Friday and weekend hospital stays: effects on mortality

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ABSTRACT While weekend hospital admissions are associated with higher mortality, the effects of weekend hospital stays are not known. We assessed whether patients hospitalised for chronic obstructive pulmonary disease (COPD) or pneumonia have higher mortality during weekend and Friday stays.

Our cohort consisted of all hospitalisations for COPD or pneumonia during 1990–2007 from the healthcare databases of the province of Quebec, Canada. The hazard ratio (HR) of in-patient death associated with Friday and weekend stay was estimated by the Cox model with time-dependent covariates, adjusted for age, sex and comorbidity.

The cohort included 323 895 hospitalisations for COPD or pneumonia during which 32 414 deaths occurred (rate of death 8.06 per 1000 per day). Mortality was higher for weekend (HR 1.06, 95% CI 1.03–1.09) but not Friday admissions (HR 0.97, 95% CI 0.95–1.00), relative to Monday–Thursday admissions. Independently of the admission day, mortality was higher during weekend stays (HR 1.07, 95% CI 1.04–1.09) and Friday stays (HR 1.05, 95% CI 1.02–1.08), relative to Monday–Thursday stays.

Patients hospitalised for COPD or pneumonia are at increased risk of death when staying over on a Friday or a weekend. The additional 40–56 deaths per 100 000 patients staying in hospital on those days are most likely due to reduced access to healthcare at that time.

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Introduction

Patients admitted to hospital on weekends have been observed to have higher mortality than those admitted on weekdays [1–4]. Inadequate adjustment for differences in case mix between weekday and weekend admissions makes it difficult to distinguish whether the excess mortality results from sicker patients being admitted on the weekend or to differences in quality of care delivered at that time [5, 6]. Studies of patients admitted for specific conditions such as stroke and myocardial infarction, believed to allow for more refined adjustment for prognostic factors to improve the ability to identify aspects of care at weekends that might be responsible for excess mortality, also show increases in mortality [7, 8].

If the excess mortality is caused by reduced staffing and access to diagnostic and treatment modalities during weekends, an increase in risk of poor outcomes should also be observed for weekend stays among patients admitted on weekdays. No study has evaluated the effects of weekend stays, rather than admissions, on patients admitted on other days of the week but who remain in hospital during the weekend. Another issue in many places around the world is that staffing on Fridays is also often reduced, which raises the question of the effect of stays during a pre-weekend day on in-hospital mortality. Indeed, a recent study from England found that patients undergoing elective surgery on Fridays and at weekends have a higher risk of death [9].

We use a large population-based cohort of patients hospitalised for COPD or pneumonia to assess the effect of weekend and Friday admissions and stays on in-hospital mortality.

Methods

Data source

We used the computerised databases of the Régie de l'Assurance Maladie du Québec (RAMQ), the agency responsible for administering the universal health insurance programme of the province of Quebec, Canada, for all its 7 million residents. The various databases include information on demographics and outpatient medical services rendered, along with the diagnostic code of the service (International Classification of Diseases (ICD)-9 or ICD-10), for all residents of the province. In addition, the database contains and provides information on all hospitalisations in acute care hospitals in Québec including dates of admission and discharge, and the primary and several secondary diagnoses. For people aged $\geqslant$65 years, social welfare recipients and, since 1996, residents who choose to join the provincial drug plan, the prescription drugs database includes all dispensed outpatient prescription medications. The RAMQ databases are linked to each resident's unique health insurance number. These databases have been used previously to conduct several epidemiological studies [10–12].

