Is weekend hospitalisation associated with an additional risk of death? A prognostic model derived from over 14 million hospitalisations in the National Health Service in England in 2009/10.

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Abstract

Background

Weekend admissions and hospital stays may be associated with additional patient risk.

Methods

We analysed all admissions to the English National Health Service (NHS) during the financial year 2009/10, , following up all patients for 30 days after admission and accounting for risk of death associated with diagnosis, co-morbidities, admission history, age, sex, ethnicity, deprivation, seasonality, day of admission and hospital trust, including day of death as a time dependent covariate. The principal analysis was based on time to in-hospital death.

Results

There were 14,217,640 admissions included in the principal analysis, with 187,337 in-hospital deaths reported within 30 days of admission. Admission on weekend days was associated with a considerable increase in risk of subsequent death compared with admission on weekdays, hazard ratio for Sunday versus Wednesday 1.16 (95% CI 1.14 to 1.18; $P < .0001$), and for Saturday versus Wednesday 1.11 (95% CI 1.09 to 1.13; $P < .0001$). Hospital stays on weekend days were associated with a lower risk of death than midweek days, hazard ratio for being in hospital on Sunday versus Wednesday 0.92 (95% CI 0.91 to 0.94; $P < .0001$), and for Saturday versus Wednesday 0.95 (95% CI 0.93 to 0.96; $P < .0001$). Similar findings were observed on a smaller US data set.

Conclusions

Admission at the weekend is associated with increased risk of subsequent death within 30 days of admission. The likelihood of death actually occurring is less on a weekend day than on a mid-week day.

Introduction

Healthcare systems organise services differently during the week-end period compared to week days and there is some evidence that this may affect the quality of care and the outcomes of patients.[1-7] Therefore identification and quantification of increased week-end mortality may promote the redesign healthcare services in order to improve outcomes.

A number of studies have identified an increased risk of death associated with weekend emergency admissions in the UK,[1] and Spain.[2] Others have identified an increased risk of death associated with weekend acute admissions for ruptured abdominal aortic aneurysms, acute epiglottitis, and pulmonary embolism in Canada,[3] for acute myocardial infarction, for acute kidney injury in US,[4,5] and an increased neonatal mortality among teenage mothers giving birth during the weekend compared with mid-week days.[6] A recent report using contemporary data illustrated a higher in hospital mortality rate for patients admitted at week-end in UK and has contributed to the debate around redesigning the NHS to provide a week end service similar to the other days of the week.[8] However, despite these reports, several questions remain unanswered. It is not known whether there is an unmeasured increased patient risk profile associated with weekend admission. Previous studies have not addressed conclusively whether the reported increased week-end mortality affects emergency or elective admissions or both, whether this phenomenon applies to the entire spectrum of diseases and whether there is a prognostic difference between being admitted or being already an in-patient at week end.

To address these deficiencies all admissions to National Health Service Hospitals in England during a 12 month period, we conducted a study to assess whether week end admissions to hospital and or being already an in-patient on weekend days were associated with any additional mortality risk. We also aimed to assess whether outcomes were consistent across a range of clinical conditions, and different analytic approaches, and whether the results for the NHS were consistent with academic not-for-profit hospitals in the US.

Methods

We developed survivorship models to estimate risks associated with hospital admissions and hospital stays on different days of the week, accounting for markers of patient severity.

Data sources and statistical models

We studied all admissions to National Health Service Hospitals in England between April 2009 – March 2010 using inpatient hospital episode information for all hospital trusts within England.[9] We accessed linked data on mortality (both inside and outside hospital) from the Office of National Statistics statutory death recording.[9] The UHB institutional review board approved the study (authorisation number CAB-03779-11).

We developed Cox models to account for differences in risk of death among admitted patients,[10] including follow up to 30 days in all patients, removing subjects from the 'at-risk' group only at death. For continuous variables with suspected non-linear response, we evaluated restricted cubic splines with 5 knots.[11] Where these achieved a substantial improvement in model fit (a reduction in Akaike's Information Criterion[12] ≥ 4) these were included in the model. For counts, we evaluated the transformation of $\log_e(1+n)$.

In the principal model we included information on available known risk factors for increased mortality: age; sex; ethnicity; whether or not the admission was classified as an emergency; source of admission (eg from home or transfer from another hospital); diagnostic group (as Clinical Classification Software Categories[13] (CCS)); number of previous emergency admissions; number of previous complex admissions; Charlson Index of co-morbidities;[14] social deprivation;[15] hospital trust; day of the year (seasonality); and day of admission. We examined the risks associated with weekend hospital stays by adding a time-dependent covariate describing hazards associated with each day, with Wednesday as the referent case day. Follow up for all patients was to in-hospital death or censorship (no longer considered at risk while not having experienced an index event) at out of hospital death or 30 days.

