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## Abstract

**Background**: The influence of patient demographics and mode of admission on the 'weekend effect' remains unclear. This study examins the relationship between day of admission, patient demographics, mode of presentation and survival.

**Methods:** Hospital admissions over a three-year period were studied. Patients with an in-patient stay less than 24 hours and those who were discharged from the emergency department were excluded. In-hospital mortality was correlated with day of admission, age, gender and mode of presentation in a binary logistical regression analysis.

**Results**: There were 448,827 admissions, of which 350,648 (85.7%) occurred during a weekday. 256,777 (62.7%) were emergency presentations, which was closely related to a weekend admission (92.3% vs 57.8%, $p<0.001$). There were 8099 deaths of which 6336 (78.2%) related to a weekday admission and 1736 (21.4%) related a weekend admission. Mortality for elective admissions was 78 (0.05%) compared to 8021 (3.12%), $p<0.001$ in emergency admissions. Univariable regression analysis revealed a weekend admission (Odds Ratio (OR) 1.68 (95% confidence interval (CI) 1.60-1.78, $p<0.001$) and emergency presentation (OR 63.02 (95%CI 50.42-78.77), $p<0.011$) were associated with weekend mortality. On multivariable analysis the OR for weekend admission reduced to 1.07 (95%CI 1.01-1.13), $p=0.013$ and the OR for emergency presentation increased to 76.68 (95%CI 61.40-96.00), $p<0.001$.

**Conclusion**:
This study highlights that higher weekend mortality rates are a consequence of a lower proportion of elective admissions. Extending the working week to seven days might reduce weekend mortality without reducing the total number of deaths.

## Introduction

Hospital patients admitted on a Saturday and Sunday may be 10% and 15% more likely to die respectively[1], possibly leading to 6000 avoidable deaths every year in the NHS[2]. The variation in healthcare services and resources available at the weekend, is well recognised in the UK[3]. Service provision within the NHS has always been organised around a division of services between weekdays and weekends with elective work largely performed during the week. Mortality data indicate that increased hospital mortality at the weekends has been linked to reduced cover by senior consultants[4]. Hospital admission at the weekend has been associated with a significantly increased 30-day mortality for both elective and emergency[1,5] admissions. In contrast, being in hospital at the weekend is associated with a reduced risk of death[6]. Other studies have shown a similar mortality rate for emergency admissions throughout the week[7].

A recent study of NHS England's mortality, which has been the largest contributor to the 7-day NHS, concludes that there is excess mortality associated with a weekend admission[1]. Significant variations in mortality rates exist between elective and emergency admissions[1]. Weekend admissions are predominantly emergency in nature and this may explain the 'weekend effect' previously reported. To test this hypothesis, this study examines the relationship between day of admission, patient demographics, mode of admission and mortality in the second largest health board in Wales over a 3-year period.

## Patients and methods

A three-year retrospective observational study analysed all the deaths in each of the 9 hospitals within Aneurin Bevan University Health Board (ABUHB). Various hospitals included in the analysis were a mix of acute and rehabilitation hospitals. Admissions over a 3-year period from 1st April 2012 to 31st March 2015 for each hospital were analysed. Patient and outcome data were sourced from merged data sets from Myrddin and Symphony IT systems. Myrddin is a national patient administration system and Symphony books and registers patients in the emergency department (ED). Entries from both data sets were merged using the patient specific NHS and case number. All admissions were analysed and data on day of admission, day of discharge, admission status and date of death or discharge recorded.

All patients admitted to hospital via the emergency department (ED), outpatient department (OPD), Emergency Assessment Unit (EAU) or directly to a ward for greater than 24 hours were included. ED and EAU discharges were excluded. The mode of admission was categorised as emergency or elective Emergency admissions included patients assessed and admitted elsewhere, patients assessed in an assessment unit and discharged, obstetric patients and patients transferred from other hospitals. The primary end point was in-hospital death according to day of admission. Statistical analysis was performed using the chi-squared test for categorical comparisons and logistical regression analysis to control for confounding factors. Variables were entered into the model in a backward conditional manner and they were retained in the final model if the corresponding p-value was $<0.05$.

## Patient involvement

Patients were not directly involved in this study as the patients' notes were analysed retrospectively.

**Results**

During the 3-year study period, there were 409,304 admissions of which 350,648 (85.7%) were during a weekday and 256,777 (62.7%) were emergency presentations. The majority of patients were male n=240642 (58.8%) and with an age range of 18-64 n=46226 (52.6%). Paediatric patients accounted for 46,226 (11.3%) of admissions with the elderly (≥ 65 years) accounting for the remainder n=147,833 (36.1%). Overall mortality was 2.0%, and equates to 8099 deaths. On average there were 410 admissions per day of which 235 were emergency and 175 were elective admissions. Collectively, there were fewer admissions on Friday, Saturday and Sunday compared to the rest of the week (Figure 1). Fifty eight per cent of all admissions on Monday-Friday were emergency compared to 92% on the weekend ($p<0.001$, table 1).

