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Weekend mortality for emergency admissions. A large, multicentre study

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ABSTRACT

Background Several studies have identified higher mortality for patients admitted as emergencies at the weekend compared with emergency admissions during the week, but most have focused on specific conditions or have had a limited sample size.

Methods Using routinely collected hospital administrative data, we examined in-hospital deaths for all emergency inpatient admissions to all public acute hospitals in England for 2005/2006. Odds of death were calculated for admissions at the weekend compared to admissions during the week, adjusted for age, sex, socioeconomic deprivation, comorbidity and diagnosis.

Results Of a total of 4 317 866 emergency admissions, we found 215 054 in-hospital deaths with an overall crude mortality rate of 5.0% (5.2% for all weekend admissions and 4.9% for all weekday admissions). The overall adjusted odds of death for all emergency admissions was 10% higher (OR 1.10, 95% CI 1.08 to 1.11) in those patients admitted at the weekend compared with patients admitted during a weekday ($p<0.001$).

Conclusions This is the largest study published on weekend mortality and highlights an area of concern in relation to the delivery of acute services.

Previous North American studies have found that mortality among patients admitted on weekends was higher than for those patients admitted on weekdays.[1 2] These papers focused on specific conditions, and in each case, poorer access to services at the weekend was implicated as a possible explanation. A recent European study suggested that although all-cause mortality was similar in patients admitted during the week and at weekends, death within the first 48 h was higher for patients admitted at weekends.[3] Neonatal mortality has also been shown to be higher for babies born on weekends than among those born on weekdays.[4] Barnett *et al*[5] found a 9% increase in risk-adjusted mortality among patients admitted to intensive care units in Iowa on weekends when compared with weekdays. There have been few UK studies looking into this issue. A small Scottish study looked at acute medical admissions to a single hospital trust over one year and found no increase in mortality for patients admitted at weekends. However, because of its sample size, it was limited in its power to detect differences in mortality.[6] A study of patients admitted to intensive care units in England, Wales and Northern Ireland found that after adjustment for case mix, there was no significant association between day of admission and increased mortality.[7] Other international studies have found the same.[8 9] However, intensive care units have well-established shift working systems with dedicated nursing and direct consultant input at a level not generally applicable to more general emergency hospital care.

We aimed to take advantage of the large numbers of records available within routinely collected hospital admissions data in England and compared mortality for emergency admissions occurring at weekends with that occurring during the rest of the week in England for a wide range of diagnoses.

METHODS

We obtained an extract of all finished consultant episodes of care for inpatients in all acute public hospitals in England from the NHS Wide Clearing Service with discharge dates between 1 April 2005 and 31 March 2006. A finished consultant episode is defined as a period of admitted patient care under a consultant or allied healthcare professional within an NHS hospital trust. There may be more than one finished consultant episode within an admission and, by linking episodes of care, our unit of analysis was an admission. We excluded day cases (day surgery) and admissions occurring in non-acute trusts, and focused on emergency inpatient admissions. As we did not have time of admission, we defined weekend admissions as those that started on a Saturday or Sunday by date. We derived the main diagnosis from the primary diagnosis of the first episode of care. If that diagnosis was vague or non-specific, then the primary diagnosis in the subsequent episode of care (if present) was used. All admissions were coded to one of 258 Clinical Classification System (CCS) diagnostic groups.[10] We assigned an area-level socioeconomic deprivation score (Index of Multiple Deprivation 2004) to each patient using their postcode of residence.[11] We also assigned a Charlson comorbidity score (a weighted index of the number of serious coexisting diseases capped at six using information from secondary diagnosis fields).[12] An admission was defined as having ended in a death if death occurred in hospital at any time during their hospitalisation (including transfers to other hospitals). Transfers were linked together into one admission to avoid multiple counting.

Counts of admissions, deaths and crude mortality rates for those admitted at a weekend and those on a weekday were calculated by age, sex, deprivation quintile and the Charlson comorbidity score. The two groups were first compared using χ^2 tests. We then calculated the odds of death in admissions occurring on a weekend compared with those on a weekday adjusting for age, sex, deprivation quintile and comorbidity for each of 50 clinical groups using logistic regression. Each group was allotted to one of three clinical categories: neoplasms, surgical and medical. We calculated the overall odds of death for all admissions occurring on a weekend compared with those on a weekday, adjusted for the above factors and additionally for diagnosis (each of the 50 CCS groups and all remaining diagnoses combined into a single group).