In supportive analyses we examined the risks associated with hospital admission and stays during the weekend including all deaths (in and out of hospital) during the 30 day period, an analysis analogous to an intention to treat approach, including for instance patients who die at home soon after discharge. We analysed separately the ten individual Clinical Classification Software (CCS) categories associated with the highest number of in-hospital deaths within 30 days for in-hospital death. We estimated risk associated with weekend hospital stays for those admitted as emergencies and those admitted as non-emergencies. Because many deaths occur soon after admission and may confound the separation of hazard associated with day of admission and risk associated with hospital stays, we repeated the in-hospital death analysis censoring deaths which occurred within 3 days of admission. We described the risks associated with hospitalisation on different days for patients admitted at the weekend and those admitted during the week. We repeated the analysis in hospitals with or without 'University' status. To ensure the observed results were not due to an artefact of the approach, we replicated the analysis separately for emergency and non-emergency admissions using a generalised linear model with a complementary log-log link function and binomial error, based upon a series of contingency tables for the risk of death over 30 days according to day of the week.

We repeated our analysis on data from July to September 2010 from United Health Care Systems, relating to activity from 254 leading managed care hospitals and representing approximately 90% of all the academic not-for-profit hospitals in the United States. The model fitted to these data could not include all the explanatory variables in the English model, specifically: previous emergency admissions; previous complex admissions; deprivation; and day of the year.

Analyses were conducted using the 64-bit version of SAS (SAS Institute, Cary NC, version 9.2), on a Dell PowerEdge R610 64-bit, 64GB, 2x Intel (R)

Xeon(R) 5550@2.67GHz,2660MHz 4Core(s), 8 logical server. The principal analysis took 12 days.

Results

Data Integrity

During the study period there were 15,061,472 reported admissions to the NHS in England. In 14,217,640 cases, information on mortality at 30 days and each of the patient characteristics listed in the analysis plan was available and was included in the principal analyses (5.6% missing). We included 187,337 in-hospital deaths reported within 30 days of admission.

The number of patients in hospital by day of the week during the 30-day period after admission is described in Figure 1. The corresponding number of deaths within 30 days of admission, both in-hospital and post discharge, is shown in Figure 2.

In the principal multivariable model, the variables Age, Previous Emergency Admissions, Previous Complex Admissions, Charlson Comorbidity Index,[14] Male vs Female, Ethnicity, Emergency Admission, Day of the year, Admission Source, Index of Multiple Deprivation,[15] Admitting clinical condition (CCS Category),[13] and Hospital Trust, were all highly statistically significant predictors of mortality (Table 1).

Effect of weekend hospital admission on mortality

We identified a significantly higher risk of subsequent in-hospital death during the 30-days follow-up period associated with admission during the weekend (Saturday or Sunday) compared to mid-week days. Admission on Tuesday through Friday was associated with the lowest risk of in-hospital death, while admission on Sunday was associated with the highest risk (Figure 3a). Admission on Saturday was associated with a marked increased mortality risk and admission on Monday was associated with a less but statistically significant increased risk.

The 10 clinical conditions (CCS groups) associated with the greatest number of in-hospital deaths were pneumonia, acute cerebrovascular disease, congestive heart failure, acute myocardial infarction, chronic obstructive pulmonary disease, cancer of bronchus; lung, septicaemia (except in labour), acute and unspecified renal failure, urinary tract infections, fracture of neck of femur (hip). The day of admission was associated with increased risk of subsequent in-hospital death in seven of the 10 most common CCS groups, but not in fracture of the neck of femur, chronic obstructive airways disease, or pneumonia.

Being an in-patient in hospital on Sunday, regardless of the day of admission was associated with a lower risk of death (on that day) than Wednesday (hazard ratio 0.92 [95% CI 0.91 to 0.94] P <.0001). Similarly Saturday was associated with reduced risk of in-hospital death compared with Wednesday (hazard ratio 0.95 [95% CI 0.93 to 0.96] P <.0001). Monday, Tuesday and Wednesday were associated with similar risks of in-hospital death, while

Thursday and Friday were associated with slightly reduced risks (both P <.0001) (Figure 3b).

Hazards associated with specific hospital stays by day of the week for the 10 CCS groups for which there was the highest number of in-hospital deaths are described in Table 2. These models showed a high level of consistency.

Supportive analyses

In the supportive model examining all deaths (in or out of hospital) within 30 days of admission 284,852 patients died (of whom 34% died after discharge from the index hospitalisation). Results for the model examining all deaths within 30 days of admission are qualitatively similar to the principal model (Table 2).

We examined the hazards associated with hospital admission and in patient stays on different days of the week for patients with emergency and non emergency admissions (Table 2). Emergency admissions included 94% of in-hospital deaths, and closely mirrored the results for all admissions. The non-emergency admissions described an increased hazard ratio for admission on Sunday compared to Wednesday (hazard ratio 1.62 [95% CI 1.50 to 1.75] P < .0001), and for Saturday compared to Wednesday (hazard ratio 1.18 [95% CI 1.09 to 1.28] P < .0001). For non-emergency admissions there were no significant differences for the risks associated with being in hospital on different days.

