ORIGINAL ARTICLE

In-hospital mortality and length-of-stay in a cohort of ED patients admitted to internistic units

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Abstract

Background: Several life-threatening acute diseases exhibit precise preferred times of onset, during the day (morning), the month or season of the year (winter), and the day of the week (Monday). Moreover, admission to the hospital during nighttime and weekend (WE) is associated with increased risk of in-hospital mortality (IHM) and length-of-hospital stay (LOS). Since most of these data have been obtained in North American settings, the aim of this study was to verify also in an Italian setting whether some factors related to ED evaluation, including time of arrival, and disease's severity evaluated by a colour code, could be associated with IHM and LOS in ED patients admitted to internal medicine units.

Methods: This study was conducted between January 1, 2010 and July 31, 2012, at the St Anna Hospital of Ferrara. We analyzed age, sex, time of arrival to the ED, ED boarding time, and triage colour code of all patients admitted to the Department of Medicine. Friday to midnight Sunday was considered as WE, and the nine main national festive days were always considered as Sunday-WE. Thus, the time period was classified into holidays (WE + festive days) and weekdays (WD), and daytime (8:00 am - 8:00 pm) and nighttime (8:00 pm - 8:00 am). IHM and LOS were assumed as primary and secondary objectives, respectively. Patients were classified into deceased and survivors, and LOS was classified depending on length lower or higher than the median (seven days). *T*-test, chi-squared test, U Mann-Whitney test, and logistic regression analysis were performed.

Results: During the 18-month period, 13,237 consecutive patients visiting the ED (43.4% males, mean age 74.8 ± 13.6 years, 56.6% females, mean age 78.0 ± 13.3 years), were considered. IHM was related to: time of admission (daytime vs. nighttime, $p = .015$; WE *vs*. WD, $p = .026$, holidays vs. no holidays, $p = .021$), colour code ($p < .001$), and age ($p < .001$). Multivariate analysis showed an independent association with IHM for colour code ($p < .001$), and age ($p < .001$). LOS >7 days was related to: time of admission (daytime vs. nighttime, $p < .001$; WE or WD, $p = .001$; holidays vs. no holidays, $p = .002$). Furthermore, LOS >7 days depended on both colour code of admission ($p < .001$), and age ($p < .001$). Multivariate analysis showed a significant correlation with LOS >7 days for yellow colour code ($p < .001$), and age ($p < .001$).

Conclusions: Although several factors, such as admission colour code and age, influence some parameters of clinical outcome, *i.e*., IHM and LOS, a striking weekend effect is not evident in a cohort of consecutive patients admitted to an Italian Medical Department, characterized by intermediate-high level of urgency.

Key words

In-hospital mortality, Length-of-stay, Emergency department, Daytime admission, Nighttime admission, Internal medicine

1 Introduction

Several life-threatening acute diseases seem to exhibit precise preferred times of onset, characterized by highest risk, during the hours of the day (morning), month or season of the year (winter), and day of the week (Monday) [1-13]. In particular, admission to the hospital during nighttime and weekend (WE) was associated with increased risk of in-hospital mortality (IHM) and length-of-hospital stay (LOS) in acute care hospitals in Canada and England [14, 15], and an increased risk has been recently reported to be associated with duration of visits in the ED [16]. Most studies, however, have been obtained in North American settings, but, to the best of our knowledge, no data are available for Italian settings. Thus, the aim of this study was to verify whether some factors related to ED evaluation, including time of arrival, and disease's severity evaluated by a colour code, could be associated with IHM and LOS in patients arriving to the ED and then admitted to internal medicine units.

2 Subjects and methods

The region Emilia Romagna (RER), located in north-eastern Italy, with a surface of 22,124 Km^2 and a population of ≈ 4.000,000, is administratively divided into nine provinces (Piacenza, Parma, Reggio Emilia, Modena, Bologna, Ferrara, Ravenna, Forlì-Cesena, Rimini). 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. RER includes eleven local health authorities (Piacenza, Parma, Reggio Emilia, Modena, Bologna, Imola, Ferrara, Ravenna, Forlì, Cesena, Rimini), five Teaching Hospitals (Parma, Reggio Emilia, Modena, Bologna, Ferrara) and one Research Orthopedic Institute (Bologna), with ≈ 17,000 beds for acute patients. The province of Ferrara (≈ 350,000 inhabitants, mean age 47.3 years, 25.9% > 65 years) is served by one Teaching Hospital (hub center) and three community hospitals (spoke centers, ≈ 200 beds/each). Local economy is mainly agriculture-based, and in minor part industrial.