Using a risk model derived from weekday admissions, we applied the estimated risk of death (based on the log odds derived from the risk model) to each patient admitted at the weekend. When summed across all these weekend patients, we were able to calculate the numbers of deaths expected at the weekend, given that the risk of death was the same as a weekday admission. We then estimated the potential excess numbers of deaths by subtracting the estimated number of deaths from the observed number at the weekend.

RESULTS

We extracted 4 317 866 records for emergency admissions in 163 acute hospital trusts in England. There were 215 054 in-hospital deaths with an overall crude mortality rate of 5.0% (5.2% for all weekend admissions and 4.9% for all weekday admissions). Comparing all weekend and weekday admissions, there were statistically significant differences in age, sex, Index of Multiple Deprivation quintile and the Charlson comorbidity index ($p<0.001$). However, the differences were small (table 1). On average, there were 25% fewer emergency admissions per day on the weekend when compared with the rest of the week. The average daily number of admissions was 9606 at the weekend compared with 12 765 during the rest of the week.

The top 50 CCS groups for mortality accounted for 1 782 476 hospital admissions (41.3% of all admissions examined) and 176 342 deaths (81.8% of all deaths). Mortality among patients with these conditions who were admitted on a weekend, compared with those that were admitted on a weekday, is shown in table 2. In total, 28 clinical groups had significantly higher odds of mortality at the weekend when compared with the weekday ($p<0.05$); 17 were significant at $p<0.001$. Three conditions had significantly lower odds of mortality at the weekend with $p<0.05$, but no conditions were significant at $p<0.001$. For the 32 medical groups, eight had significantly ($p<0.001$) higher odds of death for patients admitted at the weekend. Of the 11 cancer diagnoses examined, 8 had significantly ($p<0.001$) higher odds of death for patients admitted at the weekend. Of the seven surgical groups, one had significantly ($p<0.001$) higher odds of death for patients admitted at the weekend. The overall odds of death for all emergency admissions, adjusted by CCS diagnostic group, age, sex, deprivation quintile and comorbidity, was 10% higher (OR 1.10, 95% CI 1.08 to 1.11) in those patients admitted at the weekend compared with patients admitted during a weekday ($p<0.001$). On the assumption that patients admitted at the weekend have the same risk of death as those admitted on weekdays, we estimate a possible excess of 3369 deaths (95% CI 2.921 to 3.820) occurring at the weekend for 2005/2006, equivalent to a 7% higher risk of death.

Table 1 Numbers of admissions by age, sex, socioeconomic deprivation and Charlson index of comorbidity for emergency admissions to acute NHS hospitals 2005/2006

Characteristic	Weekday admission % of admissions (number of cases)	Weekend admission
Age in years*		
0 to 14	13.8 (458 049)	14.8 (147 394)
15 to 44	27.8 (921 471)	28.9 (288 533)
45 to 64	19.5 (648 753)	18.2 (182 213)
65 to 74	12.9 (429 674)	12.0 (119 252)
75 to 84	16.2 (538 292)	15.8 (157 979)
≥85	9.7 (322 565)	10.4 (103 691)
Sex*		
Male	47.5 (1 575 825)	49.3 (492 924)
Female	52.5 (1 742 979)	50.7 (506 138)
Index of multiple deprivation quintile*		
1 least deprived	15.1 (502 248)	14.7 (147 007)
2	16.9 (561 375)	16.6 (165 441)
3	18.8 (622 559)	18.5 (185 224)
4	21.3 (707 278)	21.4 (214 105)
5 most deprived	26.4 (876 554)	27.0 (270 199)
6 unclassified	1.5 (48 790)	1.7 (17 086)
Charlson index of comorbidity*		
0 no comorbidity	66.6 (2 209 519)	67.6 (675 850)
1	19.0 (631 280)	19.3 (192 928)
2	8.0 (266 177)	7.4 (74 173)
3	2.9 (97 672)	2.7 (27 077)
4	1.0 (34 050)	0.9 (9344)
5	1.7(56 443)	1.3 (13 809)
>6 highest comorbidity	0.7 (23 663)	0.6 (5881)
Total	100 (3 318 804)	100 (999 062)

*χ^2 test for association, $p<0.001$ for all variables.

