Increased mortality associated with weekend hospital admission: a case for expanded seven day services?

Nick Freemantle and colleagues discuss the findings of their updated analysis of weekend admissions and the implications for service design

Any modern, effective healthcare system should prevent premature deaths from treatable causes, improve quality of life for people with long term conditions, aid recovery from acute conditions, and ensure safe care. At the same time it should provide patients with as positive an experience as reasonably possible. Intuitively, reduced provision of healthcare at weekends adversely affects all of these domains. The relation between service organisation across the week and excess mortality cannot be easily studied using randomised controlled trials, so the evidence base for designing healthcare services relies on an observational approach.

Our previous study of all NHS hospital admissions in England during the financial year 2009-10 indicated that admission at the weekend (Saturday and Sunday) was associated with a significantly increased risk of in-hospital death compared with midweek admission, but being in hospital at the weekend was associated with reduced risk of death.[1] These findings were replicated in an analysis of 254 leading hospitals in the US.[1]

Because six years have elapsed since our last assessment of weekend mortality we have updated our analysis using data from NHS English hospitals and on related deaths in 2013-14. The original analysis was built on our previous work developing the QUORUM metric for comparing hospital death rates.[2] This metric identified that the risk of death is highly predictable in NHS admissions. The three main objectives of the current analysis were to characterise the patient population admitted at weekend; examine whether, after robust adjustment for case mix, weekend admission carries an increased 30 day mortality risk compared with midweek admission; and estimate whether mortality risk differs between hospital stay at weekends and during the week.

KEY MESSAGES

- Patients admitted at the weekend are more likely to be in the highest category of risk of death
- Patients admitted on Saturday or Sunday face an increased likelihood of death even when severity of illness is accounted for
- An additional risk of death exists for admission on Monday and Friday extending the weekend effect to these two days
- Around 11 000 more patients die each year within 30 days from admission occurring between Friday and Monday compared with admission on the remaining days of the week

Survivorship models

We used identical methods to those in the previous analysis[1] apart from incremental improvements in modelling strategy. We used survivorship models that accounted separately for day of admission and days of the week of hospital stay following patients for the first 30 days after admission. These analyses used a time dependent covariate to estimate the effect of days of the week of hospital stay, identifying the day of the week for each death as it occurred and the corresponding day of the week for each patient still alive and in follow-up. Our methods for case mix adjustment were similar to those in our previous analyses,[1] with some incremental advances arising from developments in the Hospital Episode Statistic (HES) dataset and methodological developments—for example, in the grouping of diagnostic categories we applied the Summary Hospital Mortality Index (SHMI) approach, which achieves greater statistical efficiency.[3] Case mix adjustment included diagnosis (SHMI) grouped Clinical Classifications Software category), age, time of year, trust, deprivation, number of previous emergency admissions, number of previous complex admissions, admission source, admission urgency, sex, ethnicity, and Charlson Comorbidity Index. Age and time of year were accounted for as non-linear predictors using restricted cubic splines.[4] These explanatory variables collectively had a C statistic of 0.92 when used to predict mortality.

One change of note from our previous analysis was that we adopted time to death either in or out of hospital as our principal outcome because this is not subject to bias; time to in-hospital death was relegated to a secondary outcome because it is somewhat biased by informative censorship. The principal analysis included 14 818 374 admissions and 280 788 deaths for the year 2013-14. Only 6.6% of all admissions in the period had to be excluded because at least one of the case mix items was missing, highlighting the high percentage of data completeness.

Characteristics of patients admitted

The number of patients admitted to hospital during the working week (Monday to Friday) averaged 2.7 million a day, with an average of 1.2 million admitted on a Saturday and 1 million on a Sunday. This translates to 17% of all admissions on each weekday, 8% on Saturday, and 6% on Sunday. A higher proportion of patients was admitted to hospital as emergencies on Saturday (635 020/1 261 085; 50%) and Sunday

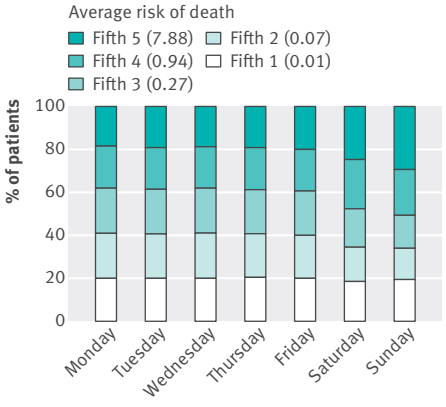

Fig 1 | Risk of death over 30 days by day of admission divided into fifths for the whole cohort (derived from a survival model including risk adjustment but not including day of admission or days of hospital stay)