This study was conducted between January 1, 2010 and July 31, 2012, at the St Anna Hospital of Ferrara, a 600-bed tertiary care teaching hospital, with a yearly ED patients flow of approximately 76,000. We analyzed age, sex, time of arrival to the ED, ED waiting time, and colour-code of all patients admitted to the Department of Medicine. In our hospital, this Department consists of four internal medicine units, and one unit each of infectious diseases, geriatrics, and gastroenterology. The Department of Medicine alone accounts for about one-third of all hospital admissions. As in all Italy, the ED triage assessment is based on a colour-code scale basis, with highest priority given to red code, followed by yellow, green, and white. The triage assessment is performed by expert nurses, with specific training and experience. Both medical and nursing staff of the hospital is permanent, with replacements (*e.g.*, festive days or holidays) warranted by apposite rotations among the entire staff. As temporal definitions, midnight Friday to midnight Sunday was considered as WE, and the nine main national festive days were always considered as Sunday-WE. Thus, the time period was classified into holidays (WE + festive days) and weekdays (WD), and daytime (8:00 am - 8:00 pm) and nighttime (8:00 pm - 8:00 am). IHM and LOS were assumed as primary and secondary objectives, respectively.

The results are presented as mean ± *SD* or percentages as appropriate. Patients were classified into deceased and survivors, and LOS was classified depending on length lower or higher than the median (seven days). Clinical parameters were compared in the two groups by t-test, chi-squared and Mann-Whitney U test as appropriate. In order to evaluate which variables were independently associated with IHM and LOS >7 days, logistic regression analysis was performed, with age, sex, time of ED arrival, ED boarding time, and colour code taken as the independent variables. A value of $p < .05$ was considered statistically significant. SPSS for Windows was used to analyze the data (SPSS, Version 13, SPSS Inc., Chicago, IL, USA).

3 Results

During the considered period, 13,237 consecutive patients visiting the ED (mean age 76.6 ± 13.5 years; 43.4% males, mean age 74.8 ± 13.6 years, 56.6% females, mean age 78.0 ± 13.3 years, $p < .001$), were admitted to the Department of Medicine. The preponderance of the female sample is given by the great percentage of old and very old inhabitants of Ferrara (3,500 people aged > 90 years), with significant presence of widows. Again, only 178 women (2.3%) were aged < 40 years (child bearing age). Patients' and ED admission characteristics are reported in Table 1.

Table 1. Main characteristics of the 13,237 subjects investigated

Mean (± *SD*) age (years)	76.6 ± 13.5
Males	5739 (43.4%)
Females	7498 (56.6%)
Daytime	9481 (71.6%)
Weekdays	9788 (73.9%)
Holiday	3667 (27.7%)
Green code	3257 (24.6%)
Yellow code	9157 (69.2%)
Red code	823 (6.2%)
Sunday	1664 (12.6%)
Monday	2217 (16.7%)
Tuesday	1940 (14.7%)
Wednesday	1904 (14.4%)
Thursday	1890 (14.3%)
Friday	1837 (13.9%)
Saturday	1785 (13.5%)
Mean (± *SD*) LOS (days)	8.9 ± 8.0

3.1 In-hospital mortality

Univariate analysis (see Table 2) showed that IHM was related to time of admission (daytime: 74.5% *vs*. 71.3%, nighttime: 25.5% *vs*. 28.7%, $p = .015$), WE or WD (WE: 28.6% *vs*. 25.8%, WD: 71.4% *vs*. 74.2%, $p = .026$), and holidays (holidays: 30.4% *vs*. 27.4%, no holidays: 69.6% *vs*. 72.6%, $p = .021$). Furthermore, IHM was in relation with colour code of admission (green: 3.9%, yellow: 9.5%, red: 41.7%, $p < .001$), and patients' age (76.2 ± 13.6 *vs*. 80.2 ± 12.0, $p < .001$). Thus, deceased subjects were older, more frequently admitted during daytime, WE and holiday, and characterized by a red colour-code.

Table 2. Univariate association for primary objective (IHS)

	Discharged (n = 11,901)	**Deceased (n = 1,336)**	***p***
Age (years)	76.2 ± 13.6	80.2 ± 12.0	< .001
Daytime	71.3%	74.5%	.015
Nighttime	28.7%	25.5%	
Weekend	25.8%	28.6%	.026
Weekday	74.2%	71.4%	
Holiday	27.4%	30.4%	.021
No holiday	72.6%	69.6%	
Green code	26.3%	9.5%	<.001
Yellow code	69.7%	64.8%	
Red code	4%	25.7%	

(Table continued on page 45)

Table 2. (continued.)