DISCUSSION

We found that of the 50 diagnosis groups with the highest number of deaths, 17 were associated with a significantly higher odds of mortality ($p<0.001$) among patients admitted on a weekend compared with those admitted on a weekday. We found a 10% higher odds of death for patients admitted as an emergency case at the weekend compared with those admitted on a weekday after adjusting for age, sex, diagnosis, deprivation and comorbidity, resulting in a possible excess of more 3369 deaths for 2005/2006. This is more than the 3201 people killed in road accidents in Great Britain in 2006.[13] We acknowledge that this is perhaps an unfair comparison, as it is likely that people dying on the roads are from a much younger age group and will be generally healthier compared with the population of people admitted as an emergency to hospital at the weekend. Some future analysis involving quality-adjusted life years might inform this issue, but quality-adjusted life years would be difficult to estimate from the limited information available to us.[14] We have also not considered a qualitative or mixed methods approach, although there might be much to be gained from narrative reports with contextual description of sentinel events or case history vignettes. This would circumvent the limitations of a purely statistical model.

Our findings could be because of a number of factors. In the analysis, we carried out a large number of statistical tests, and it is possible that of some of our findings have arisen by chance. The main finding for all diagnoses combined of a 10% higher odds of death at the weekend was highly significant ($p<0.001$). The breakdown by individual CCS group should be treated with caution. However, even after using the Bonferroni correction for multiple statistical testing,[15] 17 of the groups remain significant at $p<0.001$. We focus on these groups in the discussion.

Concerns about the quality of routine hospital data remain, and although data quality has improved greatly in recent years,[16] the analyses still need careful interpretation.[17] A recent comparison of counts of episodes generated through Hospital Episode Statistics and paper returns provided by each hospital trust suggests that the administrative database captured 98.9% of all activity.[18] We suspect that coding inaccuracy is not likely to be a source of bias in our study, as records would have to be

Table 2 Top 50 causes of death (by volume) for weekend and weekday emergency admissions to acute NHS hospitals 2005/2006

