

The impact of weekends on outcome for Acute Exacerbations of COPD

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Competing interests

'The author(s) declare that they have no competing interests.'

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How does this advance the field?"

Data from a few clinical studies suggest that hospital function less effectively on weekends than on weekdays. Even small differences in mortality between weekday and weekend admission of patients with COPD can translate to substantial numbers of additional deaths in the population because of the high incidence associated with this condition.

"What are the clinical implications?"

COPD fatality is higher in weekend compared to weekday admissions, even after adjustment for case mix. Recognition of risk cases on admission could enable to mortality reduction allowing savings in term of cost through the intensification of treatment of these cases.

The impact of weekends on outcome for Acute Exacerbations of COPD

Differences in hospital staffing may influence outcomes for patients with acute conditions, including acute exacerbations of COPD, depending on which day of week the patients are admitted. This study was conducted to determine whether weekend admission increases the risk of dying in the hospital.

We analyzed the clinical data of 289,077 adults with acute exacerbations of COPD admitted to the hospital at any public centre in Spain, in 2006 and 2007. We analyzed day of admission, demographic, medical history and comorbidity for their association with death rate. During the study period there were 35,544 (12.4%) deaths during admission in COPD patients. Weekend admissions were associated with a significantly higher in-hospital mortality (12.9%) than weekday admissions (12.1%) among COPD patients (odds ratio [OR], 1.07; 95% confidence interval [CI], 1.04-1.10). The differences in mortality persisted after adjustment for age, gender, and co-existing disorders (1.05 OR 95% CI 1.02-1.08). Analyses of deaths within 2 days after admission showed larger relative differences in mortality between the weekend and weekday admissions (OR, 1.17; 95% CI, 1.11-1.23).

Patients with acute exacerbations of COPD are more likely to die in the hospital if they are admitted on a weekend as compared to a weekday.

Keywords: COPD, mortality, weekend effect.

INTRODUCTION

Acute Exacerbations of Chronic Obstructive Pulmonary Disease (COPD) are among the leading causes of morbidity and mortality in industrialised countries.^{1;2} Approximately 10% of all hospitalisations are directly or indirectly attributable to COPD,³ and Internal Medicine⁴ and Respiratory wards cared for many patients with this disease. Acute exacerbations of COPD requiring hospital treatment are a severe strain on Health Service and are responsible for at least two thirds of the total cost of treating respiratory diseases in both Europe and the USA.⁵ The acute exacerbation phase entails a substantial rate of hospital mortality⁶ The recognition of risk factors for mortality among patients hospitalised for COPD can be of crucial importance for curtailing cost and reducing mortality.

Several studies⁷⁻¹² conclude that weekend hospitalization is associated with worse health outcomes. These studies are supported by others works which^{13;14} find a positive correlation across hospitals between annual average staff-to-patients ratios and quality of care. Meanwhile the burden of disease and demand on health services is similar from one day to the next, on weekends there are staff shortages and reduced availability of services. Unfortunately this might not be compensated for by increased care on subsequent days.

The weekend effect on COPD has been specifically studied in a recent Australian work¹⁵ by a retrospective analysis of an administrative data from public hospitals, analyzing the 30-day-in-hospital mortality in 30,000 patients where no significant weekend effect was detected. However in a Finnish study² COPD patients admitted at weekends showed significantly higher mortality rates than those admitted on a weekday. We decided to use a bigger sample to confirm if the weekend effect is present in our country, because the Australian sample could have not enough size to demonstrate this small but transcendent effect. We believe that even small differences in clinical outcomes between weekday and weekend admission of patients with COPD could translate into substantial numbers of deaths for this patient population due to of the large number of patients hospitalized with COPD each year³. We decide to compare mortality rates among patients admitted with acute exacerbation of COPD on weekends and those admitted on weekdays.

