually affects regular floors, intensive care units, operating rooms and emergency departments.

Differences in patient outcomes when comparing weekdays to weekends have also been previously described in the literature for specific diagnoses. In older studies out of Canada, higher in-hospital mortality was found in patients admitted on weekends with specific

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diagnoses, including ruptured abdominal aortic aneurysms, acute epiglottitis and pulmonary embolism.⁵ Moreover, patients admitted with acute myocardial infarcts on weekends were less likely to receive catheterization, angioplasty and bypass and thus experience worse outcomes compared to those who presented on weekdays.⁶ A more recent study of in-hospital cardiac arrests (IHCA) in US hospitals that participate in the National Registry of Cardiopulmonary Resuscitation, reported lower survival rates for adult patients with IHCA occurring on weekends (17.4% [95% CI, 16.8%–18%] compared to weekdays (20.6% [95% CI, 20.3%–21%]).⁷ Another study by Ofoma et al. used data from the Get with the Guidelines Resuscitation registry of IHCAs in the US and reported lower survival for patients with IHCA during off-hours (nights and weekends) compared to on-hours (16.8% vs 20.6%, $p < 0.0001$).⁸ Similar findings of lower survival for IHCAs occurring on weekends (16.1%) compared to weekdays (19.3%) were also reported in hospitals in the United Kingdom.⁹

To date, studies that examined temporal variability in outcomes of OHCA did not identify similar patterns and reported no difference in survival to discharge for OHCA occurring on weekends vs weekdays.^{4,10} This study aims to assess further the relationship between weekend vs weekday admission and survival in patients presenting with out of hospital cardiac arrests in the United States using a national ED database.

Methods

Study design

This retrospective observational study utilized the Nationwide Emergency Department Sample (NEDS) database of the year 2014 (released in 2017). NEDS is a database developed for the Healthcare Cost and Utilization Project (HCUP) and is the largest Emergency Department database in the United States with more than 30 million visits every year.¹¹ In 2014, there were a total of 137,807,901 weighted visits from 945 EDs in 33 states.¹²

Members of the research team completed the HCUP training course and signed the Nationwide Data Use Agreement. Exemption from the Institutional Review Board of the American University of Beirut was granted for utilizing this de-identified dataset.

Adult patients above 18 years of age who presented with “out of hospital cardiac arrest” were included in this study. They were identified by using Clinical Classification Software (CCS) code 107.¹³ CCS is grouping of patient diagnoses and procedures utilized by the Agency of Healthcare Research and Quality (AHRQ) to facilitate statistical analysis. It utilizes the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) to divide the data into clinically relevant groups.¹³ Patients with cardiac arrest related ICD-9-CM or CCS code 107 listed as “first listed diagnosis” (i.e., “the diagnosis, condition, problem or other reason for encounter/visit shown in the medical record to be chiefly responsible for the services provided”) were included.¹⁴ Only patients with confirmed outcomes (died in the ED or admitted to the same hospital) were included in this study. Patients who were discharged or transferred from ED were excluded. Variables that were included in this study were patient demographics, chronic conditions, day and season of admission, procedure details and outcomes (ED, hospital and overall). Weekdays were considered from Monday to Friday, whereas weekends were Saturday and Sunday.

Statistical analysis

Statistical analyses were carried out using the Statistical Package for Social Sciences (IBM-SPSS, 24). Age was presented by its median (interquartile ranges) and mean with associated standard deviation (\pm sd) whereas all categorical variables were described as frequencies, percentages and 95% CI. To compare the proportion of the categorical variables and the mean age by the two groups of the admission day (weekday vs weekend), a modified version of the Pearson’s chi-square test, named the Rao-Scott chi-square test, and a general linear model for complex sample were used respectively. This was followed by a multivariate logistic regression to assess the impact of the day of admission on the survival of the OHCA patients after controlling for potential confounders. A p -value of <0.05 was used to indicate statistical significance.

Results

A total of 145,774 patients with cardiac arrest were included in this study (Fig. 1). The average age was 65.9 (\pm 16.8) years with male predominance of 61.8% (95% CI: 61.3–62.3). The majority of OHCA occurred during weekdays (70.6%) with the remainder on weekends. Presentations during winter season were most common (28.1%). Most patients died in the ED (88%). Over half of those who were admitted to the hospital (52.5%) died during their hospital stay. Overall survival to hospital discharge was 5.7% (Table 1).

