Weekend admissions as an independent predictor of mortality: an analysis of Scottish hospital admissions

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ABSTRACT

Objectives: Weekend admissions have been shown to be associated with an increased risk of mortality compared with weekday admissions for many diagnoses. We analysed emergency department admissions within the Scottish National Health Service to investigate whether mortality is increased in case of weekend emergency department admissions.

Design: A cohort study.

Setting: Scotland National Health Service (NHS) emergency departments.

Participants: 5 271 327 emergency department admissions between 1999 and 2009. We included all patients admitted via emergency departments recorded in the Scottish Morbidity Records (SMR01) in NHS, Scotland for whom complete demographic data were available.

Primary outcome measures: Death as recorded by the General Register Office (GRO).

Results: There was a significantly increased probability of death associated with a weekend emergency admission compared with admission on a weekday (unadjusted OR 1.27, 95% CI 1.26 to 1.28, p<0.0001; adjusted for year of admission, gender, age, deprivation quintile and number of comorbidities OR 1.2, 95% CI 1.40 to 1.43, p<0.0001).

Conclusions: Despite a general reduction in mortality over the last 11 years, there is still a significant excess mortality associated with weekend emergency admissions. Further research should be undertaken to identify the precise mechanisms underlying this effect so that measures can be put in place to reduce patient mortality.

INTRODUCTION

Service provision within National Health Service (NHS) hospitals has traditionally been organised around a fundamental division between weekdays and weekends. However, mortality data drawn from many different sources indicate that weekend admission to hospital is associated with an increased risk of death. This has prompted a shift in health policies within the UK towards consideration of a 7-day working week within the NHS.

The evidence illustrating an adverse effect of weekend admission on death rates is strong and growing constantly. A recent study using the NHS database of all NHS hospital admissions within England showed a significantly increased risk of death for patients admitted at the weekend, even when adjusted for multiple potential confounders. Similar analyses of emergency admissions within multiple hospitals in England and Spain have shown a similar detrimental effect of weekend admissions on survival. Increased mortality with weekend admissions is consistent across multiple pathologies suggesting a systematic failure of care.

Key messages

This article addresses whether this excess mortality is seen in emergency admissions from National Health Service, Scotland between 1999 and 2009.

Strengths and limitations of this study

This study uses a large, nationally registered cohort of admissions obtained over a long time period.

Although able to adjust for many confounding variables, it was not possible to adjust for the admitting diagnosis or severity of presenting a complaint.
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(ruptured aortic aneurism, pulmonary embolism and acute epiglottitis) but not others (acute myocardial infarction, hip fracture and intracranial haemorrhage), although subsequent studies from the USA suggest that myocardial infarction presenting at weekends is associated with an increased mortality. A similar effect was observed for acute kidney injury and stroke.

This effect spans multiple different age groups (perinatal mortality is increased at weekends, although not when adjusted for birth weight) and clinical areas (intensive care admissions at the weekend are associated with an increased mortality). Particularly influential to policies has been the report by Dr Foster on an increased hospital mortality in the UK at weekends, which has been linked to a reduced cover by senior doctors at weekends.

In this study, we aimed to investigate emergency admissions within NHS, Scotland to establish if a similar effect of weekend admissions on mortality occurred in this region.

METHODS
Scottish admissions data
The Scottish Morbidity Records (SMR01) database of Scottish inpatient/daycase admissions and General Register Office (GRO) death records for Scotland were accessed on 26 February 2011 for emergency department admissions. The basic unit of analysis was the continuous spell of treatment (CIS). These were grouped according to the admission date, gender, age, deprivation quintile (based on Scottish Index of Multiple Deprivation 2009 V.2 Scotland level population-weighted quintile, where 1 is the most deprived and 5, the least) and number of recorded comorbidities. Probability matching methods were used to link together separate SMR01 hospital episodes for each patient, thereby creating ‘linked’ patient histories. Within these patient histories, SMR01 episodes are grouped according to whether they form part of a continuous spell of treatment (whether or not this involves transfer between hospitals or even Health Boards). Mortality during admission was derived from the GRO death record linked to the SMR.

Ethics statement
Anonymised data were used and we therefore followed the ethical principles of existing UK data protection legislation and guidance, including two National Statistics Protocols on data access and confidentiality, and data matching. Thus specific ethical approval was not required for this study according to the guidelines at http://www.nhnssn.org/pages/corporate/privacy_advisory_committee.php, which permitted the release of the data used in this study.

