

Increased mortality associated with week-end hospital admission: a case for expanded seven-day services?

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Introduction

Any modern, effective health care system should prevent premature deaths from treatable causes, provide co-ordinated care for people with long-term conditions, aid recovery from acute conditions and ensure safe care, whilst achieving as positive an experience for patients as reasonably possible.

Intuitively, reduced provision of healthcare at weekends has an adverse effect on all of these domains. Defining the relationship between service organisation across the week and excess mortality cannot readily be addressed using a randomised controlled design, so the evidence base for healthcare service design relies necessarily on an observational approach.

Our previous study of all NHS England admissions during the financial year 2009-10, indicated that hospital admission at the weekend (Saturday and Sunday) was associated with a significantly increased risk of in-hospital death when compared to mid-week, 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 6 years have elapsed since our last assessment of weekend mortality [1] we have refreshed our analysis using data from NHS English hospitals and related deaths in 2013/2014. The three main objectives of the analysis were to: 1) characterise the patient population admitted at weekend; 2) address whether, following robust case-mix adjustment, weekend admission carries an increased 30-day mortality risk compared to mid-week; 3) estimate whether

there is a difference in mortality risk between hospital stay at weekends and during the week days.

In this paper we discuss the main findings, their potential interpretation and implications for service design.

Complex Survivorship Models to Address Weekend Effects

We developed complex survivorship models, which accounted separately for day of admission and day 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 day 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. We utilised very similar case mix adjustment to our previous analyses [1] albeit with some advances due to the developments in the Hospital Episode Statistic (HES) data set and methodological developments in the area - for example in the grouping of diagnostic categories where we applied the Summary Hospital Mortality Index (SHMI) approach which achieves greater statistical efficiency.[2]

One change of note was that we adopted time to death either in or out of hospital as our principal outcome as this is not subject to bias, with time to in-hospital death relegated to a secondary outcome, as the latter is somewhat biased by informative censorship.

Case mix adjustment included Diagnosis (SHMI [2] Grouped CCS category); Age; Position in the year; Trust; Deprivation; number of previous emergency

admissions; number of previous complex admissions; admission source; admission urgency; gender; ethnicity; Charlson Comorbidity Index. Age, and position in the year were accounted for as non-linear predictors using restricted cubic splines.[3]. These explanatory variables collectively have a C-statistic of 0.92 when used to predict mortality.

The principal analysis included 14818374 admissions and 280788 deaths for the year 2013-2014. Only 6.6% of all admissions in the period had to be excluded because of missing data where at least one of the case-mix items was missing, highlighting the high percentage of data completeness.

Principal Analysis Results

Characteristics of patients admitted

The number of patients admitted to hospital during the working week (Mon – Fri) averaged 2.7m per day, while 1.2m patients were admitted on Saturday and 1m patients were admitted on a Sunday. This translates to 17% of all admissions per day during the week, 8% on Saturday and 6% on Sunday. A higher proportion of patients were admitted to hospital as emergencies on Saturday (635020/1261085; 50%) and Sunday (621356/952375; 65%) than weekdays (3951971/13646048; 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 the standard case-adjustment (Figure 1), derived from a survival model which included all risk factors except day of admission and day of death. For patients admitted on Saturday, 24.6% were in the highest risk

quintile, which carries a predicted 30-day mortality of 7.88%, and for Sunday admissions 29.2% were in the highest risk quintile. By contrast, for admissions on weekdays, fewer than 20% were in the highest risk quintile. The 30 day mortality for all admission was 1.8% (292277/15859508), 57% of deaths (166360) occurred in-hospital.

Risks Associated With Day of Admission and Hospital Stay

The analysis based on day of admission, showed that the relative risk of 30-day mortality compared with Wednesday was increased by 2% for admission on a Friday, 10% for admission on Saturday, 15% for admissions on a Sunday and 5% for admission on a Monday (Figure 2a).