There were fewer deaths on a Saturday n=949 (11.7%) and Sunday n=814 (10.1%) compared with Monday n=1305 (16.1%), Tuesday n=1272 (15.7%), Wednesday n=1203 (14.9%), Thursday n=1272 (15.8%) and Friday n=1279 (15.8%) (figure 2). The number of deaths associated with a weekday and weekend admission was 6336 (78.2%) and 1763 (21.8%) respectively. To account for reduced admissions on a weekend, the proportion of deaths to total admissions was calculated. This revealed a weekend mortality rate of 3.0% compared to 1.8% for weekdays ($p<0.001$, table 2). Patients admitted during the weekend, predominantly presented as emergencies n=54136 (92.3%) compared to 202641 (57.8%) during a weekday ($p<0.001$, table1).

A multivariable regression model was designed to identify the factors independently associated with poor survival. On univariable logistical regression analysis; advancing age ($p<0.001$), female gender ($p<0.001$), emergency admission ($p<0.001$) and weekend admission ($p<0.001$) were associated with poor survival (table 2). On multivariable analysis all studied factors retained independent significance ($p<0.05$, table 2). In particular, the OR for emergency admission increased from 63.02 (95%CI 50.42 – 78.77) to 76.78 (95%CI 61.40 – 96.00) with a reduction of the OR for weekend admission from 1.68 (95%CI 1.60 – 1.78), $p<0.001$ to 1.07 (95%CI 1.01 – 1.13), $p=0.013$ (table 2). Furthermore, when compared with paediatric

admissions the OR for older age increased from 60.26 (95%CI 43.98 – 82.56) to 93.53 (95%CI 68.26 – 128.18) (table 2).

## Discussion

This large study of approximately 400,000 patients demonstrates that the previously described 'weekend effect' is significantly confounded by the fact that the majority of admissions on a weekend are emergency in nature. Patients admitted as an emergency at the weekend are no more likely to die than those admitted during the week. These results indicate that the lower overall mortality seen on weekday admissions is due to a higher proportion of elective admissions, which are associated with a lower mortality rate. Expansion to a full seven-day elective working week may well reduce weekend mortality rates by diluting the high-risk emergency cases with elective admisisons. Although this would be a political success it would have little impact on crude mortality numbers.

Freemantle et al observed a 10-15% higher mortality rate between weekend admissions and a Wednesday[1], which is nearly double the rate observed in this study. The observed difference in day of admission mortality cannot be explained by the proportion of weekend emergency admissions as the Freemantle cohort contained less emergency admissions (56.8% vs 92.3%) but had a higher weekend mortality. A systematic review and meta-analysis of mortality and weekend admission revealed a death rate of 4.26% compared to 3.62% in weekday admissions and is similar to those seen in our cohort.[8]

Patients admitted at weekends are more ill than those admitted during the weekdays. The possibility of weekends seeing more severe presentations of conditions, has been explored elsewhere. A significantly higher proportion of patients presenting with acute coronary syndrome have ST-elevation-myocardial-infarction (STEMI) on weekends when compared to weekdays[9]. Possible reasons for a real effect, which may reflect social patterns of behavior including social and primary care provision, clinical and supporting service staffing levels and patient factors. Patients already in hospital maybe less likely to die over the weekend[6] suggesting that it is not simply about the numbers of doctors available at the weekend.

Seven-day working by senior consultants in Stroke Units did not reduce mortality, but higher nursing staff levels did[10]. The Francis report recommended stratification of safe clinical staffing levels, which was

considered to have been a major factor at the Mid Staffs enquiry[11]. Doubts about a seven-day service have surfaced elsewhere, particularly the benefit of reducing excess weekend deaths versus costs of implementing such a service. Increasing service provision on weekend may impact services on weekdays unless the total number of staff increase[12].

In a study conducted to investigate mortality from acute upper gastrointestinal bleeding in the UK, there was no significant difference in mortality for patients presenting on weekends versus weekdays, after adjusting for confounders, despite patients being more likely to be in a critical state when presenting on weekends. It was also shown that hospital mortality was unaffected by the presence of an out of hours endoscopy rota[13].

The strength of this study includes the dataset being obtained from the second largest health board in Wales, comprising of both acute and rehabilitation hospital settings. This ensures a large population size and a mixture of cases. The results are somewhat different to those published by Freemantle et al concluding higher hospital deaths[1] at the weekend (Friday-Monday) possibly due to the fact we analysed weekend days only (Saturday and Sunday. A relative limitation of this study is the omission of illness severity scores and other confounding factors from the regression analysis. This anonymised dataset prevented us from acquiring data on other, possibly important confounding factors.

In summary, this large study over a 3-year period in a single health board demonstrates that the excess mortality observed at the weekend relates to the higher proportion of emergency admissions. Extending the working week to seven days is likely to result in a statistically significant reduction in mortality by diluting the prognostic influence of the emergency caseload whilst not reducing the crude number of deaths.