Thirty percent of deaths occurred within 3 days of admission. The hazards associated with hospital admission and hospital stays on different days for the remaining 70% of in-hospital deaths occurring within 30 days of admission closely replicated those of the overall analysis for in-hospital deaths (Table 2). We analysed data on patients who were admitted on weekend days separately from those admitted on mid-week days. The weekend days were associated with the lowest risk of subsequent in-hospital death for those admitted at the weekend. Similarly, those admitted on weekdays experienced very similar risks to those observed in the principal analysis (Table 2). We analysed separately data for the 30 hospitals with 'University Hospital' Status and those for the 189 without 'University' status (Table 2) which again gave consistent results.

The supportive analysis based upon contingency tables for each day, utilising a complementary log-log link function and binomial error, provided similar results to those derived from the time dependent survivorship models.

In the US data model based on 254 United Healthcare Systems hospitals in managed care, admission at the weekend was associated with considerable additional risk, (hazard ratio for Sunday admission compared with Wednesday 1.18 [95% CI 1.11 to 1.26] P<.0001), with similar risks associated with admission on Saturday. Admission during other week days was not associated with higher risk than admission on Wednesday (Figure 4). The risk of death associated with weekend hospital stay in the US data was reduced compared with weekdays (P value for weekday versus weekend = 0.004).

Discussion

The principal finding of our study is that hospital admission at the week-end (Saturday or Sunday) is associated with a significant increased risk of in hospital death over the 30 days follow up period, but being in hospital at the weekend is associated with reduced risk of death. Thus for every 100 deaths among patients admitted on a Wednesday we would expect 116 among otherwise similar patients admitted on a Sunday. However for every 100 deaths among patients in hospital on Wednesday we would expect to see 92 among similar patients already in hospital on a Sunday.

These findings are consistent for emergency and for elective admissions. The findings for the English NHS were consistent with the analysis from 254 academic and not-for-profit US hospitals, suggesting that this finding may systematic in health care organisations.

Emergency admissions

Our study showed an increased 30-day mortality risk for patients admitted with emergency conditions over the week-end period compared to the rest of the week. This finding confirms previous reports for specific clinical conditions and a more recent survey of outcomes in the NHS.[8] The increased mortality associated with emergency weekend hospital admissions may be multifactorial. The cohort of patients admitted during the weekend will include those patients who would otherwise, had they been less ill, have had their admission postponed until a week-day. There may be aspects of care associated with week end admissions which disadvantage patients including reduced or altered staffing and skill mix; impact of shift system and/or changed training system for junior doctors; reduced availability of diagnostics; less availability of senior staff to review cases and to be readily available for escalation; less awareness (amongst staff unfamiliar to acute units) of unit policies around medication, therapy, communication and escalation. Some urgent conditions require prompt treatment and in some cases the way week-end care is organised may lead to delays, which affect adversely the outcome. An example of such a condition is fracture of neck of femur, for which is known that delay in treatment is associated with poorer outcomes. However, in our dataset this condition had outcomes for patient admitted on week end similar to those that were admitted during the week.

Finally there may be also coding bias affecting week end admissions with less information on co-morbidity collected or clinical decisions based on unmeasured risk factors that lead to admitting an emergency patient at week end rather than during the week.

Elective admissions

This study demonstrated an increased mortality risk over the 30 days follow-up for patients admitted electively at week-ends compared to similar patients admitted during the week days.

Although our data does not allow a scientific analysis of the mechanisms underlying this phenomenon, one could speculate that the increased risk seen for elective admission may be due to the fact that patients planned to have higher risk elective procedures at the beginning of the week are admitted over the previous week-end period. Our study analysed all deaths within 30 days from admission, whether the event occurred in or out of hospital. For emergency cases the ratio in-hospital to out of hospital deaths is approximately 2:1 and this is similar for admissions at week-ends and for those during the week-days. For elective patients this ratio is 2:1 for those admitted at week-ends but is almost reversed (1:2) for those admitted during the week. This suggests that the risk profile of elective patients admitted at weekends may be different and possibly higher from that of those admitted during the week.

We observed lower absolute rates of in-hospital and out of hospital deaths during the weekend compared with during the week (fig 2). This phenomenon must be due to the way services are organised as, *ceteris paribus*, we would expect a similar number of deaths on each day of the week.
The scaling down of hospital services at weekends may lead to fewer opportunities for patients to receive interventions and experience the adverse risks associated with these.

Strengths of the study

Our analyses are based upon all patients admitted to the English NHS during the financial year 2009/10. Selecting this large and comprehensive data source and a contemporary time period enables us to account for variation in hazard observed across the year, and provides a substantial number of events (deaths) both inside and outside hospital, and a large number of patients at risk at any time.

A recent Dr Foster report[8] describes differences in risk for different cohorts of patients who are admitted on different days of the week. However this and previous reports has not accounted for differences patient characteristics associated with admissions on different days.

In our appropriately complex survivorship analyses,[10] we separated the additional severity among cases due to admission at the weekend from any risks associated with being in hospital at the weekend which in the past has led to confusing interpretations. The latter were estimated for all patients using a time-dependent covariate term which identified the day of the week when deaths occurred and contrasted this with those at risk.