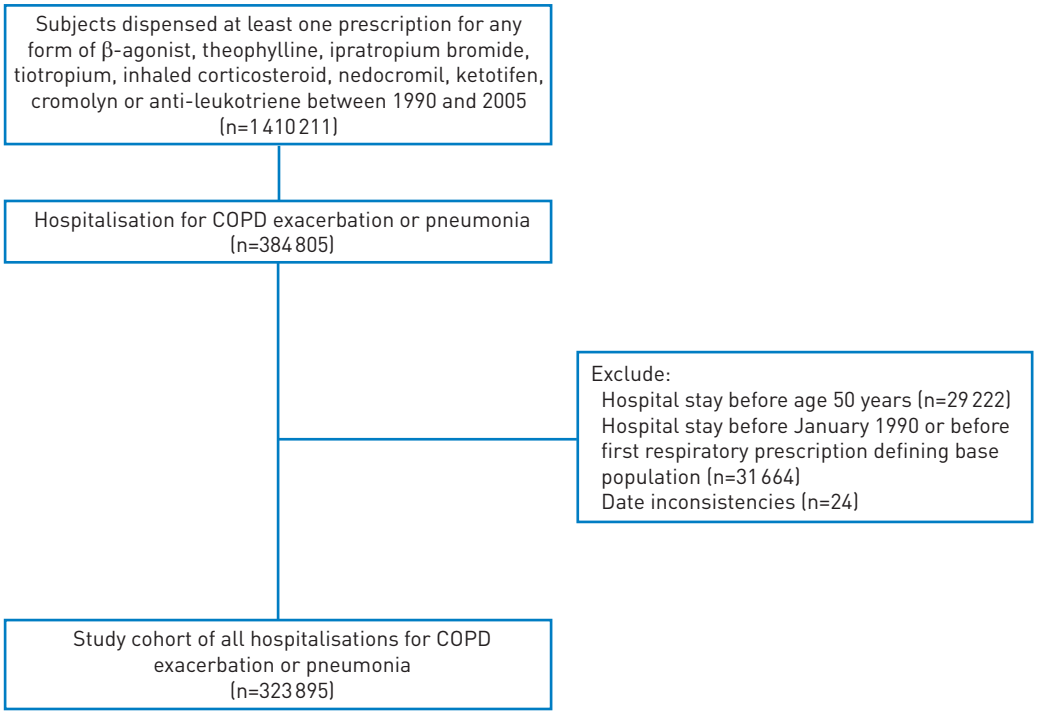

FIGURE 1 Flowchart of cohort formation. COPD: chronic obstructive pulmonary disease.

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TABLE 1 Patient characteristics on admission for the entire cohort defined by a hospitalisation for chronic obstructive pulmonary disease or pneumonia and for those who died in hospital

	Entire cohort	In-hospital deaths
Patients n	323 895	32 414
Age at cohort entry years mean±SD	75.1±9.1	78.7±8.6
Males	54.6	59.9
Cohort entry after year 2000	48.4	47.9
Prior hospitalisations		
0	42.4	46.5
1	18.8	18.8
2	11.0	10.3
⩾3	27.8	24.4
Day of admission		
Monday	14.8	14.5
Tuesday	15.1	15.4
Wednesday	15.1	15.2
Thursday	15.3	15.2
Friday	16.5	16.6
Saturday	12.0	12.0
Sunday	11.2	11.1
Modified chronic disease score#		
First quartile	25.0	24.7
Second quartile	25.3	23.4
Third quartile	24.7	24.7
Fourth quartile	25.0	24.7

Data are presented as % unless otherwise stated. #: at least one dispensed prescription, among the 94% of patients with available medication information in the year prior to cohort entry.

Cohort definition

We used data from an existing database of all residents of Quebec who, during 1990–2005, were dispensed at least one prescription for a respiratory medication, including any form of β-agonist, theophylline, ipratropium bromide, tiotropium or an inhaled corticosteroid. From this population, we identified the cohort of all patients who, between January 1, 1990, and March 31, 2007, were hospitalised with primary diagnoses of COPD (ICD-9 codes 490–492 and 496, and ICD-10 codes J40–J44) or pneumonia (ICD-9 codes 480–487.0, and ICD-10 codes J10.0, J11.0 and J12–J18) after the age of 50 years. These diagnoses in the RAMQ database have previously been shown to be valid using full medical records [13]. Cohort entry was defined as the date of admission with follow-up until discharge, alive or dead. Subjects hospitalised on more than one occasion during this period were considered independent hospitalisations and, thus, a subject could contribute multiple times to the cohort, with cohort entry redefined as the date of admission. Age on admission, sex, calendar year of admission, number of prior admissions since the first one in the cohort and comorbidity measured on admission were also included as adjustment factors for this effect. Comorbidity was measured during the year prior to cohort entry using the modified Von Korff chronic disease score (CDS), devised specifically for pharmacy claims databases, but excluding age and sex, which were considered as separate covariates [14].