MATERIAL AND METHODS

The study included all patients admitted to all acute care hospital of the Public Health Service through an emergency department in Spain between 1st January 2006 and 31st December 2007 with COPD as the primary reason for discharge. All elective admissions and elective transfers

were excluded. Hospital discharge data were obtained from the CMBD (basic minimum data set). CMBD contains sociodemographic and clinical data for each documented hospital admittance including: gender and age, primary and secondary diagnoses (according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* code); primary and secondary procedures; admission and discharge status; length of stay; and hospital characteristics (group 1 less than 150 beds; group 2: 150 to 200 beds, group 3: 200 to 500 beds; group 4: 500 to 1,000 beds; group 5 more than 1,000 beds). For every patient, a diagnosis-related group (DRG) was identified. DRGs are a way of classifying patient hospitalizations by diagnosis and procedure on the assumption that similar costs are expended on patients by using similar resources. The CMBD registry is compulsory for every patient admitted to a hospital of the Spanish National Health Service, a system that cares for more than 90% of the country's population

Cases were selected if they were discharged with the diagnosis of COPD (code DRG 88: CHRONIC OBSTRUCTIVE PULMONARY DISEASE, 540: RESPIRATORY INFECTIONS & INFLAMMATIONS WITH MAJOR COMPLICATIONS or 541: RESPIRATORY DISORDERS EXCEPT INFECTIONS, BRONCHITIS, ASTHMA WITH MAJOR COMPLICATIONS; DRG-AP.21 version). We also identify the primary diagnosis of COPD using ICD-9-MC codes in the primary diagnosis field: 491.0, 491.1, 491.9, 491.20, 491.21, 491.22, 496, 518.8, 518.81, and 518.9.

Consecutive patients were identified according to the day of the week in which they were admitted. The weekend was defined as the period between midnight on Friday and midnight on Sunday. All other times were defined as weekdays. These time frames were selected because of our confidence in the reliability of the code for day of the week. This convention has been used in other studies involving administrative databases^{8;10}. Patients were divided in two groups: 1) those dying during the hospital stay and 2) those discharged or moved to other centres. Two outcomes of interest were considered: 1) early mortality, defined as that occurring within the first 48 hours after admission, and 2) overall mortality, including deaths taking place at any time during the hospital stay.

Covariates included patient characteristics, the presence or absence of coexisting conditions (including acute respiratory failure, diabetes, hypertension, heart failure, chronic renal disease, anaemia, ischemic heart disease, dementia, cancer, pneumonia, stroke and cigarette smoking). The Charlson Co-morbidity Index (CCI)^{16;17} was computed for each patient. This index reflects the number and importance of co-morbid diseases, relies on ICD categories, and was used to

adequately adjust for the severity of illnesses. The index, which has been adapted for use with administrative databases, values the presence of 19 medical conditions, with a scale of 1-6, and a total grade between 0-37. An index value higher than 2 is related to a mortality rate greater than 50% per year.

Statistical analysis

We compared differences in demographic characteristics and mortality between patients admitted on weekends and on weekdays using the chi-square test or the T-test. Control for confounding is critical to the attribution of effects when using administrative data. We examined potential confounders (age, gender, CCI, coexisting conditions) and applied the conventional criteria for statistical significance ($p < 0.05$). Multiple logistic-regression models were used to account for confounding effects of patient demographics, coexisting conditions, and complications. Subgroup analyses were performed for patients with principal diagnosis of COPD. An analysis of deaths within one, two, three and four days after admission, and the same day of admission was performed. Differences in mortality rates were expressed as odds ratios for death, where appropriate. P values < 0.05 (two-tailed) were considered statistically significant. All statistical analyses were performed using SPSS 15.0.

RESULTS

During the study period, there were 289,077 COPD admissions which came from the emergency department. Median age of patients was 73.94 years (SD, 13.2); 69.9% of the patients were men. The median length of stay was 9.78 days (SD, 8.9). The median CCI value was 1.95 (SD 1.83; range 0-19), and a CCI ≥ 2 was present in 23.6% of the cases. COPD as a principal diagnosis was present in 132,465 cases (42.3%). Pneumonia (26,5%) was the second principal diagnosis and embolism the third one (2%). Overall, 24.1% (69,770) of the patients were admitted on weekends, and 75.9% (219,307) on weekdays. There were no relevant differences in demographic characteristics between the patients admitted on weekends and those admitted on weekdays. There were small but statistically significant differences in several conditions such as acute respiratory failure (more frequently in patients admitted on weekends), or cancer (more common in patients admitted on weekday) (Table1). The median score on the comorbidity index was higher among patients admitted on a weekday, as compared with those admitted on a weekend (1.96 vs 1.94; $p=0.005$).