In the bivariate analysis, patients who presented during weekdays were significantly more likely to survive to hospital discharge (5.9% (95% CI: 5.6–6.2) vs 5.2% (95% CI: 4.8–5.6), p -value = 0.004). They were also older with more chronic conditions including diseases of the circulatory system, factors influencing health status/health services contact and endocrine/nutritional/metabolic diseases/immunity disorders and were more likely to present in the winter (Table 2).

After adjusting for important confounders, patients admitted with out of hospital cardiac arrest on weekends were less likely to survive to hospital discharge compared to those admitted on weekdays (OR = 0.833, 95% CI: 0.727–0.954) (Table 3).

Discussion

This study examined the association between OHCA outcomes and weekend admission using the largest ED database in the United States. Overall survival to hospital discharge was 5.7% and after adjusting for confounders, patients admitted with OHCA on weekends were significantly less likely to survive compared to those admitted during weekdays.

Previous studies have examined association between admission on weekends and outcomes in different groups of patients.^{5,6} Higher mortality was reported for patients admitted with ruptured abdominal aortic aneurysm, pulmonary embolism or acute epiglottitis on weekends. This increase in mortality was much greater for conditions with significant baseline mortality.⁵ Similarly, patients presenting with acute myocardial infarction on weekends were significantly less likely to undergo catheterization, angioplasty or bypass surgery on the same day and had higher 1-year mortality and readmission rates for congestive heart failure.⁶ Increased weekend mortality was also reported for patients undergoing specific procedures (laparotomy, adhesion lysis, partial colectomy and small bowel resection)¹⁵ and for patients with

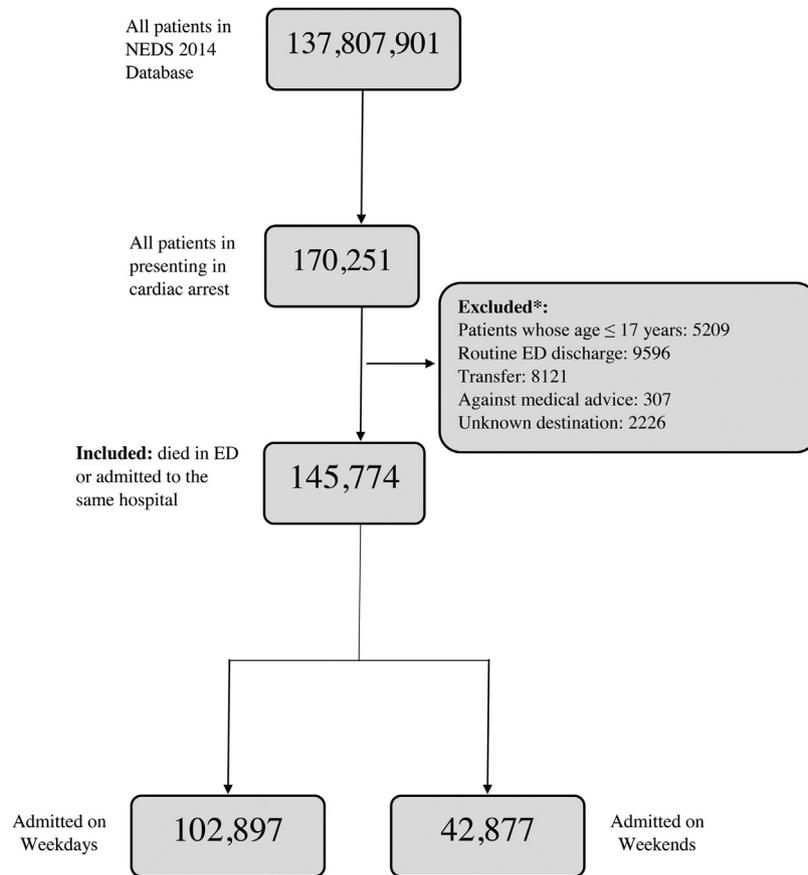


Fig. 1 – Inclusion and exclusion flowchart.

***Note: Some patients whose age ≤ 17 years old died or were admitted to the hospital. This is why the final number on which the data analysis was conducted cannot be calculated just by subtracting the number of excluded patients from the selected sample.**

Table 1 – Patient demographics, admission details & outcomes.