Data analysis

Crude rates of in-hospital death were computed using cumulated person-days of hospital stay. To estimate the effect of day of admission, the Cox proportional hazards model was used to estimate the hazard ratio (HR) of death as a function of the day of admission, comparing Friday, as well as Saturday–Sunday, to the rest of the week. To estimate the effect of a Friday or weekend stay on mortality, we also used a Cox proportional hazards model with day of stay included as a time-dependent factor. This time-dependent model allows the patient to switch between hazard functions as their stay alternates between a weekday, Friday and the weekend, while accounting for the duration of hospital stay. This model also included Friday and weekend admissions as covariates, so that the time-dependent Friday and weekend stay effects can be interpreted as above and beyond that of the day of admission. Finally, a sensitivity analysis to verify whether the effects of Friday and weekend stays remained consistent over time was performed using Poisson regression with the person-moments classified for each of the first 3 weeks of stay. This model fit the effects

TABLE 2 Rates of in-hospital death according to the day of admission and the day of stay for the cohort of patients hospitalised for chronic obstructive pulmonary disease

	Person-days	Deaths	Rate per 1000 per day
Day of admission			
Monday	587 077	4694	8.00
Tuesday	605 279	4978	8.22
Wednesday	620 525	4926	7.94
Thursday	627 313	4939	7.87
Monday–Thursday	2 440 194	19 537	8.01
Friday	687 664	5387	7.83
Saturday	469 609	3890	8.28
Sunday	425 062	3600	8.47
Day of stay			
Monday	578 073	4563	7.89
Tuesday	585 185	4594	7.85
Wednesday	585 123	4548	7.77
Thursday	581 860	4609	7.92
Monday–Thursday	2 330 241	18 314	7.86
Friday	581 730	4748	8.16
Saturday	553 855	4780	8.63
Sunday	556 703	4572	8.21

of the first, second and third Friday and weekend, with the prior weekdays as the reference group, and with time in hospital as a time-dependent factor to account for duration of hospital stay. In all models, age, sex, prior admissions, calendar year of admission (pre- and post-2000) and comorbidity, measured by the CDS and divided into quartiles, were included as adjustment factors for the estimated HRs. All analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC, USA). We obtained ethics approval for this study from the Research Ethics Committee of the Jewish General Hospital, Montreal, Canada.

Results

There were 1 410 211 people dispensed a respiratory medication during 1990–2005, generating a cohort of 323 895 hospitalisations for COPD (69%) or pneumonia (31%) in subjects age $\geqslant$50 years (fig. 1). On admission to hospital (cohort entry), the patients were 75 years of age on average and 55% were males (table 1). Moreover, the number of hospital admissions for COPD was lower on Friday, Saturday and Sunday than the rest of the week. The mean duration of hospital stay was 12.4 days, during which there were 32 414 deaths for an overall mean rate of death of 8.06 per 1000 per day.

Table 2 displays the crude mortality rate of patients admitted each day, suggesting higher rates on Saturday and Sunday, but not Friday, than when admitted on the other days of the week. It also suggests that mortality during Friday, Saturday and Sunday stays is higher than stays on the other days of the week. Table 3 shows that the corresponding adjusted estimates of the HRs of death are 1.06 (95% CI 1.03–1.09) for weekend admissions and 0.97 (95% CI 0.95–1.00) for Friday admissions, relative to weekday admissions.

TABLE 3 Crude and adjusted hazard ratios (HRs) of in-hospital death according to the day of admission and the day of stay, estimated by Cox proportional hazards model

	Day of admission		Day of stay	
	Crude HR	Adjusted[#] HR (95% CI)	Crude HR	Adjusted[#] HR (95% CI)
Weekday[¶] (reference)	1.00	1.00 (reference)	1.00	1.00 (reference)
Friday	0.98	0.97 (0.95–1.00)	1.05	1.05 (1.02–1.08)
Weekend	1.06	1.06 (1.03–1.09)	1.07	1.07 (1.04–1.09)

[#]: for age, sex, calendar year of admission, admission day (weekday, Friday or weekend), prior hospitalisation and the modified chronic disease score divided into quartiles with a fifth category to account for subjects with no medication information in the year prior to cohort entry; [¶]: Monday–Thursday inclusive.