The distributions of hospitalizations by the admission day of the week are shown in table 2. Monday was the most frequent day of admission for COPD (15.8%) and Saturday the least frequent day (11.7%). The proportion of weekend admissions differed from that which

would be expected (2/7 or 28.7%). The real proportion of weekend admissions were 24.1%.

Mortality

A total of 35,544 patients died during hospitalization (12.4%); 8,924 (25.1%) of them within the first 48 hours. In-hospital death rates differ by admission day of the week: Monday 11.7%, Tuesday 12.0%, Wednesday 11.9%, Thursday 12.3%, Friday 12.6%, Saturday 13.0% and Sunday 12.7% ($p < 0.001$). Compared to those seen on weekdays, those seen on weekends had a higher case fatality (12.9% vs 12.1%; OR 1.07 95%CI 1.04-1.10). Mortality remained significantly higher after adjustment for demographic characteristics and the presence or absence of coexisting conditions (1.04 OR 95% CI 1.02-1.07) (Table 3)

Analyses of patients with COPD as a main diagnosis showed the same differences in mortality between weekend and weekday admissions (OR 1.05 95% CI 1.01-1.10)

Short-Term Mortality

Analyses of deaths within two days after admission, rather than total in-hospital deaths, generally showed larger relative differences in mortality between weekend and weekday admissions. There was a small increase in mortality among patients admitted on a weekend (3.5% vs 3.0%, OR 1.18 95% CI 1.13-1.25). After adjustment by potential confounders there was a 16% increase in early mortality among patients admitted on a weekend (OR 1.17 95%CI 1.12-1.23). (Table 3)

Analyses of one-day in-hospital mortality showed greater weekend effect for COPD patients (adjusted odds ratio 1.39 95% CI 1.19-1.49) when compared with two days or global in-hospital mortality. Analyses of 1-day, 3-day and 4-day in-hospital mortality showed similar differences between weekend and weekday admission of COPD patients (adjusted OR 1.18 95% CI 1.12-1.26, 1-day mortality, 1.13 95% CI 1.09-1.18 for 3-days mortality and 1.13 CI 1.08-1.17 for 4-days mortality).

DISCUSSION

This study has demonstrated that among a large, representative population of patients admitted to the hospital for COPD exacerbation, there are differences in in-hospital death rates by the days of admission. Our study also showed that after adjustment for confounders, the mortality was higher among COPD patients admitted on weekends than among those admitted on weekdays. Some previous studies had not demonstrated the weekend effect in

the mortality of COPD patients¹⁵, because it is necessary a large sample to demonstrate this small (5%), but significantly and clinically relevant difference. An excess of 5% in weekend mortality means that 887 (95% CI 347-1387) COPD patients die annually in Spain due to weekend effect.

We found that the results of the adjusted analyses were similar to those of the crude analyses, suggesting that the findings were probably not due to unmeasured factors such as the severity of illness. Moreover, analyses of deaths within the same day, the first day and two days after admission yielded even larger differences in mortality between weekend and weekday admissions in COPD patients, a finding that supports a true difference and would not be expected if our findings were due to a general increase in the severity of conditions among patients admitted on weekends.

The problem with under-report conditions such as hypertension, cigarette smoking or allergies, has been previously reported²⁰ and is one of the limitations of the study. However, there is no obvious reason why errors or under-reported conditions should systematically vary between weekend and weekday admission. The figure of cigarette smoking is not plausible in this COPD database; however, smoking does not influence the increased risk of mortality of patients admitted during the weekend.