## Appendix

## Tables

## Figures

Figure 1. The relationship between number of admissions according to day of admission

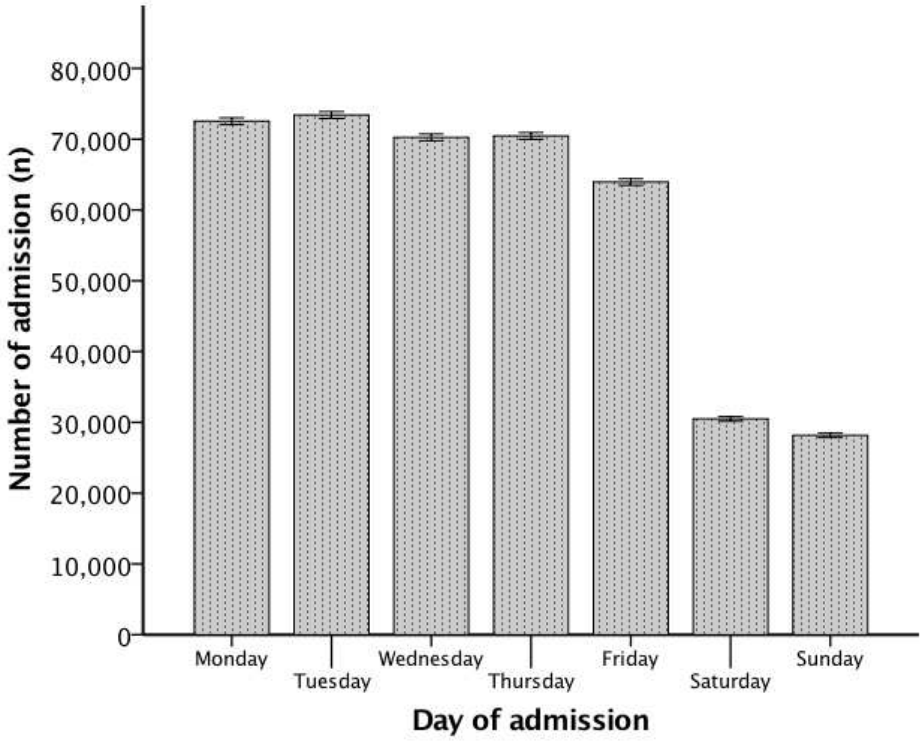
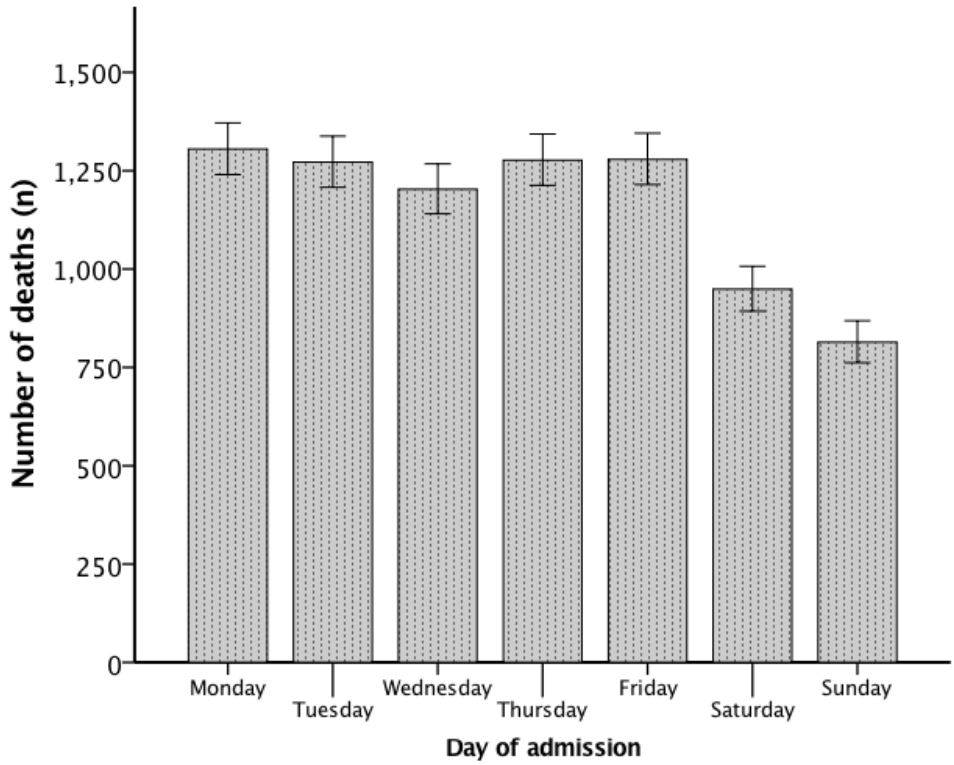



Figure 2. The relationship between number of deaths and day of admission



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