With regards to the risk of death on specific days of the week, having accounted for case mix and day of admission (Figure 2b), Friday and Saturday were modestly statistically different from Wednesday, with 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 to Wednesday. These findings were qualitatively similar but not identical to the corresponding results from our previous analyses of 2009/10 data.[1]

Censoring Early Deaths

As a greater proportion of patients are in the highest risk quintile at the weekend and at a higher risk of an early event, we confirmed the robustness

of the model by censoring (excluding) those patients who died within 3 days of admission.

63355 deaths (22.6%) occurred within the first 3 days of admission to hospital. 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 supportive analyses including either admission for Cardiovascular Disease (CVD) or for Oncology conditions derived from the principal diagnosis according the International Classification for Disease version 10 codes for diagnosis provided similar results (Figure 3a 3b; Figure 4a 4b). These two groups were chosen on the basis that they are high prevalence and associated with substantial mortality. In both cases the weekend admission days were associated with markedly increased risk of death, and with cancer admissions this was manifest for admissions occurring on Monday and Friday. However, for both CVD and Oncology admissions, the risks associated with particular hospital days was similar, with the exception of Fridays which were associated in both cases with a 5% increase in risk of death compared with Wednesday.

Length of Stay

In supportive analyses we examined the length of stay in hospital for all patients and for those in the highest risk quintile who were admitted on different days.

For all admissions (discharged alive or dead), the median length of stay is 1 day (IQR 0, 2) for mon through Fri, for Saturday it is 2 days (IQR 1, 3) and for Sunday it is 2 days (IQR 1, 4). Among those who died in hospital, the median length of stay was 5 days on Monday, and 6 days on all other days of admission. The IQR for each day was similar (IQR (2, 12) except Tuesday and Wednesday when the 75th Percentile was 13, and Saturday and Sunday when the 25th Percentile was 3.

Median length of stay for all admissions on Saturday was 4 days, Inter Quartile Range (IQR 0, 11) and 5 (IQR 0, 11) on Sunday. This contrasts with a median length of stay on Monday through Friday of 3 days (IQR 0, 8). For admissions which ended in death, the median length of stay for both Saturday and Sunday was 7 days (IQR 3, 16) while for weekdays it was 8 days (IQR 4, 18

Discussion

Our analyses show that, while fewer admissions occur at the weekend, patients admitted on Saturday and Sunday have a more adverse risk profile and face an increased likelihood of death within 30 days, a finding similar to our previous analysis.[1] In the current analyses, an additional risk of 30 day mortality is detected for admissions occurring on Friday and Monday, albeit

numerically smaller than the weekend, suggesting a more generalised “weekend effect”.

The increase in severity among patients admitted at the weekend is substantial, with over 10,000 additional deaths identified in 2013/14, which were associated with weekend admission (Friday to Monday period). It is not possible to ascertain the extent to which these deaths may be avoidable although they do present an additional challenge to the health system in to ensure timely, effective and efficient intervention. From an epidemiological perspective we may consider the weekend to be *'not otherwise ignorable'* as a source of information on risk of death.

Patients in the highest quintile 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. The relative impact of reduced hospital or out-of-hospital services on length of stay is uncertain.

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 well equipped to address them.

Usually in hospitals support services and access to senior specialist care are reduced from late Friday through the weekend, leading to disruption on Monday morning. This could go some way towards explaining our finding of a “week-end effect” extending into these two days.

We have demonstrated a clear association between weekend admission and worse patient outcomes. What organisations need to do to address this challenge is not yet clear. Our analyses show that an increased proportion of higher risk patients are admitted on Saturday and Sunday when services are reduced. There is external supportive evidence that junior hospital doctors feel clinically exposed during the weekend[4] and that hospital chief executives are concerned about levels of weekend cover[5]. This has led to calls for more senior clinician presence in hospitals at weekend by the Academy of Medical Royal Colleges, Medical Education England, the Royal College of Physicians and the Royal College of Surgeons.[4-10]

In starting to address these concerns, NHS England incorporated a set of clinical standards into the national NHS contract with hospitals from 2014 to promote greater diagnostic capability at the weekend coupled with more timely, increased consultant involvement [11] and a more structured handover between staff. In view of the current analysis, it may be necessary for further consideration to be given to the breadth of services that need to be improved at the weekend, both to address 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 every day of the week. Patients have no choice but to accept the risks associated with their condition and with any necessary treatment, but they should never have to accept an increased risk or delay in accessing treatment because of the way healthcare services are designed.

