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There is no association between weekend admissions and delays in antibiotic administration for patients admitted to the emergency department with suspicion of sepsis

A retrospective cohort study

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Abstract

Admission to the emergency department (ED) on weekends has been associated with an increase in mortality and poor outcomes, but the associated findings are not consistent. It has been hypothesized that this association may be due to lower adherence to standards of care.

This study was conducted to evaluate whether weekend admissions to the ED increases the time to antibiotic administration in septic patients.

A retrospective cohort study of adult patients who were included in the sepsis protocol at a tertiary ED between January 2015 and December 2017 was performed. The sepsis protocol was activated for all patients with suspected severe infection.

A total of 831 patients with a mean age of 59 ± 21 years were evaluated, of whom 217 (26.1%) were admitted on weekends. In addition, 391 (47.1%) patients were male, and 84 (10.1%) died in the hospital. Overall, the mean sequential organ failure assessment score was 2 ± 1.9, and the mean Charlson comorbidity index was 3.7 ± 3. The time to antibiotic administration was similar between patients admitted on weekends (36.29 ± 50 minutes CI 95%) and patients admitted on weekdays (44.44 ± 69 minutes CI 95%), $P = .06$; U = 60174.0. Additionally, mortality was similar in both groups of patients, with a 10.3% mortality rate on weekdays and a 9.8% mortality rate on weekends, $P = 821$.

In this cohort of patients with suspicion of sepsis in the ED, admission on weekends was not associated with increased delays in antibiotic therapy or higher mortality rates.

Abbreviations: CCI = Charlson comorbidity index, ED = emergency department, ICU = intensive care unit, SOFA = sequential organ failure assessment.

Keywords: prognostic, sepsis, weekend effect

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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1. Introduction

It is of great scientific interest to determine the prognostic factors for patients admitted to the emergency department, thus enabling the identification of death predictors and the development of measures to improve outcomes.[1] It has been hypothesized that weekday admission is associated with an increased risk of death. This association has been named the weekend effect and is described as an increase in mortality for patients admitted to the ED on weekends.[1] Its possible causes include reduced staff, less-qualified staff, and the admission of patients with more severe illness on weekends.[1] Although some studies have identified the weekend effect in their facilities,[1–6] others have obtained negative results,[7–10] which makes the validation of weekday admission as a prognostic factor uncertain. In this context of disparity, there is no consensus about the appropriate methodological approach among studies regarding the weekend effect. The existing literature is extremely heterogeneous regarding the analysis of medical care quality.

Sepsis is one of the greatest challenges in the emergency context. Mortality rates are high, and prompt diagnosis and measures are crucial for treatment.[11] There is evidence that early

empiric antibiotic therapy is associated with lower mortality rates.[12] Therefore, sepsis treatment can be an important measure for evaluating hospital staff efficiency.

In the present study, we aimed to assess the association between weekend admissions and an increased delay in antibiotic administration in patients with suspicion of sepsis at the emergency department. Additionally, we aimed to evaluate whether there is an increase in mortality among patients admitted on weekends.

2. Methods

2.1. Study design

A retrospective cohort was implemented to evaluate the data from patients who underwent the institutional sepsis protocol at the emergency department of Hospital São Rafael.

2.2. Setting

Hospital São Rafael is a private, tertiary hospital in Salvador, Brazil, with 352 beds, including 22 beds in the emergency department and 69 beds in the intensive care unit (ICU). The hospital serves patients with health insurance and private patients. In 2008, a sepsis protocol was created for this institution, aiming to recognize possible septic patients and standardize the therapy and measures for the care of these individuals. When activated, the emergency department, ICU, laboratory, and pharmacy medical staff begin the following measures: arterial blood analysis within 15 minutes, collection of material for cultures as well as antibiotic therapy within 1 hour, and decisions regarding ICU admission are carried out. Data were collected from patients admitted to the emergency department between January 2015 and December 2017.

2.3. Participants

The inclusion criteria were patients admitted to the emergency department who underwent the sepsis protocol. This protocol was initiated for every patient with suspected infection and a calculated quick sequential organ failure assessment[11] score ≥ 2. A combination of interventions as already mentioned in the setting subsection of this article was then initiated. The exclusion criteria were patients under the age of 18.

2.4. Variables

The exposition variable in this study was weekend admissions (Saturday at midnight to Sunday at 11:59 pm), a qualitative binary variable of "yes" or "no".

