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SHORT PAPER

Weekend effects on health outcomes and operational efficiency in emergency admissions to general medicine services of the Central Hospital of the Autonomous Province of Bolzano, Italy

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Abstract

The possibility of higher death rates after admission to hospital during the weekend has been intensively investigated in North America and Northern Europe, while data are almost absent from Southern Europe and other WHOV regions. Increased death rates have not been uniformly confirmed. Differences in hospital care on weekends can vary depending on the reason for hospital admission, place and time. The aim was to verify whether weekend admission from the emergency department to internal medicine services is associated with parameters of operational efficiency in a Northern Italian hospital.

A retrospective analysis was performed using hospital administration data of 3,594 admissions in 2016. A total of 287 patients (8.0%) had intensive care unit/IMCU transfers and 218 patients (6.1%) deceased in the hospital. Patients admitted on the weekend were similar to patients admitted during the week across age and gender, while weekend patients were more likely to be admitted on a "bad" day, defined as a day with a median number of admitted patients per day of >10 during the week and >9 on weekend. When adjusting for age and gender, patients admitted on weekend had significantly shorter length of stay compared to patients admitted during the week. In conclusion, emergency weekend admission to an internal medicine service was not associated with worse hospitalization-relevant outcomes in a regional hospital in Italy. Lower length-of-stay when emergency admission was on weekend is suggestive of lower disease severity of patients admitted to internal medicine services than on weekdays. If this represents higher risk of inappropriate hospital admission on weekends requires further study.

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Introduction

The "weekend effect" describes higher death rates after admission to hospital during the weekend (1). The existence of a weekend effect has been debated, after increased mortality could not be confirmed in several studies (2). Since increased mortality of weekend admissions would have important implications for patients, clinicians, and policy makers, ongoing research efforts try to clarify this issue.

Most previous studies of weekend effects have focussed on mortality as primary outcome using administrative data from hospital diagnostic coding that have been identified as biased (3). This may explain why increased death rates have not been uniformly confirmed. In addition, mortality is an insensitive measure of the overall quality of hospital care (4). Poorer care provided during weekends does not necessarily result in patient deaths. Therefore, investigations should focus on other dimensions of quality.

Data regarding weekend admissions and their impact on dimensions of quality other than death rates are limited. In a North American tertiary care hospital study, weekend admissions to the general medicine services from the emergency department (ED) were not associated with worse hospitalization-relevant outcomes, including hospital length-of-stay (LOS) and intensive care unit (ICU) or intermediate care unit (IMCU) transfer during hospitalization (5). A striking weekend effect on LOS was also not evident in a cohort of consecutive patients admitted to an Italian general medicine service (6). The aim of this study was to verify whether weekend admission from the ED to internal medicine units is associated with LOS or transfer to ICU/IMCU during hospitalization.

Subjects and Methods

A retrospective analysis was performed using hospital administration data on all patients hospitalized in 2016 in the internal medicine services of the Division of Internal Medicine of the Central Hospital of Bolzano (BZ), Italy (110 beds; internal medicine with specialized units for cerebral stroke, rheumatology, diabetes, endocrinology and angiology). The Italian National Health Service (NHS), that provides free and equal health care access to all citizens, is controlled by regional governments and administered by local health authorities. The Central Hospital of Bolzano is a 700-bed academic teaching hospital in the Autonomous Province of Bolzano, Italy, with a yearly ED patients flow of approximately 95,000. Both medical and nursing staff of the hospital is permanent, with replacements warranted by ad hoc rotations among the entire staff. The Division of Internal Medicine alone accounts for about one-quater of all hospital admissions.

Only ED admissions were analyzed. Friday midnight to Sunday midnight was considered as weekend, and the nine main national festive days were also considered as Sunday. LOS and transfer to ICU or IMCU were assumed as primary and hospital mortality as secondary objectives. Overall, n = 3,594 admissions were available for analyzing ICU/IMCU transfers and mortality. Thirteen patients were still hospitalized on Dec. 30, 2016. The remaining n = 3,581 admissions were used to analyze LOS. The median number of patients per day was used to classifiy patients as being admitted on "good" (≤ median) or "bad" (> median) days. Median cut-offs were separately computed for workdays (Md = 10) and weekends (Md = 9).