	Discharged (n = 11,901)	Deceased (n = 1,336)	*p*
Time to medical visit	0:46 ± 0:53	0:29 ± 0:36	< .001
Green code	0:57 ± 0:59	0:40 ± 0:43	.001
Yellow code	0:43 ± 0:50	0:32 ± 0:38	< .001
Red code	0:20 ± 0:28	0:16 ± 0:21	NS
Time of medical visit	1:37 ± 2:05	1:19 ± 1:09	<.001
Green code	1:36 ± 2:20	1:09 ± 1:03	.004
Yellow code	1:38 ± 2:02	1:22 ± 1:16	< .001
Red code	1:21 ± 0:59	1:14 ± 0:50	NS
Total time in the ED	2:23 ± 2:17	1:48 ± 1:19	< .001
Green code	2:33 ± 2:32	1:49 ± 1:12	< .001
Yellow code	2:21 ± 2:14	1:54 ± 1:27	< .001
Red code	1:41 ± 1:10	1:30 ± 0:56	NS
LOS (days)	9.0 ± 7.8	8.2 ± 10.1	.001

At the further multivariate analysis, an independent association with mortality was maintained only for colour code of admission yellow and red (yellow: OR = 2.5 [95% CI 2.06-3.03], $p < .001$, red: OR = 17.1 [95% CI 13.6-21.5], $p < .001$), and, with a less extent, age (OR = 1.02 [95% CI 1.02-1.03], $p < .001$) (see Table 3).

Table 3. Multivariate analysis for primary objective (IHS)

	In-hospital mortality		
	OR	**95% CI**	***p***
Age	1.02	1.02 - 1.03	< .001
Male	0.84	0.75 - 0.95	.006
Daytime	0.77	0.67 - 0.89	< .001
Yellow code	2.5	2.06 - 3.03	< .001
Red code	17.12	13.64 - 21.50	< .001

3.2 Length of stay

LOS (mean 8.9 ± 8 days, median seven days) was higher in subjects discharged alive than in deceased (9 ± 7.8 *vs*. 8.2 ± 10.1 days, $p < .001$). Due to the high variation of Standard Deviation, secondary to the non-normal distribution of LOS, we calculated also the median (M) and the interquartile range (IQR). Again, the difference was highly significant (M 7 and IQR 7 *vs*. M 5 and IQR 10.1, $p < .001$, for discharged alive and deceased, respectively).

Table 4. Univariate analysis for secondary objective (LOS)

	LOS < 7 days (n = 7,342)	LOS > 7 days (n = 5,895)	*p*
Age (years)	75.8 ± 14.2	77.6 ± 12.6	< .001
Daytime	68.4%	75.7%	< .001
Nighttime	31.6%	24.3%	
Weekend	27.2%	24.7%	.001
Weekday	72.8%	75.3%	
Holiday	28.8%	26.3%	.002
No holiday	71.2%	73.7%	
Green code	27.1%	21.5%	
Yellow code	66.4%	72.6%	< .001
Red code	6.5%	5.9%	

Univariate analysis showed that LOS > 7 days was related to time of admission (daytime 75.7% *vs*. 68.4%, nighttime 24.3% *vs*. 31.6%, $p < .001$), WE or WD (WE: 24.7% *vs*. 27.2%, WD 75.3% *vs*. 72.8%, $p = .001$), and holidays (holidays: 26.3% *vs*. 28.8%, no holidays 73.3% *vs*. 71.2%, $p = .002$). Furthermore, LOS > 7 days depended on both colour code of admission (green: 38.9%, yellow: 46.8%, red: 42.3%, $p < .001$), and patients' age (77.6 ± 12.6 *vs*. 75.8 ± 14.2, $p < .001$) (see Table 4). Thus, a longer LOS was associated with age, admission during daytime, WD and no holiday, and yellow code.

At the multivariate analysis (see Table 5), a significant correlation with a longer LOS was maintained only for yellow colour code (OR = 1.36; [95% CI 1.26-1.48], $p < .001$), and, with a less extent, for age (OR = 1.01; [95% CI 1.007-1.012], $p < .001$).