Our analysis was replicated on data from 254 leading US managed care hospitals, finding increased risk of death for admission to hospital at the weekends and a reduced risk associated with hospital stays on weekend days compared to week days. This was despite differences in the organisation and delivery of health care between England and managed care in the US, and slight differences in risk adjustment in the models.

Limitations of our study

Our outcome measure was relative hazard of death by day of the week and, in order to avoid introducing bias, our population at risk was all patients who had been hospitalised and remained alive, not just those in hospital. It could be argued that more precise estimates would be obtained by restricting our population at risk to those still in hospital, thus censoring subjects on discharge. However, such an analysis would be biased as patients were discharged preferentially on certain days of the week. Being discharged alive is informative, and those remaining in hospital, on average, represent patients with more complex and serious conditions who also face a higher probability of death. As discharges vary with day of the week (eg, patients are less likely to be discharged on a Sunday), and given the large size of the dataset, we pre-specified the unbiased analysis as our principal analysis. Furthermore 66% of the deaths within 30 days of admission occurred in hospital, and all those admitted may be considered at risk of death at the weekend in hospital.

The NHS is a single payer, publicly funded health care system providing health care on the basis of need, and free at the point of use. The NHS provides the overwhelming majority of health care in England, with a modest private sector providing some non-urgent surgery but little acute or emergency medicine. Our study represents a unique, population wide assessment of the risks associated with weekend admission and hospital stay.

Conclusion

We have found clear evidence of an excess of mortality associated with admission to hospital on weekend days in the National Health Service in England and in not-for-profit hospitals in the USA. Although being admitted at the weekend is associated with increased risk of subsequent death, we also found corresponding evidence of a reduced risk of death occurring among patients already in hospital on weekend days versus week days.

It may be that reorganised services providing 7 day access to all aspects of care could improve outcomes for higher risk patients currently admitted at the weekend. However the economics for such a change need further evaluation to ensure that such reorganisation represents an efficient use of scarce resources.

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Table 1. Principal Model – risk of in hospital death within 30 days of admission

Effect	DF	ChiSq	P Value
Age†	4	1479.1	<.0001
Day of the year†	4	119.6	<.0001
Previous Emergency Admissions‡	1	27.0	<.0001
Previous Complex Admissions‡	1	4574.0	<.0001
Charlson Comorbidity Index	1	23349.9	<.0001
Male vs Female	1	38.6	<.0001
Ethnicity	5	1668.8	<.0001
Emergency Admission	1	51718.4	<.0001
Admission Source	7	24296.6	<.0001
Index of Multiple Deprivation	1	77.5	<.0001
CCS Category	253	173015.7	<.0001
Hospital Trust	218	4131.9	<.0001
Day of Admission	6	539.1	<.0001
Day of death	6	185.5	<.0001

† 5 knot restricted cubic spline
‡ $\log_e$ (1+ number of events)

Table 2. Risk Associated with Day of Admission and Day of Hospital Stay (Compared to Wednesday) for In hospital Deaths and All Deaths Within 30 Days of Admission. Hazard Ratios and 95% Confidence Intervals.