Statistical analysis
Data were analysed in STATA V.12.0 (StataCorp LP, College Station, Texas, USA). Multiple logistic regression was used for calculating ORs, 95% CIs and p values for individual factors. We interpreted p values of <0.05 as nominally significant. χ² Tests were used for testing for significance of trends within factors. Only records without missing data were included in the multiple logistic regression model.

RESULTS
Scottish emergency department admissions
There were 5 343 906 admissions to emergency departments in Scotland between 1999 and 2009, of which 5 271 327 (98.6%) had admission date, gender, age, deprivation quintile and number of comorbidities recorded. Of all admissions, 270 463 (5.03%) ended in death. This was very similar to the proportion of admissions for which all data were recorded that ended in death (266 119 (5.05%)). The majority of deaths for which all data were recorded occurred during weekdays (191 929, 4.77% of weekday admissions) rather than on weekends (74 190, 5.77% of weekend admissions). The subsequent analysis applies only to those admissions with complete records of the above data. About 4 025 845 (76.4%) of these were on weekdays and 1 245 482 (23.6%) on weekends. There were few admissions during weekends than expected from a random distribution (23.6% observed vs 28.6% expected, p<0.0001). Admissions and death rates broken down by each category are shown in table 1.

Mortality for weekend admissions compared with weekday admissions
The mortality for weekend admissions was found to be higher than that for weekday admissions (5.96% vs 4.77%, unadjusted OR 1.27, 95% CI 1.26 to 1.28, p<0.0001). The effect of weekend admissions was still statistically significant when adjusted for admission year, gender, age group, deprivation quintile and number of comorbidities (adjusted OR 1.42, 95% CI 1.40 to 1.43, p<0.0001). All of the potential confounders included in the logistic regression model were independently statistically associated with the probability of death for emergency admissions as shown in tables 1 and 2. Notably, the number of comorbidities shows an inverse trend on mortality that would not be expected a priori. Further, mortality after being admitted to a hospital has been declining over time (2009 mortality was 25% less than that in 1999, p<0.0001). However, the effect of admission at weekends on mortality remained much the same throughout the 11-year period studied (table 3).

Causes of death
Our study was not designed to investigate cause-specific aspects of mortality data. Table 4 shows the top 50 causes of death for weekend and weekday admissions. The patterns of mortality seem to appear relatively similar between weekends and weekdays. Further research would be needed to gather diagnosis-specific admission data to analyse mortality further.
Table 1: Number and percentages of emergency department admissions by category

| Category                        | Weekdays | Weekends | Total | Mortality (%) | OR  | 95% CI          | p Values | Test for trend |
|--------------------------------|----------|----------|-------|---------------|-----|----------------|----------|---------------|
|                                 |          |          |       |               |     |                |          |               |
|                                 |          |          |       |               | 1   |                | <0.0001 | N/A           |
| Wednesdays                      | 4025845  | 638824   | 104141 | 4.77          |     |                |          |               |
| Thursdays                       | 4354269  | 666585   | 110204 | 5.53          | 1.2  | 1.19           | 0.001    |               |
| Fridays                         | 373835   | 59822    | 433657 | 5.71          | 1.15 | 1.14           | 0.004    |               |
| Saturdays                       | 452485   | 71989    | 524474 | 5.52          | 1.21 | 1.20           | 0.001    |               |
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The number and percentage of emergency department admissions for each category are shown in the above table, along with the percentage that ended in death. The unadjusted OR along with lower and upper limits of the 95% CIs are shown in each row along with the significance for the test and significance for the trend within each category, if appropriate. Note that this analysis includes only those admissions where complete records of all potential confounders were kept.

*Patients under the age group 45–49 were used as the baseline group for calculation of ORs.

Handel AE, Patel SV, Skingsley A, et al. BMJ Open 2012;2:e001789. doi:10.1136/bmjopen-2012-001789

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BMJ Open: first published as 10.1136/bmjopen-2012-001789 on 6 November 2012. Downloaded from http://bmjopen.bmj.com/ on September 21, 2023 by guest. Protected by copyright.
DISCUSSION

Our study shows that the excess of admissions ending in deaths at weekends compared with those during weekdays seen elsewhere were also found in Scotland and, in fact, appear to be of a larger magnitude than the effects reported elsewhere (table 5). Despite a reduction in mortality over the course of the study, after adjusting for this and multiple other potential confounding variables, the weekend effect on mortality remains.