Table 5. Multivariate analysis for secondary objective (LOS)

Lenght of Stay > 7 days			
	OR	**95% CI**	***p***
Age	1.01	1.007 - 1.012	< .001
Daytime	0.71	0.65 - 0.76	< .001
Yellow code	1.36	1.26 - 1.48	< .001

4 Discussion

It is always rather complicated to try to analyze data and performances when considering the activity of an ED, a crucial node for hospital organization. Moreover, the time factor is important, since ED arrivals show also peculiar differentiated patterns depending on different diseases [17].

The main finding of our study is that IHM and LOS are not strictly affected by a weekend effect but rather by clinical conditions, such as disease severity expressed by colour code, and age. In fact, multivariate analysis showed that both parameters are associated with daytime admission, which appeared to be a protective factor, in agreement also with Lee *et al.* [18], who showed an increased IHM in patients admitted during the evening and night. Possibly, an earlier start of diagnostic procedures and treatment could impact patients' prognosis. Again, IHM rate was higher when admission occurred in post-office hours [8] and during the holidays [19]. As for WE versus WD, although a high mortality in subjects admitted during the WE has been reported by several authors, with an estimated increase of risk between 10% and 32% [14, 15, 20-22], in our study there was a trend in which more patients admitted during the WE died than those admitted on WD, but this was not confirmed by multivariate analysis. The results reported in the literature are not always consistent when considering the levels of hospital: the prognostic value of WE admission was identified more frequently in major teaching hospitals compared with nonteaching hospitals [23], but no correlation between WE admission and IHM was found in patients admitted to tertiary care hospitals [24].

As for LOS, in our study it was mainly dependent on patients' clinical conditions and, to a lesser extent, to age. LOS was higher in patients admitted with yellow colour code, probably due to extremely high mortality (> 25%) for patients admitted with red code. Moreover, LOS is also influenced by hospitalization during daytime, which seems to represent a protective factor. A study involving more than 45,000 patients admitted to different hospital departments, showed that hospitalization during WE (Friday, Saturday and Sunday) was associated with a longer LOS, and the same for admission during the afternoon and evening. In this study, however, the relationship between LOS and WE admission was not statistically significant for the medical department, but evident for general surgery, respiratory, and neurology departments [25]. The data are also inconclusive for admissions to the Intensive Care Unit (ICU). On the one hand, two studies did not show higher hospital mortality rate in patients admitted on WE or during off-hours in the United States and France, respectively [26, 27]. On the other, an increased risk of death was found in patients admitted to an ICU over the weekend, but not during the nighttime, in the United States [28]. Finally, Singer *et al.* [16] found that hospital mortality and

LOS were associated with length of ED boarding (from 2.5% in patients boarded less than two hours to 4.5% in those boarding 12 hours or more). However, these latter results are not comparable with those of our hospital, where mean ED LOS is only 2+/- 2 hours, and probably different organization is involved.

Limitations

The main limitation of this study is given by the setting (single center), and by a retrospective design based on colour-code assessment. This since colour-code assessment represents subjective judgement, and no precise data, *i.e.*, past medical history, presence of risk factors, medications assumed at home, physical examination on admission, were available. However, a major strength is given by the large sample size, well representative of the real world of the everyday hospital practice.

5 Conclusions

A series of studies confirmed a worst outcome for patients hospitalized on WE for several acute diseases [29-35], so that the definition of weekend effect has been introduced. Generally, this weekend effect has been ascribed to factors related to medical organization, such as presence of a less experienced staff, lower availability of procedures and reduction in the surveillance to patients secondary to understaffing [4]. We aimed to focus on the mass of urgent patients that is managed in the ED and then admitted to internal medicine units. This cohort of patients is characterized by intermediate-high level of urgency (6% red code, 69% yellow code, 25% green code, 0 white code), and probably by the need for lower intensity of instrumental procedures immediately requested. Again, health organization is different in our country, compared with United States or United Kingdom, where the majority of studies on WE mortality have been performed. We have not substantial differences in the presence of senior trained doctors and availability of technological equipment between WD and WE. Of course, the number of doctors on duty is reduced during WE, but not the level of experience of the medical, nursing and technical staff on duty. To the best of our knowledge, this is the first study specifically addressed to evaluate some outcome indicators of ED patients admitted to internal medicine wards in Italy. Although several unmodifiable factors influence clinical outcome, such as disease severity expressed by colour code on admission and age, a striking weekend effect is not evident for in-hospital mortality nor hospital length-of-stay. It seems that our hospital organization, although more expensive in terms of energies of senior doctors who maintain the rotations despite the continuously decreasing staffing secondary to economic constraints, may warrant equal intensity of care along the entire week.

Competing interests

The authors declare that they have no competing interests.

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