Descriptive results are presented as mean ± SD or percentages as appropriate. In order to evaluate which variables were independently associated with outcome

parameters, logistic regression analysis was performed to predict ICU/IMCU transfer and hospital mortality. LOS (i.e., the number of days of hospitalization) was treated as a count variable. Due to overdispersion, negative binomial (NB) regression models were used. Appropriateness of NB modeling was checked using rootograms of observed and model-based expected counts (7). In all models, patients' age (in years), sex (0 = male, 1 = female), type of admission day (0 = "good", 1 = "bad"), and type of admission (0 = workday, 1 = weekend) were used as independent variables. For ease of interpretability of model parameters, age was mean-centered. Model selection was performed using likelihood ratio tests for nested models. All multivariate models were evaluated for the presence of potential two-way interaction effects. Variance inflation factors were computed to confirm the absence of multicolinearity issues. A value of $p < .05$ was considered statistically significant. Non-significant predictors were removed from the final multivariate models for reasons of parsimony. The R Statistical Programing Environment Version 3.3.1 (8) was used to analyze the data.

Results

Main characteristics of the sample are given in Table 1. The average patient was female (50.7%) and 73.5 years of age (*SD* = 14.8). The average LOS was 9.2 days (*SD* = 8.7 days). Overall, 287 patients (8.0%) had an ICU/IMCU transfer, 218 patients (6.1%) deceased in the hospital. Patients admitted on the weekend were similar to patients admitted during the week across age ($t(2,242.9) = 1.42$, $p = 0.158$) and gender ($\chi^2(1) = 1.01$, $p = 0.314$), while weekend patients were more likely to be admitted on a "bad" day ($\chi^2(1) = 15.08$, $p < .001$; see Table 1). Table 2 summarizes the results of univariate and multivariate NB regression models to predict LOS. For

Table 1 - Main characteristics of study population (n = 3,594).

Variable		Workday	Weekend	Total
LOS[(a)]	*M* (*SD*)	9.34 (8.82)	8.91 (8.35)	9.21 (8.68)
ICU/IMCU Transfer	*n* (%)			
No		2,285 (92.1)	1022 (91.8)	3,307 (92.0)
Yes		196 (7.9)	91 (8.2)	287 (8.0)
Hospital Mortality	*n* (%)			
No		2,341 (94.4)	1,035 (93.0)	3,376 (93.9)
Yes		140 (5.6)	78 (7.0)	218 (6.1)
Age (yrs)	*M* (*SD*)	72.43 (14.85)	75.85 (14.26)	73.49 (14.75)
Sex	*n* (%)			
Male		1,237 (69.8)	534 (30.2)	1,771 (49.3)
Female		1,244 (68.2)	579 (31.8)	1,823 (50.7)
Type of Day	*n* (%)			
"Good Day"		1,189 (72.3)	455 (27.7)	1,644 (45.7)
"Bad Day"		1,292 (66.3)	658 (33.7)	1,950 (54.3)

Note: n = frequencies, M = arithmetic mean, SD = standard deviation
(a) LOS is based on n = 3,581 patients with valid discharge dates.
ICU/IMCU = intensive care unit/intermediate care unit; LOS = length-of-stay.

Table 2 - Results of univariate and multiple negative binomial regression models (n = 3,581; R-squared of the multiple NB model = 0.052).