Type	CCS Category	In Hospital Deaths	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	187,337	1.16 (1.14 to 1.18)	1.02 (1.01 to 1.04)	1.00 (0.99 to 1.02)	1.00 (0.98 to 1.01)	1.00 (0.98 to 1.02)	1.11 (1.09 to 1.13)
Hospital Stay	All Categories	187,337	0.92 (0.91 to 0.94)	1.01 (1.00 to 1.03)	1.00 (0.99 to 1.02)	0.96 (0.95 to 0.98)	0.95 (0.93 to 0.96)	0.95 (0.93 to 0.96)
Admission	122 - Pneumonia	26910	1.03 (0.98 to 1.08)	1.00 (0.95 to 1.04)	1.00 (0.95 to 1.04)	1.00 (0.95 to 1.04)	0.99 (0.95 to 1.04)	1.03 (0.99 to 1.08)
Hospital Stay	122 - Pneumonia	26910	0.93 (0.89 to 0.97)	1.04 (1.00 to 1.09)	0.99 (0.94 to 1.03)	0.98 (0.94 to 1.03)	0.98 (0.94 to 1.03)	0.91 (0.87 to 0.96)
Admission	109 - Acute cerebrovascular disease	14137	1.16 (1.09 to 1.23)	1.00 (0.94 to 1.06)	0.99 (0.93 to 1.05)	1.02 (0.96 to 1.08)	1.01 (0.95 to 1.07)	1.13 (1.06 to 1.20)
Hospital Stay	109 - Acute cerebrovascular disease	14137	0.95 (0.89 to 1.01)	0.99 (0.93 to 1.06)	1.03 (0.97 to 1.09)	0.97 (0.92 to 1.04)	0.94 (0.89 to 1.00)	0.92 (0.87 to 0.98)
Admission	108 - Congestive heart failure	7247	1.10 (1.01 to 1.21)	0.96 (0.89 to 1.05)	0.99 (0.91 to 1.08)	0.93 (0.85 to 1.01)	0.93 (0.86 to 1.02)	1.16 (1.06 to 1.27)
Hospital Stay	108 - Congestive heart failure	7247	0.91 (0.83 to 0.99)	1.00 (0.92 to 1.09)	1.00 (0.91 to 1.08)	0.96 (0.88 to 1.05)	0.94 (0.86 to 1.02)	0.88 (0.80 to 0.96)
Admission	100 - Acute myocardial infarction	6119	1.11 (1.01 to 1.23)	0.95 (0.86 to 1.05)	1.07 (0.97 to 1.18)	1.07 (0.98 to 1.18)	1.01 (0.91 to 1.11)	1.05 (0.95 to 1.16)
Hospital Stay	100 - Acute myocardial infarction	6119	0.88 (0.79 to 0.97)	1.05 (0.95 to 1.15)	1.00 (0.91 to 1.10)	0.97 (0.88 to 1.06)	0.91 (0.83 to 1.00)	0.96 (0.87 to 1.05)
Admission	127 - Chronic obstructive pulmonary disease	5826	1.02 (0.93 to 1.13)	0.98 (0.89 to 1.08)	1.02 (0.93 to 1.12)	1.08 (0.98 to 1.18)	1.01 (0.91 to 1.11)	1.13 (1.02 to 1.24)
Hospital Stay	127 - Chronic obstructive pulmonary disease	5826	0.92 (0.83 to 1.01)	1.13 (1.03 to 1.24)	0.97 (0.88 to 1.07)	0.96 (0.88 to 1.06)	0.94 (0.85 to 1.03)	0.97 (0.88 to 1.07)
Admission	19 - Cancer of bronchus; lung	5635	1.28 (1.16 to 1.43)	0.99 (0.90 to 1.09)	0.95 (0.87 to 1.05)	0.96 (0.87 to 1.06)	0.97 (0.88 to 1.07)	1.44 (1.29 to 1.60)
Hospital Stay	19 - Cancer of bronchus; lung	5635	0.82 (0.75 to 0.91)	0.99 (0.90 to 1.09)	0.96 (0.87 to 1.05)	0.88 (0.80 to 0.97)	0.89 (0.80 to 0.98)	0.90 (0.82 to 0.99)
Admission	2 - Septicemia (except in labor)	5536	1.07 (0.96 to 1.18)	1.07 (0.97 to 1.18)	1.01 (0.91 to 1.11)	0.95 (0.86 to 1.05)	0.92 (0.83 to 1.02)	0.98 (0.88 to 1.09)
Hospital Stay	2 - Septicemia (except in labor)	5536	0.92 (0.83 to 1.02)	1.00 (0.91 to 1.10)	1.05 (0.95 to 1.15)	0.98 (0.89 to 1.08)	0.90 (0.81 to 0.99)	0.99 (0.90 to 1.09)
Admission	157 - Acute and unspecified renal failure	4792	1.37 (1.23 to 1.53)	1.06 (0.95 to 1.17)	1.00 (0.90 to 1.10)	0.97 (0.87 to 1.07)	0.96 (0.87 to 1.07)	1.20 (1.08 to 1.35)
Hospital Stay	157 - Acute and unspecified renal failure	4792	0.92 (0.82 to 1.02)	1.01 (0.91 to 1.12)	0.88 (0.79 to 0.98)	0.92 (0.83 to 1.02)	0.94 (0.85 to 1.05)	0.93 (0.84 to 1.03)
Admission	159 - Urinary tract infections	4460	1.08 (0.97 to 1.21)	1.05 (0.94 to 1.17)	0.94 (0.84 to 1.05)	0.94 (0.84 to 1.05)	0.92 (0.82 to 1.02)	0.98 (0.88 to 1.10)
Hospital Stay	159 - Urinary tract infections	4460	0.89 (0.79 to 0.99)	1.00 (0.89 to 1.11)	1.00 (0.90 to 1.11)	0.89 (0.80 to 0.99)	0.90 (0.81 to 1.01)	0.90 (0.81 to 1.01)
Admission	226 - Fracture of neck of femur (hip)	4253	1.07 (0.95 to 1.19)	0.98 (0.87 to 1.09)	0.99 (0.89 to 1.11)	0.97 (0.87 to 1.09)	1.04 (0.93 to 1.16)	0.94 (0.84 to 1.05)
Hospital Stay	226 - Fracture of neck of femur (hip)	4253	0.82 (0.73 to 0.91)	0.91 (0.82 to 1.02)	0.89 (0.79 to 0.99)	0.85 (0.76 to 0.95)	0.87 (0.78 to 0.97)	0.88 (0.79 to 0.98)
	CCS Category	All Deaths	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	284852	1.14 (1.13 to 1.16)	1.03 (1.02 to 1.05)	1.02 (1.00 to 1.03)	1.00 (0.99 to 1.01)	1.01 (0.99 to 1.02)	1.12 (1.10 to 1.14)
Hospital Stay	All Categories	284852	0.96 (0.95 to 0.97)	1.02 (1.00 to 1.03)	1.00 (0.99 to 1.02)	0.99 (0.97 to 1.00)	0.97 (0.96 to 0.99)	0.98 (0.97 to 1.00)
		Hospital deaths with events within 3 days of admission censored	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	130551	1.11 (1.09 to 1.13)	1.04 (1.02 to 1.06)	1.01 (0.99 to 1.03)	1.00 (0.98 to 1.02)	1.00 (0.98 to 1.02)	1.07 (1.05 to 1.09)
Hospital Stay	All Categories	130551	0.88 (0.86 to 0.90)	0.99 (0.97 to 1.01)	0.99 (0.97 to 1.01)	0.96 (0.94 to 0.98)	0.93 (0.92 to 0.95)	0.93 (0.91 to 0.94)
		Hospital deaths for Emergency Admissions	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	175511	1.14 (1.12 to 1.16)	1.02 (1.00 to 1.04)	1.01 (0.99 to 1.02)	1.00 (0.98 to 1.01)	1.00 (0.98 to 1.02)	1.11 (1.09 to 1.13)
Hospital Stay	All Categories	175511	0.92 (0.90 to 0.94)	1.01 (1.00 to 1.03)	1.01 (0.99 to 1.02)	0.96 (0.94 to 0.98)	0.95 (0.93 to 0.97)	0.95 (0.93 to 0.96)
		Hospital Deaths for Non Emergency Admissions	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	11826	1.62 (1.50 to 1.75)	1.00 (0.94 to 1.06)	0.97 (0.91 to 1.03)	0.98 (0.92 to 1.04)	0.98 (0.92 to 1.04)	1.18 (1.09 to 1.28)
Hospital Stay	All Categories	11826	0.95 (0.89 to 1.02)	1.00 (0.94 to 1.07)	0.95 (0.89 to 1.02)	1.02 (0.96 to 1.09)	0.96 (0.90 to 1.03)	0.98 (0.91 to 1.05)