References

1. Freemantle N, Richardson M, Wood J, Ray D, Khosla S, Shahian D, Roche WR, Stephens I, Keogh B, Pagano D. Weekend hospitalization and additional risk of death: An analysis of inpatient data. *Journal of the Royal Society of Medicine*, 2012; 105: 74-84.
2. Clinical Indicators Team. Indicator Specification: Summary Hospital - level Mortality Indicator. The NHS Information Centre. Accessed 08/05/2015 http://www.hscic.gov.uk/media/11151/Indicator-SpecificationSummary-Hospital-level-Mortality-Indicator-methodology/pdf/SHMI_Specification.pdf
3. Harrell FE Jr, Lee KL, Mark DB. Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. *Stat Med* 1996;15:361-87.
4. General Medical Council. National training survey 2012 report. www.gmc-uk.org/education/national_summary_reports.asp.
5. Clover B. Chief executives not confident on out-of-hours safety. *Health Serv J* 2013 Jan 2. www.hsj.co.uk/acute-care/chief-executives-not-confident-on-out-of-hours-safety/5053046.article.
6. Temple J. Time for training. 2010. www.wp.dh.gov.uk/healtheducationengland/files/2012/08/Time-for-training-report.pdf
7. Collins J. Foundation for excellence: an evaluation of the foundation programme. 2010. www.wp.dh.gov.uk/healtheducationengland/files/2012/08/Foundation-for-excellencereport.pdf.

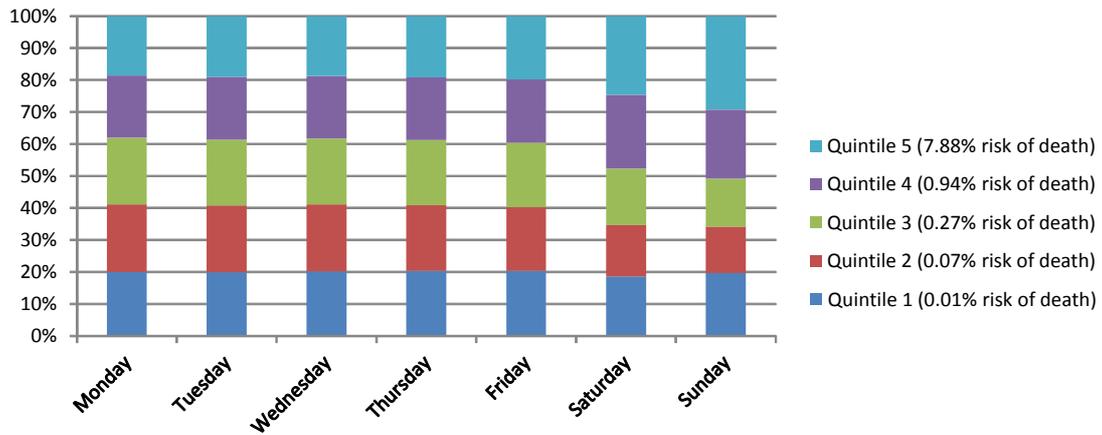
8. Health Education England. Better training, better care.
www.hee.nhs.uk/work-programmes/btbc/.
9. Royal College of Physicians. Position statement: care of medical patients out of hours. 2010.
<http://www.rcplondon.ac.uk/sites/default/files/rcp-position-statement-care-of-medicalpatients-out-of-hours.pdf>
10. Academy of Royal Colleges. Seven day consultant present care.
www.aomrc.org.uk/publications/reports-a-guidance/doc_details/9532-seven-day-consultant-present-care.html.
11. NHS Commissioning Board. Everyone counts: planning for patients 2013/14. 2012.
www.commissioningboard.nhs.uk/files/2012/12/everyonecounts-planning.pdf.

Keogh and Bennett are employed by the NHS England. Ray, McNulty, Rosser and Pagano are employed by University Hospitals Birmingham NHS Trust, and Freemantle has an honorary appointment with University Hospitals Birmingham NHS Trust

Keogh requested that our earlier analyses be updated with more recent data. Freemantle and McNulty ran the analyses. Freemantle wrote the first draft of the paper which all authors reviewed and revised.