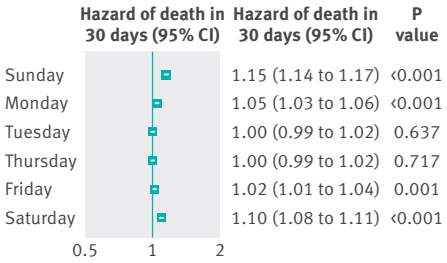

Fig 2 | Hazard ratio (95% confidence interval) for death within 30 days by day of admission compared with Wednesday

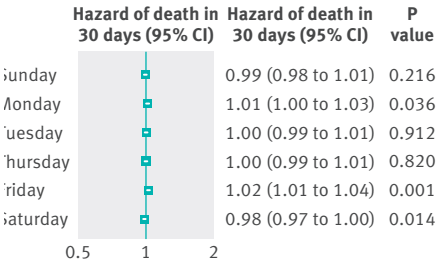

Fig 3 | Hazard ratio (95% confidence interval) for day of death during hospital stay compared with Wednesday

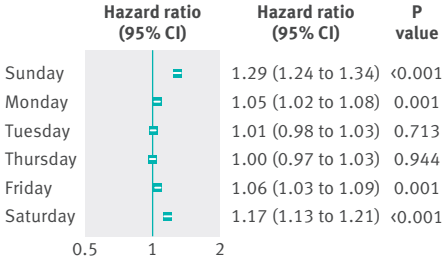

Fig 4 | Hazard ratio (95% confidence interval) for death within 30 days among oncology patients by day of admission compared with Wednesday

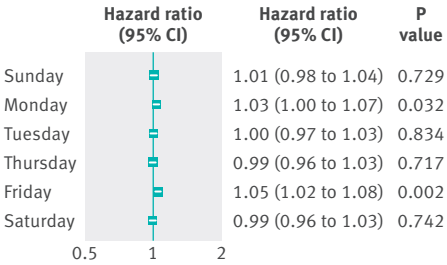

Fig 5 | Hazard ratio (95% confidence interval) for day of death during hospital stay compared with Wednesday for oncology patients

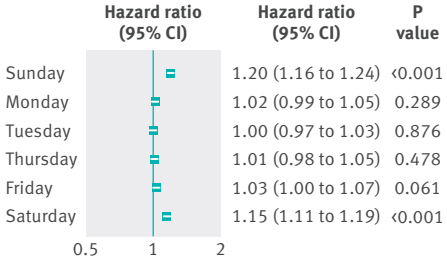

Fig 6 | Hazard ratio (95% confidence interval)for death within 30 days among patients with cardiovascular disease by day of admission compared with Wednesday

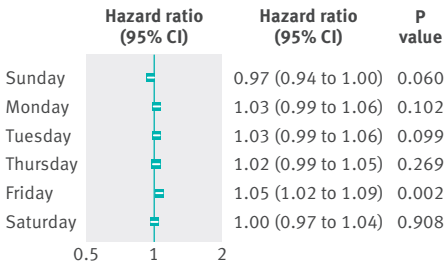

Fig 7 | Hazard ratio (95% confidence interval) for day of death during hospital stay compared with Wednesday for patients with cardiovascular disease

(621 356/952 375; 65%) than on weekdays (3 951 971/13 646 048; 29%).

The cohort admitted at weekend included a greater prevalence of patients with higher predicted mortality risk than those admitted during the week according to our case adjustment (fig 1). This was derived from a survival model that included all our identified risk factors except day of admission and day of death, and dividing all patients (regardless of the day of admission) into five equal strata using quintiles of predicted risk of death. For patients admitted on Saturday, 24.6% were in the highest risk of death category (without a weekend effect we would expect 20%), which carries an average predicted 30 day mortality of 7.88%, and for Sunday admissions 29.2% were in the highest risk category. By contrast, for admissions on weekdays, fewer than 20% were in the highest risk category.