		Hospital Deaths for Weekend Admissions	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Hospital Stay	All Categories	46591	0.88 (0.83 to 0.94)	0.97 (0.91 to 1.03)	0.96 (0.92 to 1.01)	0.95 (0.91 to 1.00)	0.90 (0.84 to 0.96)	0.89 (0.83 to 0.95)
		Hospital Deaths for Weekday Admissions	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Hospital Stay	All Categories	140746	0.89 (0.88 to 0.91)	1.00 (0.98 to 1.03)	1.01 (0.99 to 1.03)	0.97 (0.95 to 0.99)	0.96 (0.95 to 0.98)	0.95 (0.93 to 0.97)
		US Hospital Deaths	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	14499	1.18 (1.11 to 1.26)	1.00 (0.95 to 1.07)	0.97 (0.91 to 1.03)	0.99 (0.93 to 1.05)	1.04 (0.98 to 1.11)	1.16 (1.09 to 1.24)
Hospital Stay	All Categories	14499	0.99 (0.93 to 1.06)	1.07 (1.01 to 1.14)	1.04 (0.98 to 1.11)	1.06 (1.00 to 1.13)	1.03 (0.97 to 1.09)	0.96 (0.90 to 1.02)
		University Hospitals Hospital Deaths	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	41093	1.17 (1.12 to 1.21)	1.05 (1.01 to 1.09)	1.04 (1.00 to 1.07)	1.00 (0.96 to 1.04)	0.99 (0.95 to 1.02)	1.16 (1.12 to 1.20)
Hospital Stay	All Categories	41093	0.92 (0.89 to 0.96)	1.02 (0.98 to 1.06)	1.03 (0.99 to 1.06)	0.99 (0.96 to 1.03)	0.99 (0.95 to 1.02)	0.98 (0.95 to 1.02)
		Non University Hospitals Hospital Deaths	Sun vs Wed	Mon vs Wed	Tue vs Wed	Thu vs Wed	Fri vs Wed	Sat vs Wed
Admission	All Categories	146244	1.16 (1.13 to 1.18)	1.02 (1.00 to 1.03)	1.00 (0.98 to 1.01)	0.99 (0.98 to 1.01)	1.00 (0.98 to 1.02)	1.10 (1.08 to 1.12)
Hospital Stay	All Categories	146244	0.92 (0.90 to 0.94)	1.01 (0.99 to 1.03)	1.00 (0.98 to 1.02)	0.96 (0.94 to 0.97)	0.94 (0.92 to 0.96)	0.94 (0.92 to 0.95)