Age (N = 145,774)	Mean (\pm sd) 65.90 (\pm 16.80) Frequency (N = 145,774)	Median (IQR) 67 (55–79) Percentage (95% CI)
Sex		
Male	89959	61.8 (61.3–62.3)
Female	55662	38.2 (37.7–38.7)
Day of admission		
Weekday	102897	70.6 (70.1–71.0)
Weekend	42877	29.4 (29.0–29.9)
Season of admission		
Winter	34549	28.1 (27.6–28.6)
Spring	30397	24.7 (24.3–25.2)
Summer	27941	22.7 (22.3–23.2)
Autumn	29982	24.4 (23.9–24.9)
ED outcome		
Admitted to hospital	17447	12.0 (11.7–12.3)
Died in ED	128327	88.0 (87.7–88.3)
Overall outcome		
Survived	8284	5.7 (5.5–5.9)
Died in the ED/hospital	137490	94.3 (94.1–94.5)

subarachnoid hemorrhage.¹⁶ Survival rates were also lower for patients who had IHCA over weekends or during off-hours compared to weekdays or on-hours despite adjusting for major confounders.^{7–9} The results of all these studies are in line with ours, showing increase in

mortality of patients admitted on weekends compared to weekdays. It is important to mention however that none of these studies found any differences in patient demographics and previous health status between those admitted on weekends vs weekdays.

Table 2 – Bivariate analysis of patient demographics, admission details & outcomes.

Continuous variables	Weekdays		Weekends		p-Value
	Frequency	Mean (\pm sd)	Frequency	Mean (\pm sd)	
Age	102897	66.21 (16.58)	42877	65.17 (17.29)	<0.001
Categorical variables	Frequency	Percentage (95% CI)	Frequency	Percentage (95% CI)	p-Value
Season					
Winter	25220	29.1 (28.5–29.7)	9329	25.7 (24.9–26.6)	<0.001
Spring	21103	24.4 (23.8–24.9)	9294	25.6 (24.8–26.5)	
Summer	19435	22.4 (21.9–23.0)	8506	23.5 (22.6–24.3)	
Autumn	20859	24.1 (23.5–24.6)	9123	25.2 (24.3–26.0)	
Chronic conditions					
Endocrine/nutritional/metabolic diseases/immunity disorders	33259	32.3 (31.8–32.9)	13209	30.8 (30.0–31.7)	0.003
Respiratory system	21633	21.0 (20.5–21.5)	8208	19.1 (18.4–19.9)	<0.001
Genitourinary system	14019	13.6 (13.2–14.0)	5100	11.9 (11.3–12.5)	<0.001
Symptoms, signs, and ill-defined conditions	19858	19.3 (18.8–19.8)	7761	18.1 (17.4–18.8)	0.006
Injury and poisoning	7271	7.1 (6.8–7.4)	3379	7.9 (7.4–8.4)	0.005
Factors influencing health status/health services contact	35139	34.1 (33.6–34.7)	14081	32.8 (32.0–33.7)	0.013
Procedures					
Noncardiac vascular catheterization	7687	7.5 (7.2–7.8)	2937	6.9 (6.4–7.3)	0.032
Other therapeutic procedures	2299	2.2 (2.1–2.4)	716	1.7 (1.5–1.9)	<0.001
ED outcome					
Admitted to hospital	12678	12.3 (11.9–12.7)	4769	11.1 (10.6–11.7)	0.001
Died in ED	90219	87.7 (87.3–88.1)	38108	88.9 (88.3–89.4)	
Overall outcome					
Survived	6069	5.9 (5.6–6.2)	2215	5.2 (4.8–5.6)	0.004
Died in the ED/hospital	96828	94.1 (93.8–94.4)	40662	94.8 (94.4–95.2)	

Table 3 – Logistic regression model of survival.

	Crude		Adjusted [*]	
	OR (95% CI)	p-Value	OR (95% CI)	p-Value
Admission day (Weekday)				
Weekend	0.869 (0.789–0.957)	0.004	0.833 (0.727–0.954)	0.009

^{*} Adjusted for: Admission day is a weekend - Age - Season of admission - Factors influencing health status and contact with health services - Endocrine, nutritional, and metabolic diseases and immunity disorders - Diseases of the respiratory system - Symptoms, signs, and ill-defined conditions - Diseases of the genitourinary system - injury and poisoning - Injury diagnosis reported on records - Primary expected payer (proxy for socioeconomic status) - Diagnosis (Ventricular fibrillation & ventricular flutter) - Respiratory intubation and mechanical ventilation - Diagnostic cardiac catheterization; coronary arteriography - Other vascular catheterization; not heart - Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator - Conversion of cardiac rhythm - Percutaneous transluminal coronary angioplasty (PTCA) - Blood transfusion - Coronary artery bypass graft (CABG) - Extracorporeal circulation auxiliary to open heart procedures - Other therapeutic procedures.