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TABLE 4 Crude and adjusted rate ratios (RRs) of in-hospital death according to the day of stay, relative to weekdays[#], stratified by diagnosis, sex and year of admission time

	Friday stay		Weekend stay	
	Crude RR	Adjusted[¶] RR (95% CI)	Crude RR	Adjusted[¶] RR (95% CI)
Hospitalisation diagnosis				
COPD	1.05	1.06 (1.01–1.10)	1.09	1.09 (1.05–1.13)
Pneumonia	1.04	1.04 (1.00–1.09)	1.04	1.04 (1.00–1.08)
Sex				
Male	1.07	1.07 (1.03–1.12)	1.08	1.08 (1.05–1.12)
Female	1.01	1.02 (0.97–1.07)	1.04	1.04 (1.00–1.08)
Calendar year of admission				
1990–1995	1.08	1.08 (1.02–1.15)	1.07	1.07 (1.02–1.12)
1996–2000	1.02	1.02 (0.96–1.08)	1.06	1.05 (1.01–1.10)
2001–2007	1.05	1.05 (1.01–1.11)	1.08	1.07 (1.03–1.12)

COPD: chronic obstructive pulmonary disease. [#]: Monday–Thursday inclusive; [¶]: for age, sex, calendar year of admission, admission day (weekday, Friday or weekend), prior hospitalisation and the modified chronic disease score divided into quartiles with a fifth category to account for subjects with no medication information in the year prior to cohort entry.

It also shows that, irrespective of the admission day, the HR of death is 1.05 (95% CI 1.02–1.08) during Friday stays and 1.07 (95% CI 1.04–1.09) during weekend stays, relative to weekday stays. Table 4 presents the HRs for Friday and weekend stays stratified by hospitalisation diagnosis, sex and calendar year of admission, with generally similar effects.

Table 5 confirms the consistency of these effects observed for Friday and weekend stays across successive weeks of hospitalisation. Figure 2 depicts the estimated rate ratio of death (from table 3), illustrating Friday and weekend mortality for typical patients admitted on a Monday and staying 3 weeks. It shows the increase in mortality on Fridays and weekends, and the return of the baseline rate on Monday, above and beyond the inherent increasing mortality with longer length of stay.

Discussion

In a cohort of >300 000 patients hospitalised for COPD or pneumonia, we identified an excess in-hospital mortality for in-patients staying over on the weekend. We also found that patients staying over on Friday had higher mortality, albeit less than on the weekend. Moreover, as in previous reports, we confirmed an excess in-hospital mortality for those admitted at weekends. Prior studies have assessed the effect of

TABLE 5 Crude and adjusted hazard ratios (HRs) of in-hospital death according to the day of stay relative to weekdays for each of the first three weeks of hospitalisation, estimated by Poisson regression

	Deaths	Person-days	Rate per 1000 per day	Crude HR	Adjusted[#] HR (95% CI)
First week					
Weekday[¶] (reference)	2293	473 288	4.84	1.00	1.00 (reference)
Friday	1307	228 225	5.73	1.18	1.05 (0.98–1.12)
Weekend	3276	516 287	6.35	1.31	1.04 (0.98–1.10)
Second week					
Weekday[¶] (reference)	6013	869 309	6.92	1.00	1.00 (reference)
Friday	1272	153 558	8.28	1.20	1.10 (1.03–1.17)
Weekend	2127	241 882	8.79	1.27	1.10 (1.03–1.17)
Third week					
Weekday[¶] (reference)	3372	370 665	9.10	1.00	1.00 (reference)
Friday	707	68 020	10.39	1.14	1.08 (0.99–1.18)
Weekend	1241	113 271	10.96	1.20	1.10 (1.01–1.19)

[#]: for age, sex, calendar year of admission, prior hospitalisation and the modified chronic disease score divided into quartiles with a fifth category to account for subjects with no medication information in the year prior to cohort entry, as well as time in hospital, as a time-dependent factor to control for the effect of the length of hospital stay; [¶]: Monday–Thursday of the week preceding the respective Friday and weekend.