Figure 1. Hospital Population by Day, for patients within 30 days of admission

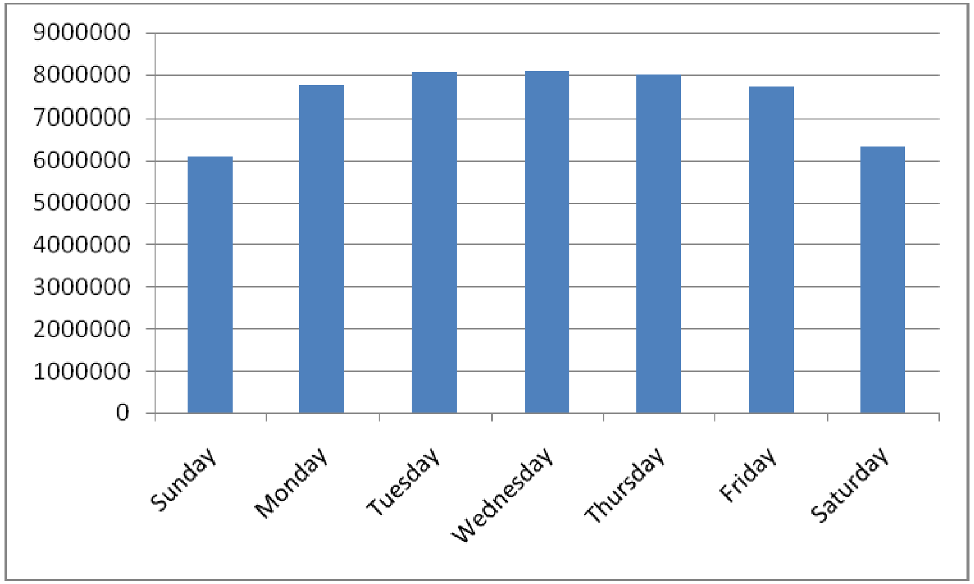


Figure 2. In and Out of Hospital Deaths Within 30 days of Admission

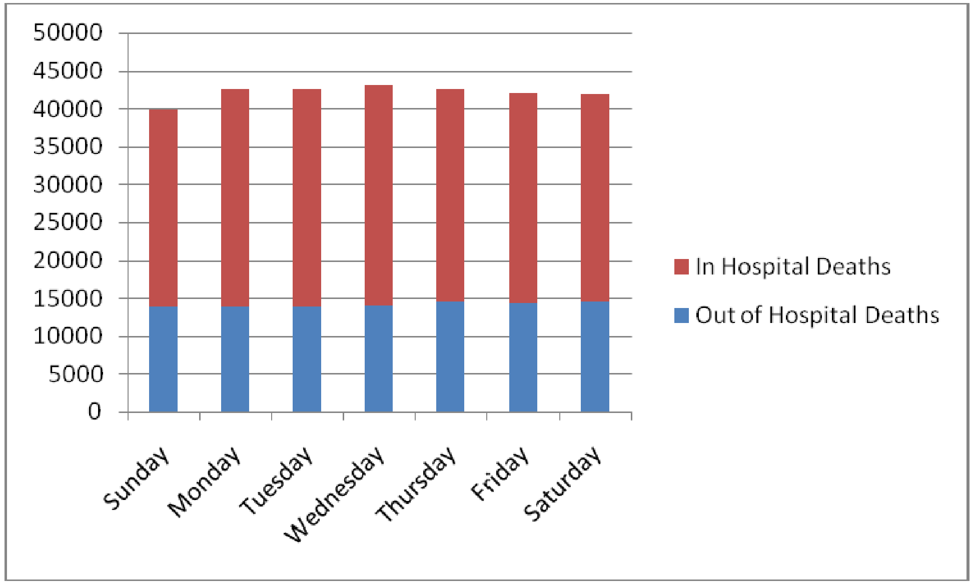
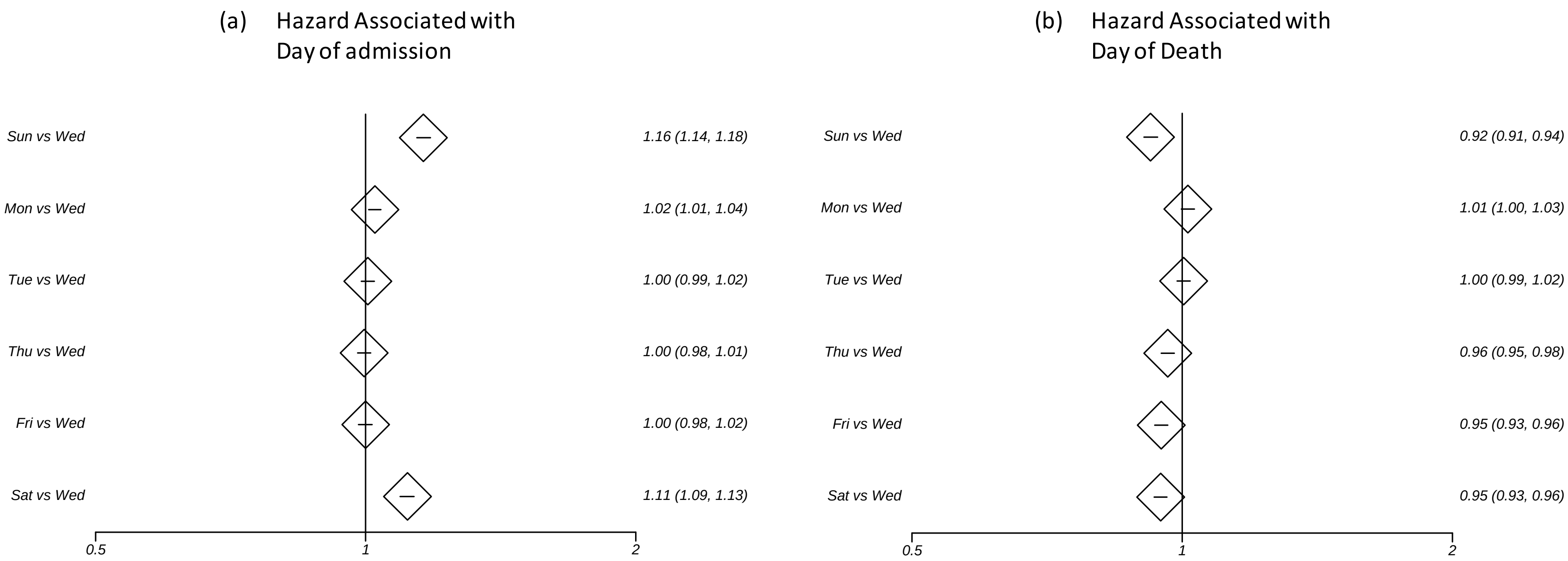
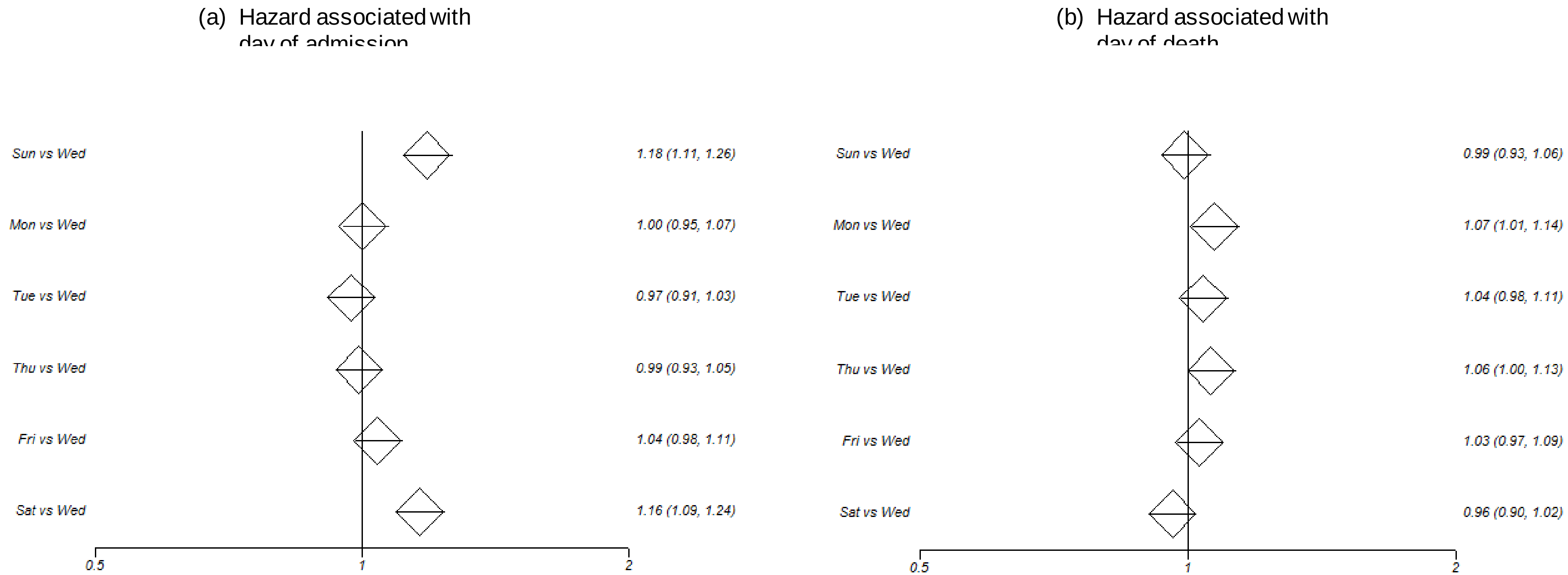


Figure 3. Conditional Hazard Associated with Admission to Hospital by Day of the Week of Admission (a) and day of death (b). Hazard ratios and 95% confidence intervals compared to Wednesday



Hazard ratios and 95% confidence intervals from the principal model examining time to in-hospital death or censorship (at out of hospital death or 30 days) within 30 days of admission

Figure 4. Conditional Hazard Associated with Admission to US Hospital by Day of the Week of Admission (a) and day of death (b). Hazard ratios and 95% confidence intervals compared to Wednesday



Hazard ratios and 95% confidence intervals from the US model examining time to in-hospital death or censorship (at out of hospital death or 30 days) within 30 days of admission