On the other hand, other studies did not find an association between survival and admission on weekends. Mortality for patients with upper gastrointestinal hemorrhage (from variceal bleeds only),¹⁷ hip fractures¹⁸ or major trauma¹⁹ was unchanged based on weekend vs weekday admissions. Patients sustaining major trauma are usually taken to Major Trauma Centers (MTCs), which are particularly equipped to handle patients with those types of injuries, irrespective of the day of the week. More specifically, studies examining OHCA did not show a difference in survival rates for this condition when patients are stratified by weekend vs

weekday admissions.^{4,10} These studies used data from large databases (Cardiac Arrest Registry to Enhance Survival (CARES)⁴ and the Resuscitation Outcomes Consortium Epistry – Cardiac Arrest¹⁰) and adjusted mainly for prehospital variables and confounders with limited information on in-hospital procedures and post resuscitation therapies. In contrast, our study adjusted for several confounders including major in-hospital therapeutic procedures (Table 3).

Several potential factors can contribute to this weekend effect. Firstly, hospitals experience a decrease in staffing on weekends compared to weekdays, making them more vulnerable to adverse outcomes regarding patient care. This can lead to reduction and delays in procedures and treatments that these patients require. Specialists are also less likely to be present in the hospital during those days, causing even further delay and contributing to potentially worse outcomes for these patients. Although it is not the case in OHCA, patients admitted on weekends may be sicker than those on weekdays and would not wait until the end of the weekend to present to hospital. A recent meta-analysis examined the weekend effect on hospitalized patients and identified a higher mortality for those admitted on weekend without attributing this effect to “differences in staffing, procedure rates and delays, and illness severity”.²⁰ This association between weekend admission and increased mortality in patients with OHCA should however prompt hospitals to examine more closely modifiable factors that may help improve outcomes further for OHCA victims. With the evolving concept of “cardiac arrest centers” where patients with OHCA are cared for at designated or accredited “cardiac arrest centers” and with the promising early evidence about outcomes of patients treated at such centers, variation in outcomes based on day of the week might not remain significant in the future.

Numerous studies have been conducted to identify predictors of outcome in OHCA. Predictors of survival include younger age, witnessed by bystander or Emergency Medical Services (EMS), basic life support in

less than 5 min after collapse, initial cardiac rhythm of ventricular fibrillation or ventricular tachycardia, return of spontaneous circulation (ROSC) in less than 20 min and arrest due to cardiac etiology.^{3,21,22} Predictors of poor outcome include cardiac arrests occurring at home, absence of pupillary and corneal reflexes and low blood pH.² However, none of the above-mentioned studies included day of the week as a predictor of outcome. Future adjustment for this variable is recommended when examining outcomes of OHCA patients at hospital discharge.

The limitations of this study are due to its retrospective nature. The selection of the data from the NEDS database was done using ICD-9-CM for cardiac arrest. Variations in coding from one hospital to another could have affected this process, thereby not including all eligible cardiac arrest patients presenting to the ED. Patients who had different ED dispositions recorded (other than “died in ED”) were also excluded since they had unknown outcomes or had potentially inaccurate disposition recorded (related to coding errors). This might have resulted in potential nonsystematic selection bias. There was also lack of pre-hospital information in the database however adjustment in the multivariate analysis was done for significant confounders including major procedures and diagnosis of Ventricular fibrillation and ventricular flutter. NEDS is however a national database and its findings can be generalized to most US hospitals. Even though the potential effect size of interventions to improve survival for patients admitted on weekends is small in terms of saving a large numbers of patients, efforts should still be maximized to reduce discrepancies in outcomes related to weekend vs weekday admissions.

Conclusions

In this study, cardiac arrest patients admitted to the ED on weekends had slightly lower survival compared to those admitted on weekdays. Future studies should aim at identifying modifiable factors related to this finding to help reduce outcome discrepancies and improve cardiac arrest survival further.

Financial support

None.

Conflicts of interests

None declared.

Appendix A

Appendix 1 - Variable recoding

Administrative characteristics

- Month of admission from (1) January to (12) December. To improve the statistical power and to simplify the analysis, the month of admission was grouped into 4 seasons:
 - The months December through February classified as (1) winter, March through May as (2) spring, June through August

as (3) summer, and September through November as (4) autumn.

- Admission on weekday or weekend:

- (0) admission on Monday to Friday, (1) admission on Saturday-Sunday

Clinical characteristics

- Chronic conditions (Yes/No) and their different types

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