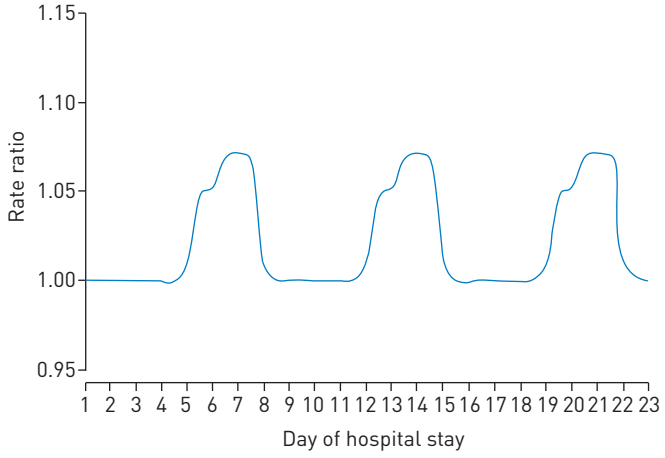

FIGURE 2 Estimated rate ratio of in-hospital death for Friday, Saturday and Sunday stays, above and beyond the effect of length of stay, over the course of hospitalisation for typical patients admitted on a Monday (day 1) and hospitalised for 22 days.

weekend admission on mortality. A study of >3.7 million hospital admissions in Ontario, Canada, found increases in hospital mortality for 23 of the 100 most common causes of death for patients admitted to hospital at the weekend compared with weekday admissions [1]. This excess mortality was most apparent for pre-specified conditions where rapid assessment and institution of care appear most critical, such as acute epiglottitis, ruptured aortic aneurysm or intracerebral bleed [1]. More recently, a 10% excess mortality for nonelective weekend admissions was reported in a 20% sample of US community hospitals [2]. A similar excess in hospital mortality for elective admissions has recently been reported from the UK [3]. Studies of outcome among patients hospitalised for specific conditions found a 14% excess in stroke mortality for weekend admissions after adjustment for comorbidities and medical complications [7]. Similarly, a 1% absolute excess in mortality was reported for weekend admissions for a first myocardial infarction, which was partially explained by the lower rate of invasive procedures carried out on the weekend [8]. An excess has been previously reported for patients admitted for COPD exacerbations with a greater excess for deaths occurring in the first 48 h [15].

Our study is the first report of mortality increases for in-patients staying over the weekend. Our study implies that, irrespective of when patients are admitted, their risk of death increases by 5% on Fridays and by 7% on Saturday and Sunday, returning to baseline once Monday comes around. This strongly suggests that excess weekend mortality is due to reduced quality of care on weekends, which appear to start as of Friday. One would not expect the prognosis of in-patients admitted for COPD or pneumonia to vary by weekday after accounting for the effect of duration of stay. HORWICH *et al.* [16] have found a decrease in indicators of good quality of care in patients with heart failure admitted or discharged on the weekend. Prognosis of in-hospital cardiac arrest is poorer if it occurs on weekends and at night, although this is less pronounced in monitored settings [17]. The lack of a weekend effect on mortality after adjustment for case mix in well-staffed intensive care units suggests that assuring similar quality of care at all times eliminates the excess in weekend mortality [18, 19].

The use of a population-based cohort approach that includes all hospitalisations in this inception cohort of patients using respiratory medications is a strength of the study, avoiding selection bias. Another strength is the large sample size, which provides tight confidence intervals for these estimates. Limiting the study to patients admitted to hospital for the specific diagnoses of COPD or pneumonia, and adjusting for age, sex and comorbidity makes it less likely that the excess mortality resulted from greater severity of patients admitted on the weekend. The results stratified by hospitalisation diagnosis, sex and calendar year of admission produced generally consistent effects, within expected variations from random error as evidenced by the largely overlapping confidence intervals. A potential limitation of the study is the diagnosis of COPD and pneumonia, based exclusively on discharge codes, although these were based on the primary discharge diagnoses, previously shown to be valid in this database [13].

The implications of our findings are important. First, with a weekday mortality rate of 80.0 per 10 000 per day, an increase of 5% on Friday and 7% on the weekend implies an expected additional four deaths per 10 000 patients staying in hospital on Fridays and 5.6 per 10 000 for each weekend day. In Quebec, yearly, there are ~30 000 patients in hospital for COPD or pneumonia on any given Friday and weekend. Our study implies that 12 additional deaths occur by the mere fact of being in hospital on the Friday and 33 by staying on the Saturday or Sunday.

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In all, this study identified a crucial time period during which in-patients are more likely to die. Adjustments in the organisation of care of patients staying in hospital from Friday to Sunday could avert a significant number of probably preventable deaths.

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