Variables	Univariate NB Regressions					Multiple NB Regressions			
		95% CI					95% CI		
	IRR	lower	upper	p	R-squared	adj. IRR	lower	Upper	p
Weekend	0.954	0.899	1.012	0.116	0.001	0.914	0.863	0.969	0.003
Bad Day	1.026	0.971	1.084	0.353	0.000	–	–	–	–
Female	0.923	0.874	0.975	0.004	0.002	0.883	0.837	0.932	<.001
Age	1.013	1.011	1.014	<.001	0.044	1.013	1.012	1.015	<.001

NB = negative binomial; CI = confidence interval; IRR = incident rate ratio, p = p-value

unadjusted outcomes, patients admitted on weekend have a similar LOS compared to patients admitted during the week (Incidence Risk Ratio [IRR] = 0.945, 95% confidence interval [CI] = [0.899; 1.012]). Similarly, "bad" admission days were not associated with LOS (IRR = 1.026, 95% CI = [0.971; 1.084]). Age was positively associated with LOS (IRR = 1.013, 95% CI = [1.011; 1.014]) and women were more likely to show shorter LOS (IRR = 0.923, 95% CI = [0.874;0.975]). The age and gender effects remained in the final multivariate model (cf. Table 2, left panel). In addition, when adjusting for age and gender, patients admitted on weekend had significantly shorter LOS compared to patients admitted during the week (adj. IRR = 0.914, 95% CI = [0.863; 0.969]).

Table 3 summarizes the univariate and multivariate logistic regression results for ICU/IMCU transfer and mortality. For unadjusted outcomes, admissions on "bad" days and on weekend were not associated with ICU/IMCU transfers ("bad" day: odds ratio [OR] = 0.945; 95% CI = [0.742;1.204], weekend: OR

Table 3 - Results of the univariate and multiple logistic regression models for hospital mortality and ICU/IMCU transfer (n = 3,594; R-squared of multiple logistic regression models were 0.018 and 0.085 for ICU/IMCU transfer and mortality respectively).

Variables	Univariate Logistic Regressions					Multiple Logistic Regressions			
		95% CI					95% CI		
	OR	lower	upper	p	R-squared	adj. OR	lower	Upper	p
	ICU/IMCU transfer								
Weekend	1.038	0.798	1.341	0.778	0.000	–	–	–	–
Bad Day	0.945	0.742	1.204	0.646	0.000	–	–	–	–
Female	0.731	0.573	0.932	0.012	0.004	0.776	0.606	0.990	0.042
Age	0.981	0.974	0.989	0.000	0.015	0.982	0.975	0.989	0.000
	Hospital mortality								
Weekend	1.260	0.943	1.673	0.114	0.002	–	–	–	–
Bad Day	1.014	0.771	1.337	0.920	0.000	–	–	–	–
Female	0.914	0.695	1.203	0.522	0.000	0.717	0.540	0.952	0.021
Age	1.068	1.054	1.084	<.001	0.081	1.072	1.056	1.088	<.001

ICU/IMCU = intensive care unit/intermediate care unit; CI = confidence interval; OR = odds ratio; p = p-value; adj. = adjusted.

= 1.038; 95% CI = [0.798,1.341]) and mortality ("bad" day: OR = 1.014, 95% CI = [0.771;1.337], weekend: OR = 1.260, 95% CI = [0.943;1.673]). Age was positively associated with hospital mortality (OR = 1.068, 95% CI = [1.054; 1.084]) and negatively associated with ICU/IMCU transfers (OR = 0.981; 95% CI = [0.974;0.989]). Further, female patients were less likely to be transferred to the ICU/IMCU (OR = 0.731; 95% CI = [0.573; 0.932]). Age and gender effects remained significant in the multivariate model for ICU/IMCU transfers (Table 3, upper right panel). In addition, when adjusting for age, a significant negative association of female gender and mortality was observed (adj. OR = 0.717, 95% CI = [0.540;0.952]).

Discussion and Conclusions

Acute care hospitals operate differently on weekdays and at the weekend. At the weekend, there is less staff cover and also reduced access to certain treatments and procedures (9). Increased illness severity has been identified as explaining much of the observed increase in mortality risk at the weekend (10).