This work was registered as an audit with University Hospitals Birmingham NHS Trust

Figure 1 Quintiles of risk of mortality over 30 days, by day of admission.



Note Derived from a survival model including risk adjustment but not including day of admission or day of hospital stay

Figure 2a

Day of Admission vs Wednesday: Hazard Ratio and 95% Confidence Interval

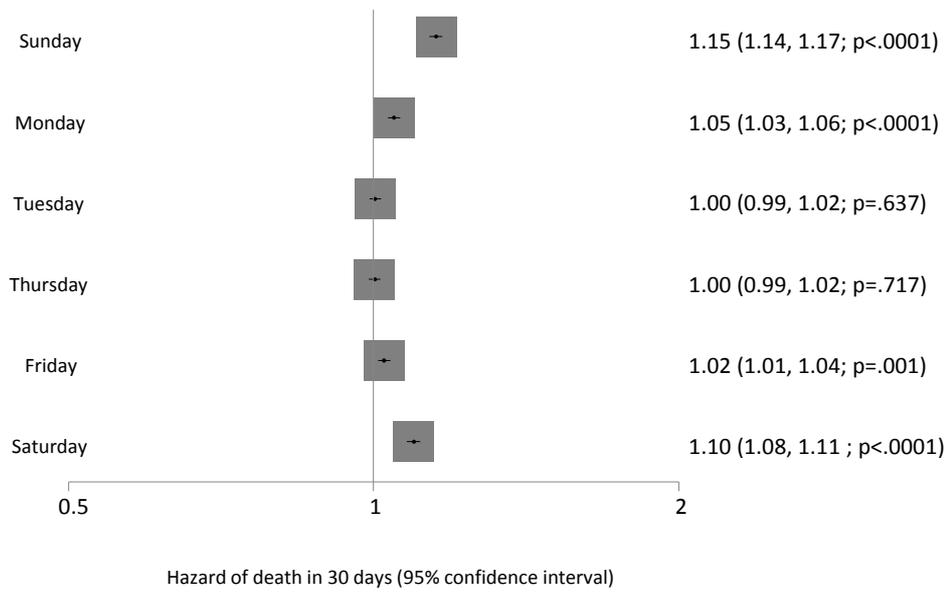


Figure 2b

Day of Death During Hospital Stay vs Wednesday: Hazard Ratio and 95% CI

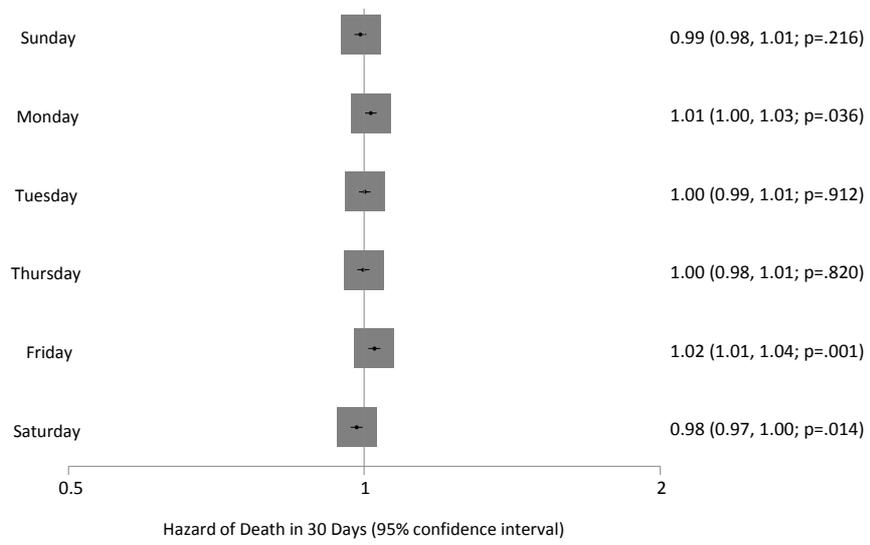


Figure 3a

Day of Admission vs Wednesday in Oncology Patients: Hazard Ratio and 95% Confidence Interval