The strength of our study is that it analyses data from a large number of emergency admissions drawn from over a relatively long period of 11 years. There are a number of limitations. We lack data on cause and severity of admissions. The analysis relies on the accuracy of data input by clinicians and clerical staff involved in individual admissions and thus unlikely to be entirely accurate. Furthermore, since the regression analysis only included records with complete data recorded, there is a possibility of introducing systematic bias into our study. Several possible explanations may clarify the seemingly counter-intuitive finding that the number of comorbidities is inversely associated with mortality. It is possible that timing of utilisation of emergency department admissions differs by number of comorbidities or that this merely relects a survivor effect, whereby those that live longer accumulate more comorbid diagnoses.

The cause for this increased mortality is an area of considerable debate. Many of the studies reporting excess deaths at weekends adjusted for many of the obvious potential confounders (age, comorbidities, deprivation, etc). However, interestingly the effect appears to be persistent even when more careful analyses adjusting for specific confounders that would a priori be hypothesised to be adversely affected at weekends, such as time to angiography for myocardial infarction and time to oesophagogastroduodenoscopy in peptic ulcer-related upper gastrointestinal haemorrhage. However, in a recent study from Australia it was noted that, of the conditions they assessed (myocardial infarction, chronic obstructive pulmonary disease, diabetes, and chronic obstructive pulmonary disease), the excess weekend mortality was only seen in myocardial infarction, with no effect seen in the other conditions.

The adjusted OR along with lower and upper limits of the 95% CIs are shown in each row along with the significance for the trend within each category, if appropriate. These were derived from a logistic regression analysis. Note that this analysis includes only those admissions where complete records of all potential confounders were kept. *Patients under the age group of 45–49 were used as the baseline group for the calculation of OR.
| Rank | Weekends | Number | Percentage | Weekdays | Number | Percentage | Combined deaths (weekends and weekdays) |
|------|----------|--------|------------|----------|--------|------------|----------------------------------------|
| 1    | Malignant neoplasm of bronchus and lung | 4281   | 18.87      | Malignant neoplasm of bronchus and lung | 18400  | 81.13      | 22681                                  |
| 2    | Chronic ischaemic heart disease       | 4056   | 21.82      | Chronic ischaemic heart disease         | 14536  | 78.18      | 18592                                  |
| 3    | Acute myocardial infarction           | 4406   | 24.39      | Acute myocardial infarction             | 13658  | 75.61      | 18064                                  |
| 4    | Other septicemia                      | 3656   | 22.16      | Other septicemia                        | 12839  | 77.84      | 16495                                  |
| 5    | Pneumonia, organism unspecified       | 3029   | 23.00      | Pneumonia, organism unspecified         | 10139  | 77.00      | 13168                                  |
| 6    | Other chronic obstructive pulmonary disease | 2176   | 24.49      | Other chronic obstructive pulmonary disease | 6708  | 75.51      | 8884                                   |
| 7    | Stroke, not specified as haemorrhage or infarction | 2368   | 26.71      | Stroke, not specified as haemorrhage or infarction | 6497  | 73.29      | 8865                                   |
| 8    | Malignant neoplasm of breast          | 1058   | 16.80      | Malignant neoplasm of breast            | 5240   | 83.20      | 6298                                   |
| 9    | Heart failure                         | 1226   | 22.12      | Heart failure                           | 4317   | 77.88      | 5543                                   |
| 10   | Malignant neoplasm of colon           | 946    | 18.06      | Malignant neoplasm of colon             | 4293   | 81.94      | 5239                                   |
| 11   | Malignant neoplasm without specification of site | 822    | 16.37      | Malignant neoplasm without specification of site | 4199  | 83.63      | 5021                                   |
| 12   | Malignant neoplasm of prostate        | 872    | 17.93      | Malignant neoplasm of prostate          | 3991   | 82.07      | 4863                                   |
| 13   | Malignant neoplasm of oesophagus      | 781    | 17.75      | Malignant neoplasm of oesophagus        | 3619   | 82.25      | 4400                                   |
| 14   | Non-insulin-dependent diabetes mellitus | 832   | 20.85      | Non-insulin-dependent diabetes mellitus | 3159  | 79.15      | 3991                                   |
| 15   | Unspecified diabetes mellitus         | 814    | 22.41      | Unspecified diabetes mellitus           | 2818   | 77.59      | 3632                                   |
| 16   | Alcoholic liver disease               | 681    | 19.01      | Alcoholic liver disease                 | 2902   | 80.99      | 3583                                   |
| 17   | Malignant neoplasm of pancreas        | 593    | 17.43      | Malignant neoplasm of pancreas          | 2809   | 82.57      | 3402                                   |
| 18   | Atrial fibrillation and flutter       | 782    | 24.02      | Atrial fibrillation and flutter         | 2473   | 75.98      | 3255                                   |
| 19   | Intracerebral haemorrhage             | 798    | 25.77      | Intracerebral haemorrhage               | 2299   | 74.23      | 3097                                   |
| 20   | Malignant neoplasm of stomach         | 517    | 16.77      | Malignant neoplasm of stomach           | 2566   | 83.23      | 3083                                   |
| 21   | Cerebral infarction                   | 753    | 27.01      | Cerebral infarction                     | 2035   | 72.99      | 2788                                   |
| 22   | Malignant neoplasm of bladder         | 479    | 17.33      | Malignant neoplasm of bladder           | 2285   | 82.67      | 2764                                   |
| 23   | Unspecified dementia                  | 614    | 23.69      | Unspecified dementia                    | 1978   | 76.31      | 2592                                   |
| 24   | Essential (primary) hypertension       | 581    | 23.23      | Essential (primary) hypertension        | 1920   | 76.77      | 2501                                   |
| 25   | Malignant neoplasm of ovary           | 435    | 17.81      | Malignant neoplasm of ovary             | 2007   | 82.19      | 2442                                   |
| 26   | Other cerebrovascular diseases        | 522    | 22.20      | Other cerebrovascular diseases          | 1829   | 77.80      | 2351                                   |
| 27   | Pulmonary embolism                    | 466    | 21.07      | Pulmonary embolism                      | 1746   | 78.93      | 2212                                   |
| 28   | Pneumonitis due to solids and liquids | 525    | 24.37      | Pneumonitis due to solids and liquids    | 1629   | 75.63      | 2154                                   |
| 29   | Other and unspecified types of non-Hodgkin’s lymphoma | 372    | 17.43      | Other and unspecified types of non-Hodgkin’s lymphoma | 1762  | 82.57      | 2134                                   |
| 30   | Sequelae of cerebrovascular disease   | 465    | 23.13      | Sequelae of cerebrovascular disease     | 1545   | 76.87      | 2010                                   |
| 31   | Aortic aneurysm and dissection        | 489    | 24.39      | Aortic aneurysm and dissection          | 1516   | 75.61      | 2005                                   |
| 32   | Malignant neoplasm of rectum          | 320    | 16.74      | Malignant neoplasm of rectum            | 1592   | 83.26      | 1912                                   |
| 33   | Malignant neoplasm of kidney, except renal pelvis | 280    | 15.23      | Malignant neoplasm of kidney, except renal pelvis | 1558  | 84.77      | 1838                                   |
| 34   | Malignant neoplasm of liver and intrahepatic bile ducts | 307    | 17.11      | Malignant neoplasm of liver and intrahepatic bile ducts | 1487  | 82.89      | 1794                                   |