Risks associated with day of admission and hospital stay

The 30 day mortality for all admissions was 1.8% (292 277/15 859 508); 57% of deaths (166 360) occurred in hospital. The analysis based on day of admission showed that the relative risk of death within 30 days compared with admission on a Wednesday was increased by 2% for admission on a Friday, 10% for admission on Saturday, 15% for admission on a Sunday, and 5% for admission on a Monday (fig 2). When we accounted for case mix and day of admission in an analysis of day of death (fig 3), Friday and Saturday were modestly statistically different from Wednesday, with

An increased proportion of higher risk patients are admitted on Saturday and Sunday, when services inside and outside the hospital are reduced

Friday associated with a 2% increase in the relative risk of death compared with Wednesday, and Saturday associated with a 2% reduction in the relative risk of death compared with Wednesday. These findings were qualitatively similar to the corresponding results from our previous analyses of 2009-10 data.[1]

The cause of death by day of the week on which death occurred was broadly similar for all days (table). There was also no qualitatively important difference in mortality by age through the week.

As a greater proportion of patients are in the highest risk category at the weekend and at a higher risk of an early event, we confirmed the robustness of the model by excluding those who died within three days of admission. A total of 63 355 deaths (22.6%) occurred within the first three days of admission. The increased mortality risk associated with weekend admission was still present, although numerically attenuated, with Sunday admissions associated with a 10% increase in risk and Saturday admissions associated with a 7% increase in the risk of death.

Analysis for disease groups

Separate analyses for admissions for cardiovascular disease or oncological conditions (derived from the principal diagnosis according to the International Classification of Diseases—ICD-10) provided similar results (figs 4-7). We chose these two disease groups because they have high prevalence and are associated with substantial mortality. In both cases weekend admissions were associated with noticeably increased risk of death, and with cancer admissions risk was also increased for admissions occurring on Monday and Friday. However, for both cardiovascular and oncological admissions, the risks of dying on particular hospital days were similar, with the exception of Fridays, which were associated in both cases with a 5% increase in risk of death compared with Wednesdays.

Length of stay

We examined the length of stay in hospital for all patients and for those in the highest risk category who were admitted on different days. For all patients (whether discharged alive or dead), the median length of stay was one day (interquartile range 1-3) for those admitted Monday through Friday, three days (2-5) for Saturday admissions, and three days (2-6) for Sunday. Among those who died in hospital, the median length of stay was nine days for those admitted on Monday through Thursday, seven days on Friday, and eight days on Saturday and Sunday. The interquartile range was similar for all days: Monday 4-18, Tuesday 5-18, Wednesday and Thursday 4-19, Friday 5-19, Saturday and Sunday 4-17.

Median length of stay for patients in the highest risk category was five days (3-12) for Saturday admissions and six days (3-12) for

Number (%) of deaths on each day of the week for causes accounting for at least 1% of deaths

Cause of death (disease category)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Infectious and parasitic	594 (1.49)	552 (1.38)	501 (1.24)	540 (1.34)	531 (1.28)	526 (1.33)	566 (1.45)	3810 (1.36)
Circulatory system	10 001 (25.04)	10 032 (25.02)	9815 (24.3)	9912 (24.57)	10 128 (24.42)	9577 (24.28)	9318 (23.82)	68 783 (24.5)
Digestive system	2470 (6.18)	2550 (6.36)	2527 (6.26)	2555 (6.33)	2615 (6.31)	2530 (6.42)	2488 (6.36)	17 735 (6.32)
Genitourinary system	967 (2.42)	965 (2.41)	940 (2.33)	926 (2.30)	959 (2.31)	883 (2.24)	959 (2.45)	6599 (2.35)
Nervous system	1029 (2.58)	1083 (2.70)	1027 (2.54)	1027 (2.55)	1106 (2.67)	1074 (2.72)	1064 (2.72)	7410 (2.64)
Respiratory system	5846 (14.64)	5914 (14.75)	6127 (15.17)	5978 (14.82)	6074 (14.65)	5807 (14.72)	5921 (15.14)	41 667 (14.84)
Endocrine, nutritional, and metabolic	608 (1.52)	659 (1.64)	586 (1.45)	550 (1.36)	675 (1.63)	506 (1.28)	654 (1.67)	4238 (1.51)
External causes	757 (1.90)	665 (1.66)	772 (1.91)	727 (1.80)	741 (1.79)	703 (1.78)	691 (1.77)	5056 (1.80)
Mental and behavioural	1660 (4.16)	1679 (4.19)	1601 (3.96)	1633 (4.05)	1733 (4.18)	1681 (4.26)	1734 (4.43)	11 721 (4.17)
Neoplasms	13 995 (35.04)	13 940 (34.77)	14 456 (35.79)	14 461 (35.85)	14 819 (35.73)	14 118 (35.8)	13 731 (35.1)	99 520 (35.44)
Other causes	1006 (2.52)	1050 (2.62)	950 (2.350	980 (2.43)	1045 (2.52)	1029 (2.61)	1066 (2.73)	7126 (2.54)
Unknown	1010 (2.53)	1005 (2.51)	1091 (2.70)	1050 (2.60)	1046 (2.52)	1003 (2.54)	923 (2.36)	7128 (2.54)
Total	39 943	40 094	40 393	40 339	41 472	39 437	39 115	280 793