The principal limitation of this study is that unmeasured confounders may have contributed to the reported differences in mortality between patients admitted on weekends and those admitted on weekdays. For example, the data base does not include data on previous use of home oxygenotherapy, admission to the intensive care unit, blood gas values or medications administered during hospitalization. It is possible that differential administration of pharmacologic agents could explain some of the observed differences between weekend and weekday admission. Furthermore, patients admitted on weekends tended to have less neoplastic disease which would be associated with lower mortality, and had slightly higher rates of acute respiratory failure, which would be associated with higher mortality. Our study does not account for deaths that happened outside the hospital, which are more common on weekends than on weekdays, in some studies⁸. With the type of data used in this study, the interval exacerbation to admission can not be taken into account, which is also a limitation. But, although small differences were noted in certain baseline characteristics between

weekend and weekday admissions, they were included in the multivariate analysis, and differences in adjusted mortality were still observed. The increase in mortality persisted after adjustment for age, sex, the score on the Charlson comorbidity index and other potential confounders. We found that the results of the adjusted analyses were similar to the crude analyses, suggesting that the findings were probably not due to unmeasured factors such as the severity of illness. Moreover, analyses of deaths within two days after admission yielded even larger differences in mortality between weekend and weekday admissions, a finding that supports a true difference and would not be expected if our findings were due to a general increase in severity of conditions among patients admitted on weekends.

Our findings have several possible explanations. Hospital staffing is reduced on Saturdays and Sundays, also fewer supervisors are present in the hospital on weekends.^{13;14} In addition, the level of physician coverage for patients also differs on weekends in most hospital settings, and the weekend physician staff frequently provide coverage for other health professionals which might be less familiar with the patients under their care.^{9;18} There is less accessibility to certain resources as laboratory, radiology, or pulmonary specialist and weekend staff may be less familiar with non-invasive ventilation^{14;21} In COPD patients, the poorer prognosis may be linked to a shortage of pulmonary specialist or specialized internist on call at weekends. A young emergency department physician may be more reluctant to begin non-invasive ventilation to assist in a situation of respiratory insufficiency, which has been shown to reduce hospital mortality and improve the prognosis.¹⁹ Even small differences in clinical outcomes in patients with COPD could translate into substantial numbers of deaths for this patient population because of the large number of patients hospitalized with COPD each year³. Other plausible alternative explanations could be delay in admission patients during weekend. In addition weekend related changes in diet, physical activity, environmental cigarette smoke, exposure to infection^{2;22}, could play a role on the type of COPD patients admitted during weekends.

In conclusion COPD patients admitted at weekends showed poorer survival. Efforts should be made to increase the efficacy and decrease the fallibility of doctors during periods of short staffing. Although additional research is needed, electronic automated alarms designed to detect patients at higher risk or to ensure physicians apply specific protocols for special patients could help in this task²³. A recent study has provided empirical evidence that greater automation of a hospital's information systems may be associated with reductions in mortality, complications, and costs²⁴. Health information technology, such as electronic

medical records, computerized provider order entry systems, and clinical decision support systems, have been touted to improve patient safety and quality of care, while lowering costs.

Competing interests

'The author(s) declare that they have no competing interests.'

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Authors' contributions

Raquel Barba is responsible of the idea of this paper, did all the statistical analysis and work with the results.

Javier Marco confectioned the first draft and its final version for the approval of the other authors.

Susana Plaza help to obtain some meaning from the massive amount of results obtained from the raw data.

Juan E Losa did all the pertinent crosses between partial results in order to achieved final results with statistical significance.

Jesús Canora helped write the discussion of the paper and made the bibliographic revision.

Cristina Rosado did the bibliographic revision.

Antonio Zapatero was the coordinator of the group and, as president of the Group of Medical Management of the SEMI (Sociedad Española de Medicina Interna – Spanish Society of Internal Medicine) was the official liaison with the Spanish Ministry of Health for the procurement of the crude data.

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Table 1- Characteristics of COPD patients with a hospital admission on weekends and weekdays.