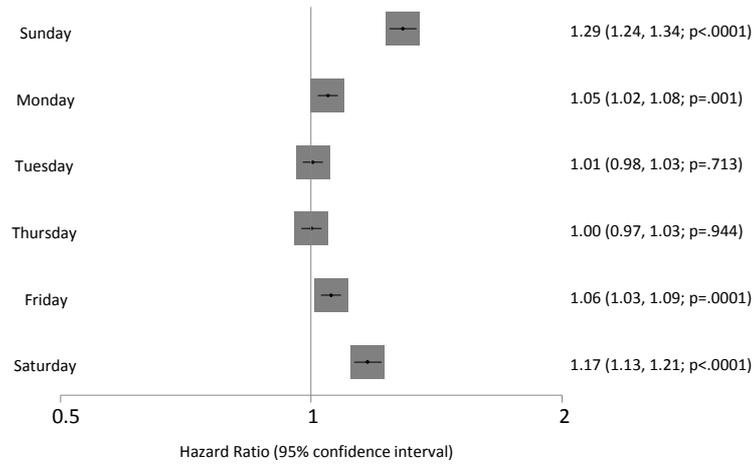


Figure 3b

Day of Death During Hospital Stay vs Wednesday in Oncology Patients: Hazard Ratio and 95% CI

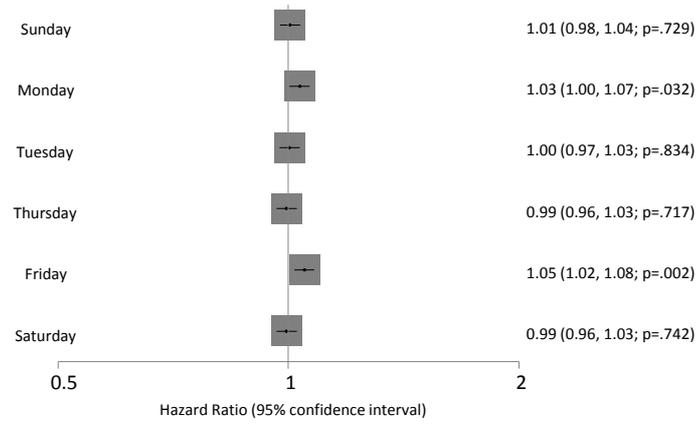


Figure 4a

Day of Admission vs Wednesday in CVD Patients: Hazard Ratio and 95% Confidence Interval

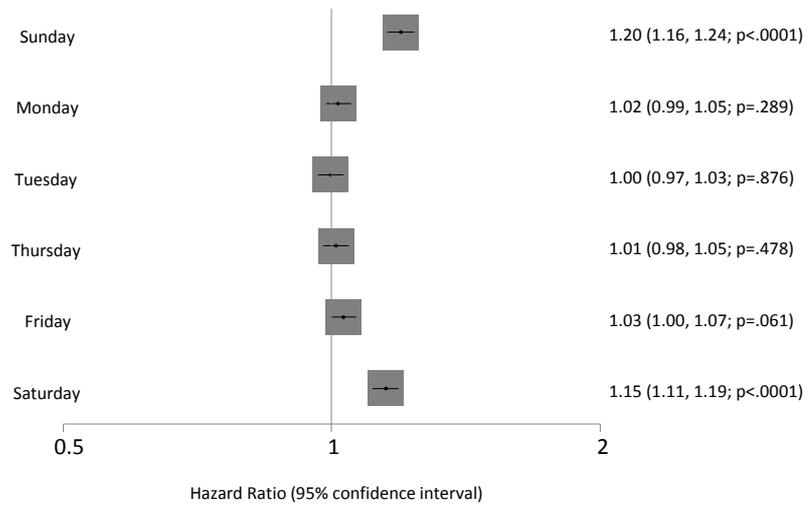


Figure 4b

Day of Death During Hospital Stay vs Wednesday in CVD Patients: Hazard Ratio and 95% CI