The outcome variables included qualitative delay of antibiotic administration (a binary variable of "yes" or "no"); quantitative delay of antibiotic administration (measured in minutes) – for both of the aforementioned variables, delay was defined as a time from activation of the sepsis protocol to antibiotic administration greater than 60 minutes; and in-hospital mortality (absolute and relative).

Table 1

Association between clinical features and weekend admission.

Variable	Weekday (n = 614)	Weekend (n = 217)	*P*-value
Age (yr), median	61.0 (41.0–76.0)	64.0 (42.5–79.5)	.262
Sex			.444
Female	324 (52.7%)	116 (53.4%)	
Male	290 (47.8%)	101 (46.6%)	
Mortality	63 (10.3)	21 (9.8)	.821
Charlson Comorbidity index	3 (1–6)	4 (1–6)	.315
UCI admission	235 (38.5%)	88 (40.9%)	.523
SOFA	2 (1–3)	2 (1–3)	.707
Primary site of infection			.383
Abdominal	117 (19.1%)	52 (24.1%)	.061
SSTIs	48 (7.8%)	10 (4.6%)	.055
Nervous system	8 (1.3%)	4 (1.9%)	.284
Urinary	142 (23.1%)	47 (21.8%)	.329
Pulmonary	192 (31.3%)	72 (33.3)	.301
Not established	92 (15.0%)	25 (11.6%)	.103
Others	15 (2.4%)	6 (2.8%)	.397
Antibiotic delay (>1h)	101 (16.4%)	33 (15.4%)	.725
Antibiotic delay (min) (median IQR)	28 (10.0–48.25)	25 (2.75–45.0)	.066
Lactate delay (min)(median IQR)	28 (21.0–38.0)	27 (21.0–35.0)	.303
Use of vasoactive drug	27 (4.4%)	3 (1.4%)	.041
Medium arterial pressure, median (IQR)	93 (78.3–105.3)	93 (80.15–106.45)	.620
Glasgow coma Scale	15 (15–15)	15 (15–15)	.165
Shift turnover	82 (13.4%)	33 (15.2%)	.497
Night shift	184 (30.0%)	71 (32.7%)	.450
Laboratory values on admission, median IQR			
PaO^2/FiO^2	403.5 (341.0–500.0)	391 (331.5–478.0)	.124
Bilirubin	0.5 (0.1–1.1)	0.5 (0.1–1.2)	.857
Creatinine	0.9 (0.6–1.2)	0.9 (0.7–1.25)	.275
Platelets	224.5 (159.0–308.0)	214 (165.0–296.5)	.790

Values represent n (%), mean and median (IQR).

SOFA = sequential organ failure assessment, SSTIs = skin and soft tissue infections.

Table 2

Multivariate analyses: mortality x covariates.

Variable	B	OR	IC 95%		*P*-value
Weekend admission	–0.078	0.925	0.529	1.616	.784
Sex	–0.078	0.925	0.559	1.531	.761
Age	0.020	1.020	1.002	1.039	.028
CCI	0.205	1.227	1.101	1.367	.000
SOFA	0.371	1.450	1.291	1.628	.000
Constant	–5475				

The covariates included age (in years), sex (male/female), Charlson comorbidity index (CCI)[13] on admission, sequential organ failure assessment (SOFA) score[11] on admission, primary site of infection (abdomen, skin and soft tissue, nervous system, urinary tract, lung, not established, and other), lactate measurement delay (time in minutes from protocol activation to serum lactate measurement), use of vasoactive drugs, medium arterial pressure, Glasgow Coma Scale,[14] shift turnover admission (6 am–7:59 am and 6 pm–7:59 pm), night shift admission (7 pm–7 am) and laboratory results on admission (PaO2/FiO2, bilirubin, creatinine, and platelets).

2.5. Data sources/measurements

All data for all variables were obtained from electronic medical records. For the CCI, MedCalc Statistical Software version 16.4.3 was used.[20]

2.6. Data availability

The data that support the findings of this study are available from the corresponding author, B.V.B.F, upon reasonable request.

2.7. Statistical methods

Statistical analysis was conducted using "IMB SPSS Statistics 21.0". We tested for associations between weekend admissions and the time to antibiotic administration by applying 2 statistical methods: a Chi-squared test, using the categorical variables "weekend admission" and "delay to antibiotic administration"; and a Mann–Whitney *U* test, in which the categorical variable "weekend admission" and the continuous variable "time to antibiotic administration" were used. Additionally, the correlation between weekend admissions and time to serum lactate measurement was tested using the Mann–Whitney *U* test.