Continued
| Rank | Weekends                                      | Number | Percentage | Weekdays                                      | Number | Percentage | Combined deaths (weekends and weekdays) |
|------|----------------------------------------------|--------|------------|----------------------------------------------|--------|------------|----------------------------------------|
| 35   | Malignant neoplasm of brain                  | 271    | 17.18      | Malignant neoplasm of brain                  | 1306   | 82.82      | 1577                                   |
| 36   | Multiple myeloma and malignant plasma cell neoplasms | 265    | 17.64      | Multiple myeloma and malignant plasma cell neoplasms | 1237   | 82.36      | 1502                                   |
| 37   | Malignant neoplasm of rectosigmoid junction  | 222    | 14.90      | Malignant neoplasm of rectosigmoid junction  | 1268   | 85.10      | 1490                                   |
| 38   | Myeloid leukaemia                            | 247    | 17.13      | Myeloid leukaemia                            | 1195   | 82.87      | 1442                                   |
| 39   | Unspecified fall                             | 377    | 26.44      | Unspecified fall                             | 1049   | 73.56      | 1426                                   |
| 40   | Non-rheumatic aortic valve disorders         | 244    | 17.55      | Nonrheumatic aortic valve disorders          | 1146   | 82.45      | 1390                                   |
| 41   | Malignant neoplasm of other and ill-defined digestive organs | 233    | 17.65      | Malignant neoplasm of other and ill-defined digestive organs | 1087   | 82.35      | 1320                                   |
| 42   | Other disorders of urinary system            | 317    | 24.11      | Other disorders of urinary system            | 998    | 75.89      | 1315                                   |
| 43   | Vascular dementia                            | 252    | 19.58      | Vascular dementia                            | 1035   | 80.42      | 1287                                   |
| 44   | Subarachnoid haemorrhage                     | 332    | 28.23      | Subarachnoid haemorrhage                     | 844    | 71.77      | 1176                                   |
| 45   | Other peripheral vascular diseases           | 226    | 19.28      | Other peripheral vascular diseases           | 946    | 80.72      | 1172                                   |
| 46   | Other bacterial intestinal infections        | 280    | 24.93      | Other bacterial intestinal infections        | 843    | 75.07      | 1123                                   |
| 47   | Parkinson’s disease                          | 194    | 18.28      | Parkinson’s disease                          | 867    | 81.72      | 1061                                   |
| 48   | Unspecified acute lower respiratory infection| 259    | 25.77      | Unspecified acute lower respiratory infection| 746    | 74.23      | 1005                                   |
| 49   | Mental and behavioural disorders due to use of alcohol | 259    | 25.87      | Mental and behavioural disorders due to use of alcohol | 742    | 74.13      | 1001                                   |
| 50   | Other interstitial pulmonary diseases        | 216    | 23.20      | Other interstitial pulmonary diseases        | 715    | 76.80      | 931                                    |