Sunday admissions. This contrasts with a median length of stay for Monday to Friday admissions of four days, except Thursdays which had a median of 3 days. The interquartile range for Monday was 2-10, and for Tuesday through Friday was 2-9. For highest risk category admissions that ended in death, the median length of stay for patients admitted on both Saturday and Sunday was eight days (4-17). This compared with nine days (5-18) on Monday, Wednesday, and Thursday and nine days (5-19) on Tuesday and Friday.

Interpretation

Our analyses show that, although fewer hospital admissions occur at the weekend, patients admitted on Saturday and Sunday are sicker and face an increased likelihood of death within 30 days even when severity of illness is taken into account. This finding is similar to that of our previous analysis.[1]

In the current analysis we also detected a smaller increased risk of 30 day mortality among patients admitted on Friday and Monday, suggesting a more generalised "weekend effect." Our analysis of 2013-14 data suggests that around 11 000 more people die each year within 30 days of admission to hospital on Friday, Saturday, Sunday, or Monday compared with other days of the week (Tuesday, Wednesday, Thursday). It is not possible to ascertain the extent to which these excess deaths may be preventable; to assume that they are avoidable would be rash and misleading.[5] From an epidemiological perspective, however, this statistic is "not otherwise ignorable" as a source of information on risk of death and it raises challenging questions about reduced service provision at weekends. Similar to our previous analysis,[1] we have found that patients already in hospital over the weekend do not have an increased risk of death.

An advantage of the statistical method that we used is that it is not subject to bias caused by systematic differences in coding practices between hospitals. Furthermore, any differences in coding practice between the weekend and weekdays within all hospitals are captured in our estimate of the additional severity of weekend admissions and thus do not affect interpretation of the results. Our previous study found no systematic differences in the hospital weekend effect.[1]

Patients in the highest category of predicted mortality risk admitted at weekends who survive the in-hospital episode have a longer length of stay than similar patients admitted during the working week. For patients from this higher risk group who die, the time to death is shorter for those admitted at weekend. This raises questions about the relative effect of reduced hospital or out of hospital services on length of stay. These observations are not unique to the NHS in England, but as the largest and most comprehensive health service in the world, the NHS may be the best equipped to understand and address them.

Appropriate support services in hospitals are usually reduced from late Friday through the weekend, leading to disruption on Monday morning. This could go some way towards explaining our finding of a "weekend effect" extending into Friday and Monday.

We have shown a clear association between weekend admission and worse patient outcomes. Our analyses show that an increased proportion of higher risk patients are admitted on Saturday and Sunday, when services inside and outside the hospital are reduced. There is evidence that junior hospital doctors feel clinically exposed during the weekend[6] and that hospital chief executives are concerned about levels of weekend cover.[7] This has led to calls from the Academy of Medical Royal Colleges, Medical Education England, the Royal College of Physicians, and the Royal College of Surgeons,[6-12] for a review of the way services are provided in hospitals at weekend, with a particular focus on urgent care.

In starting to address these concerns, NHS England incorporated a set of clinical standards into the national NHS acute contract, building on work originally undertaken by the London Clinical Senate and endorsed by the Academy of Medical Royal Colleges.[13] Our analysis shows that we need to determine exactly which services need to be improved at the weekend to tackle the increased risk of mortality and also to ensure, for example, that frail elderly patients and patients needing end of life care receive appropriate treatment in the right place every day of the week. Patients generally accept the risks associated with their condition and with any necessary treatment, but they should never have to accept an increased risk because of the way healthcare services are designed and delivered.

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