To assess the associations between the other variables and weekend admissions, Chi-squared tests and Mann–Whitney *U* tests were conducted for categorical and noncategorical variables, respectively (Table 2).

Finally, 2 multivariable models were used to identify independent predictors for mortality and antibiotic delay. These models included age, sex, weekend admissions, and severity scores. Logistic regression was conducted. The choice of these variables was based on a theoretical rationale. Crude and adjusted odds ratio (OR) values were calculated. *P*-values $< .05$ were considered significant.

2.8. BIAS analysis

We conducted, through theoretical rationale, the variables that could be possible biases of our analysis. In this way, we constructed 2 logistic regression models that included the following independent variables: weekend admissions, sex, age, CCI, and SOFA.

2.9. Ethical considerations

This study was approved by Hospital São Rafael Research Ethics Committee number 2.200.054 on August 3, 2017. (CAAE number 71553417.2.0000.0048). Research Ethics Committee number 2.200.054 on August 3, 2017.

3. Results

In the study period, 850 patients were eligible for activation of the sepsis protocol. Among them, 19 were excluded because they fulfilled the exclusion criteria (2.47%). Thus, data from 831 patients were evaluated. A total of 614 patients were admitted on weekdays (73.9%), and 217 were admitted on weekends (26.1%). All patients were followed until discharge.

Among these patients, 391 (47.1%) were male, and the mean age of the sample was 59 ± 21 (Table 1). The overall hospital mortality rate was 10.1% (84 deaths). Figures 1 and 2

There was no significant difference between the number of delayed antibiotic administrations (more than 60 minutes) on weekdays (16.4%) and weekends (15.4%) ($P = .725$). Additionally, there was no statistically significant difference between the mean time, in minutes, of antibiotic administration on weekends (36.29 ± 50 minutes) and weekdays (44.44 ± 69 minutes), $P = .06$; $U = 60174.0$. There was no association between weekend admissions and delay in lactate, $P = .303$, $U = 62984$. In addition, no difference was observed between the mortality of patients

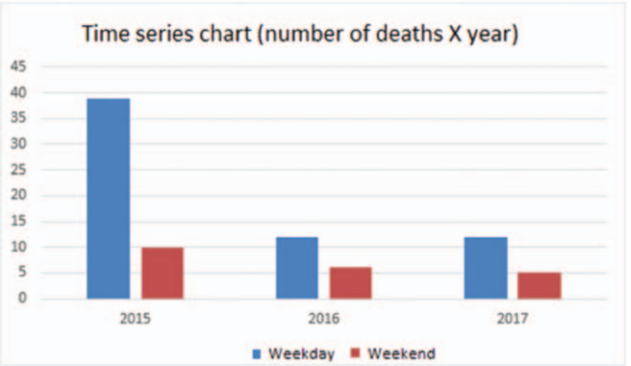

Figure 1. Total absolute number of deaths among patients included in the study, in each of the years in which this study was conducted (2015, 2016, 2017). Blue bars correspond to deaths occurred during weekdays. Red bars correspond to deaths occurred during weekends.

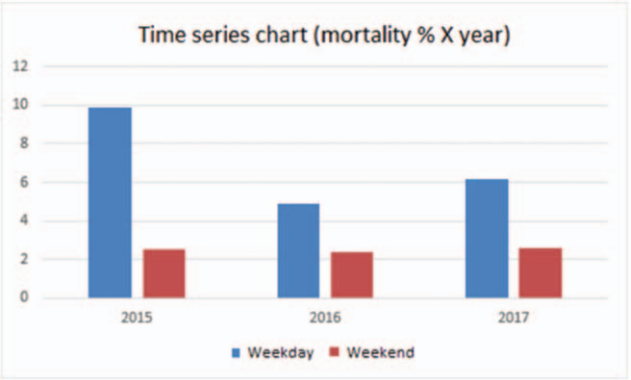

Figure 2. Relative (%) number of deaths among patients included in the study, in each of the years in which this study was conducted (2015, 2016, 2017). Blue bars correspond to deaths occurred during weekdays. Red bars correspond to deaths occurred during weekends.

admitted on weekends (9.8%) and weekdays (10.3%) [OR (95% CI) = 0.95 (0.56–1.58)].

Among the other variables used in our univariate model, only "use of vasoactive drugs" had statistical significance ($P = .04$), but with a low rate of association (Phi: -0.071 Cramer's V: 0.071).