	Weekend	Weekday	p
Nº Admissions (%)	69,770 (23.4)	219,307 (76.6)	
Median Age yr (SD)	74.23 (13.23)	73.85 (13.19)	<0.001
Male Sex (%)	48,452 (69.4)	153,617 (70.0)	0.03
Comorbidity: Charlson			0.02
0	8160 (11.7%)	24628 (11.2%)	
1	27410 (39.3%)	85861 (39.2%)	
2	17910 (25.7%)	56859 (25.9)	
>2	1625 (23.3%)	51872 (23.7%)	
Coexisting conditions (%)			
Acute respiratory failure	38,463 (55.1)	117,044 (53.4)	<0.001
Chronic Renal Disease	3,728 (5.3)	11,611 (5.3)	0.651
Anemia	7,223 (10.4)	22,035 (10.1)	0.02
Heart failure	12,449 (17.8)	38,935 (17.8)	0.593
Ischemic Heart disease	3,642 (5.2)	11,093 (5.1)	0.1
Cancer	8,238 (11.8)	26,744 (12.2)	0.006
Pneumonia	20,497 (26.1)	62,589 (27.8)	<0.001
Pulmonary embolism	1425 (2.0%)	4740 (1.9%)	0.457
Dementia	4,292 (6.2)	12,358 (5.6)	<0.001
Diabetes	16,332 (23.4)	51,260 (23.4)	0.850
Cigarette smoking	9,784 (14.0)	32,211 (14.7)	<0.001
Hypertension	12,449 (17.8)	38,935 (17.8)	0.593
Non invasive ventilation	4296 (1.8%)	1237 (1.7%)	0.041
Length of Stay (days)	9.56 (9.01)	9.84 (8.90)	<0.001
Mortality (%)	8,982 (12.9)	26,562 (12.1)	<0.001
Early mortality (%)	2,440 (3.5)	6,484 (3.0)	<0.001

Table 2 - Number and percentage of patients admitted each day of the week.

	<i>Frequency</i>	<i>Percent</i>
Sunday	33955	11.7
Monday	45667	15.8
Tuesday	44815	15.5
Wednesday	42928	14.9
Thursday	42296	14.6
Friday	43601	15.1
Saturday	35815	12.4
Total	289077	100.0

Table 3 – Association between COPD characteristics and both short term and overall mortality

	Undjusted OR Short-Term Mortality*	Adjusted# OR Short-Term Mortality*	Undjusted OR Overall Mortality	Adjusted OR# Overall Mortality
Age (median)	2.05 (1.97-2.15)	1.76 (1.68-1.84)	2.05 (2.01-2.10)	1.81 (1.76-1.85)
Gender (woman)	1.37 (1.31-1.43)	1.14 (1.11-1.20)	1.28 (1.27-1.31)	1.13 (1.11-1.16)
Chalson index (CCI)				
0	1	1	1	1
1	0.51 (0.47-0.54)	0.55 (0.51-0.59)	0.56 (0.54-0.59)	0.62 (1.59-0.64)
2	0.71 (0.66-0.76)	0.73 (0.68-0.79)	0.83 (0.80-0.87)	0.88 (0.84-0.92)
>2	1.1 (1.01-1.16)	1.17 (1.09-1.25)	1.54 (1.49-1.90)	1.74 (1.68-1.82)
Dementia	2.67 (1.51-2.84)	1.97 (1.84-2.11)	2.95 (1.85-3.06)	2.11 (2.04-2.20)
Acute respiratory failure	2.45 (1.34-2.57)	2.18 (2.08-2.30)	1.21 (1.16-2.26)	2.03 (1.98-2.08)
Pneumonia	1.50 (1.44-1.57)	1.19 (1.13-1.25)	1.56 (1.52-1.59)	1.34 (1.30-1.37)
Pulmonary embolism	1.76 (1.57-1.98)	1.53 (1.35-1.72)	1.57 (1.47-1.68)	1.49 (1.39-1.60)
Non invasive ventilation	1.09 (0.94-1.27)	1.14 (0.98-1.33)	1.42 (1.32-1.53)	1.55 (1.43-1.67)
Weekend admissions	1.21 (1.15-1.17)	1.17 (1.11-1.23)	1.07 (1.04-1.10)	1.05 (1.02-1.08)

*Deaths within two days after admission

Regression logistic analyses