The main finding of our study is that emergency weekend admissions to an internal medicine service were not associated with worse hospitalization-relevant outcomes in a regional hospital in Italy. Among patients admitted to the medicine services, weekend admissions were associated with better outcomes in terms of LOS. Prior research indicates worse outcomes during "offhours" (1, 9, 10) but we did not replicate this finding in our study regarding weekend admission effects. The mortality difference between weekend and weekday admission is more likely attributable to patients' severity of illness and comorbid conditions at the time of admission rather than the quality of hospital care (1). In our study of hospitalization-relevant outcomes, LOS was significantly lower when emergency admission was on weekend, suggesting lower disease severity of patients admitted to internal medicine services than on weekdays. Similarly, a trend to lower ICU transfer rate had been described previously (5), which would be compatible with such hypothesis even though that outcome observation was not confirmed in our study, maybe due to low event rates. Interestingly, deprivation has been identified as a powerful determinant of weekend admissions, and more deprived patients admitted during the weekends had a significantly lower in-hospital mortality (11).

There are a number of limitations in our work. The major limitation is the use of administrative data without additional information, particularly regarding case-mix adjustment and illness acuity of the patients at the time of admission. Other limitations are the following: firstly, admissions to internal medicine service only were analyzed and there are a number of other admitting services in our institution for which we do not have available data, including gastroenterology, cardiology and pneumology, therefore our results are not necessarily generalizable to these specialties; secondly, this study was based in a single institution serving as sole hospital for a mixed rural and urban population including many deprived and, consequently, the external validity of the findings require confirmation in other settings; thirdly, due to the overall low mortality rates, there remains the possibility that small differences may not have been detected.

In conclusion, emergency weekend admissions to an internal medicine service were not associated with worse hospitalization-relevant outcomes in a regional hospital in Italy. Lower LOS when emergency admission was on weekend is suggestive of lower disease severity of patients admitted to general medicine wards than on weekdays. If this represents a higher risk of inappropriate hospital admission on weekends requires further study.

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Riassunto

Gli effetti del fine settimana sui risultati di salute e sull'efficienza operativa nei ricoveri d'urgenza al reparto di medicina interna dell'Ospedale Centrale della Provincia Autonoma di Bolzano, Italia

L'eventualità di un aumento dei tassi di morte dopo ricovero ospedaliero durante il fine settimana è stata oggetto di ricerca intensiva in Nord America e Nord Europa, mentre i dati sono pressoché assenti per quanto riguarda l'Europa meridionale e le altre regioni del mondo. Non sono stati uniformemente confermati tassi di mortalità aumentati. Le differenze nell'assistenza ospedaliera nel fine settimana possono variare a seconda del motivo del ricovero ospedaliero, del luogo e dell'ora. L'obiettivo era di verificare se il ricovero durante il fine settimana dal dipartimento di urgenza/emergenza al reparto di medicina interna fosse associata a parametri di efficienza operativa in un ospedale italiano.

Un'analisi retrospettiva è stata effettuata usando i dati amministravi ospedalieri di 3.594 ricoveri dell'anno 2016. Di questi un totale di 287 pazienti (8,0%) sono stati trasferiti in unità di terapia intensiva / semi-intensiva e 218 pazienti (6,1%) sono deceduti in ospedale. I pazienti ricoverati durante il fine settimana erano simili ai pazienti ricoverati durante giorni feriali per età e sesso, mentre i pazienti del fine settimana avevano maggiore probabilità di essere accettati in una giornata "cattiva" definita dal numero di pazienti ricoverati al giorno superiore a 10 durante i giorni feriali e superiore a 9 durante il fine settimana. Correggendo per età e sesso, i pazienti ricoverati nel fine settimana avevano una durata di ricovero significativamente più breve rispetto ai pazienti accolti durante la settimana. In conclusione, i ricoveri d'urgenza durante il fine settimana in un reparto di medicina generale di un ospedale regionale in Italia non sono stati associati a risultati peggiori di ospedalizzazione. La durata di degenza media più breve nei ricoveri d'urgenza effettuati nel fine settimana rispetto a quella nei giorni feriali suggerisce una minore gravità di malattia dei pazienti ammessi nel fine settimana ai reparti di medicina generale. Sono comunque necessari ulteriori studi per poter concludere che i ricoveri ospedalieri del fine settimana sono a maggiore rischio di non appropriatezza.

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