A logistic regression model analysis showed age [OR (95% CI) = 1.020(1.002–1.039)], the SOFA score [OR (95% CI) = 1.336(1.180–1.513)] and the CCI [OR (95% CI) = 1.202(1.076–1.344)] as independent mortality predictors (Table 2). There was no impact of patient sex or weekend admission on mortality.

A second logistic regression model analysis (Table 3) showed that none of the variables chosen based on our theoretical rationale were independent predictors of antibiotic delay.

4. Discussion

In this cohort of patients with a suspicion of sepsis in the ER, admission on weekends was not associated with higher delays in antibiotic therapy or higher mortality. These findings suggest that this sepsis protocol helps to ensure consistency of care and therefore represents a potentially improved model for septic patients.

This is the first Brazilian study to assess the weekend effect in septic patients. In the present study, there was no significant difference in the time to administration of antibiotics between patients admitted to the hospital on weekdays and those admitted on weekends. Furthermore, there was no significant difference in mortality. In lieu of these results, it is important to highlight that the hospital where this study took place is an infection control reference hospital, with a well-established protocol to address every suspected case of infectious disease.

Results of most of the existing literature on this theme are inconsistent with our results, reporting the existence of the weekend effect[1–6,15] either in septic patients[3,15] or patients with other diseases (e.g., congestive heart failure, stroke, peptic ulcer hemorrhage, and cranioencephalic trauma).[1,2,4,5] Nevertheless, all these previous studies were conducted with a population from multicentric studies, therefore making it impossible to analyze standardized protocols that guarantee quality of care. With that in mind, multicentric studies regarding this theme must be criticized, as their results include heterogeneous groups from hospitals with differences in staff, diagnostic methods, and therapeutic resources. One of these multicentric studies[5] reported that most of the ICUs in Finland did not have 24 hours of coverage with intensive care specialists on weekends.

On the other hand, the studies that showed consistent results regarding the absence of the weekend effect[7–10] were conducted in unicentric populations. Three of them,[7–9] which had a significantly larger population than ours, included patients regardless of disease, and only 1 study[10] had a similar population and included patients with a specific condition (cranioencephalic trauma). These studies had a trained (or in training) team of intensive care physicians 24 hours a day, every day, as did our study. In one of the studies,[10] the hospital also had an institutional protocol for the specific disease assessed. Therefore, we suggest that the use of specific protocols and trained teams 24 hours a day, 7 days a week, produces similar results in terms of mortality outcomes.

Notably, most of the studies about this theme analyzed mortality as the main outcome. Our study goes beyond this outcome by using the antibiotic administration time as the main outcome for the weekend effect in septic patients, as it has already been established in the literature as the main factor for changing the prognosis in septic patients,[11] especially when administered in the first hour.[12,16]

Additionally, delays in procedures, such as antibiotic therapy, have already been reported by several studies with other populations[17–19] as the main factor related to the weekend effect, despite other possible theories, such as the reduced or limited experience of healthcare teams on weekends.

Therefore, we concluded that the absence of the weekend effect in our study could be explained by our effective protocol, which endorses antibiotic administration within 1 hour. A similar conclusion was reached by Seymour et al,[16] who showed better outcomes among septic patients who received antibiotics within the first hour. Nevertheless, due the high mortality of sepsis around the world, especially in developing countries, the constant evaluation of the results of the protocol is needed and may improve prognosis in this group of patients.

Table 3

Multivariate analyses: ATB delay x Covariates.

Variable	B	OR	IC 95%		*P*-value
Weekend admission	–0.069	0.933	0.607	1.434	.753
Sex	0.145	1.156	0.793	1.684	.451
Age	–0.003	0.997	0.985	1.010	.687
Charlson Comorbidity Index	–0.020	0.980	0.893	1.076	.674
SOFA	0.000	1.000	0.901	1.110	.999
Constant	–1.470				

It is important to emphasize that in the period this study was conducted, the Sepsis-3[11] diagnosis criteria had not been established for patients whose hospital stay occurred in 2015. Most mortality rates, absolute and relative, were higher in that year. This evidence supports the importance of continuously developing research that amplifies our knowledge about sepsis syndrome and allows improvements in management protocols.

The limitation of this study is the small sample size, as other similar studies[2–9,15] had a larger population. In addition, in this study, we only assessed some of the possible poor outcomes, not considering other possible markers that may denote worse outcomes, such as length of stay in the ICU. Therefore, we did not consider all possible signs of the weekend effect.

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