Admissions ending in death for the top 50 causes of death as ranked for weekends and weekdays admissions combined. The percentage of total deaths for that diagnosis is shown beside each diagnosis.
out-of-hours primary care has been shown to alter the profile of emergency department admissions. Further work should focus on understanding the precise mechanism behind the increased mortality observed for weekend admissions so that effective measures can be implemented to combat this. Ideally, this would entail ascertaining diagnosis and severity-specific weekend mortality by region and level of service infrastructure, incorporating broad aspects of prebased care and hospital-based care.

Table 5

| Study First author | Year | OR 95% CI | Notes |
|--------------------|------|-----------|-------|
| Barba 2006         | 1.40 | 1.18     | 1.62  | Single centre study in Spain 1999–2003 excluding all elective admissions, elective transfers, critical care patients and births. Adjusted for age, gender, diagnosis-related group weight and comorbidity. |
| Aylin 2010         | 1.10 | 1.08     | 1.11  | National Health Service (NHS), England emergency admissions 2005/2006. Adjusted for age, sex, deprivation quintile and comorbidity. |
| Marco 2010         | 1.07 | 1.05     | 1.10  | Spanish NHS emergency admissions to internal medicine wards 2005. Adjusted for age, sex and comorbidity |
| Freemantle 2012    | 1.11 | 1.09     | 1.13  | NHS, England emergency admissions 2009/2010. Adjusted for age; sex; ethnicity; whether the admission was classified as an emergency; source of admission (eg, from home or transfer from another hospital); diagnostic group; number of previous emergency admissions; number of previous complex admissions; comorbidity; social deprivation; hospital trust; day of the year (seasonality) and the day of admission. |

It is clearly critical to understand the precise cause of this excess mortality before measures can be put in place to mitigate the effect of weekend admissions on survival, particularly given the potentially huge costs involved in upgrading weekend services. Resources and manpower in the hospital will clearly play a huge part in this, however, the importance of reduced primary care support at weekends in the community should not be forgotten, since early identification of unwell patients is likely to improve later outcomes and out-of-hours primary care has been shown to alter the pulmonary disease, intracranial haemorrhage and acute hip fracture), there was observed an association of weekend admissions with mortality in myocardial infarction, the condition in which a delay to instrumentation is likely to have the largest effect on outcome. Certainly, institutional standards appear to be able to mitigate the excess weekend mortality, at least in case of ischaemic strokes, wherein no increase in mortality for weekend admissions has been observed in ‘comprehensive stroke centres’ within the USA, but is still seen in less-specialist centres. It may also be that emergency departments see a different, more unwell population of patients at weekends, since, in one study which used a biochemical measure of severity, adjustment for this variable rendered the weekend effect insignificant. It is possible that a confounding variable associated with severity, for which we were unable to control, underlies the weekend effect. This could mean that the effect we observe is actually due to admissions over the weekend comprising a more unwell population of patients, who would suffer a higher rate of mortality regardless of factors that may apply exclusively to the weekend.

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Acknowledgements We are grateful to NHS, Scotland for providing us with data and to colleagues for many useful and informative conversations.

Contributors AEH and SVR conceived the study idea. SVP analysed the data. AEH, SVP, AS, KB, RS and SVR wrote the paper.

Funding This work was funded by the Wellcome Trust (Grant Number 075491/Z/04). The funder had no role in data analysis or deciding to submit this manuscript for publication.

Competing interests None.

Provenance and peer review Not commissioned; externally peer-reviewed.

Data sharing statement Extra data can be accessed via the Dryad data repository at http://datadryad.org with the DOI:10.5061/dryad.rm857.
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