Condition	No. of admissions	Mortality rate: Weekday admission — Mortality % (number of deaths)	Mortality rate: Weekend admission — Mortality % (number of deaths)	p Value	OR (95% CI)‡
All admissions	4 317 866	4.9 (162 639)	5.2 (52 415)	<0.001‡	1.10 (1.08 to 1.11)
Medical					
Acute and unspecified renal failure (CCS 157)	14 134	25.6 (2924)	33.3 (909)	<0.001†	1.45 (1.32 to 1.60)
Acute bronchitis (CCS 125)	103,224	5.3 (4142)	5.6 (1409)	0.920	1.00 (0.94 to 1.07)
Acute cerebrovascular disease (CCS 109)	70 500	27.5 (14 451)	30.2 (5437)	<0.001†	1.13 (1.09 to 1.18
Acute myocardial Infarction (CCS100)	68 932	13.5 (6803)	14.4 (2650)	0.002*	1.08 (1.03 to 1.14)
Aspiration pneumonitis, food/vomitus (CCS 129)	6233	49.2 (2222)	49.1 (843)	0.640	0.97 (0.86 to 1.10)
Cardiac arrest and ventricular fibrillation (CCS 107)	2576	64.9 (1238)	68.1 (455)	0.048*	1.22 (1.00 to 1.48)
Cardiac dysrhythmias (CCS 106)	86 134	1.9 (1270)	2.4 (453)	<0.001†	1.31 (1.17 to 1.47)
Chronic obstructive pulmonary disease and bronchiectasis (CCS 127)	106 951	7.7 (6174)	7.6 (2005)	0.840	1.00 (0.94 to 1.05)
Chronic ulcer of skin (CCS 199)	9402	10.3 (831)	11.5 (154)	0.104	1.17 (0.97 to 1.42)
Congestive heart failure non-hypertensive (CCS 108)	56 394	17.9 (7944)	19.6 (2351)	<0.001†	1.11 (1.05 to 1.17)
Coronary atherosclerosis and other heart disease (CCS 101)	91 836	2.4 (1676)	2.8 (583)	0.008*	1.14 (1.04 to 1.26)
Deficiency and other anaemia (CCS 59)	30 422	3.5 (951)	4.2 (152)	0.015*	1.25 (1.04 to 1.49)
Fluid and electrolyte disorders (CCS 55)	17 436	9.6 (1359)	11.3 (365)	0.013*	1.17 (1.03 to 1.33)
Gastrointestinal haemorrhage (CCS 153)	57 937	7.3 (3196)	7.8 (1087)	0.042*	1.08 (1.00 to 1.17)
Intestinal infection (CCS 135)	40 519	2.9 (886)	2.7 (274)	0.385	0.94 (0.81 to 1.09)
Liver disease, alcohol-related (CCS 150)	10 401	18.5 (1576)	20.4 (382)	0.042*	1.14 (1.01 to 1.30)
Other circulatory disease (CCS 117)	20 659	6.1 (1015)	7.0 (280)	0.025*	1.18 (1.02 to 1.36)
Other gastrointestinal disorders (CCS 155)	50 774	3.9 (1535)	4.4 (485)	0.114	1.09 (0.98 to 1.22)
Other liver diseases (CCS 151)	13 376	9.8 (1107)	13.1 (276)	<0.001†	1.40 (1.20 to 1.62)
Other lower respiratory disease (CCS 133)	23 515	6.7 (1239)	8.6 (432)	<0.001†	1.26 (1.12 to 1.42)
Peripheral and visceral atherosclerosis (CCS 114)	4347	28.9 (1018)	38.4 (315)	<0.001†	1.61 (1.36 to 1.90)
Pleurisy, pneumothorax pulmonary collapse (CCS 130)	23 000	7.6 (1442)	10.1 (403)	<0.001†	1.42 (1.26 to 1.60)
Pneumonia (CCS 122)	102 465	24.3 (18 619)	25.4 (6574)	0.899	1.00 (0.97 to 1.04)
Pulmonary heart disease (CCS 103)	16 314	9.1 (1200)	11.0 (349)	0.046*	1.15 (1.00 to 1.31)
Residual codes, unclassified (CCS 259)	54 004	4.6 (1922)	4.8 (575)	0.069	1.10 (0.99 to 1.21)
Respiratory failure, insufficiency arrest (adult) (CCS 131)	3842	41.0 (1175)	41.6 (406)	0.909	1.01 (0.86 to 1.18)
Senility and organic mental disorders (CCS 68)	34 290	9.2 (2371)	8.2 (691)	0.014*	0.89 (0.82 to 0.98)
Septicaemia (except in labour) (CCS 2)	16 719	38.6 (4827)	39.4 (1656)	0.321	1.04 (0.96 to 1.13)
Skin and subcutaneous tissue infections (CCS 197)	86 786	1.4 (975)	1.3 (227)	0.687	1.03 (0.89 to 1.20)
Syncope (CCS 245)	66 769	2.1 (1018)	2.0 (361)	0.301	0.94 (0.83 to 1.06)
Urinary tract infections (CCS 159)	92 721	4.9 (3386)	5.1 (1183)	0.700	1.01 (0.95 to 1.09)
Non-infectious gastroenteritis (CCS group 154)	60 122	3.4 (1550)	3.0 (444)	0.028*	0.88 (0.79 to 0.99)
Neoplasms					
Cancer of breast (CCS 24)	6382	21.5 (1107)	23.4 (288)	0.022*	1.21 (1.03 to 1.41)
Cancer of bronchus, lung (CCS 19)	20 701	32.5 (5370)	39.3 (1641)	<0.001†	1.34 (1.24 to 1.44)
Cancer of colon (CCS 14)	8994	22.7 (1666)	24.2 (404)	0.233	1.08 (0.95 to 1.23)
Cancer of oesophagus (CCS 12)	5893	21.3 (1031)	27.9 (295)	<0.001†	1.42 (1.22 to 1.66)
Cancer of pancreas (CCS 17)	5063	29.1 (1221)	37.3 (322)	<0.001†	1.51 (1.29 to 1.77)
Cancer of prostate (CCS 29)	6935	21.6 (1230)	27.4 (340)	<0.001†	1.42 (1.22 to 1.64)
Cancer of stomach (CCS 13)	4155	25.2 (854)	33.2 (256)	<0.001†	1.51 (1.27 to 1.79)
Leukaemias (CCS 39)	12 526	10.6 (1097)	13.8 (299)	<0.001†	1.65 (1.42 to 1.92)
Malignant neoplasm without specification of site (CCS 43)	5105	44.5 (1863)	51.2 (472)	<0.001†	1.33 (1.15 to 1.55)
Non-Hodgkin's lymphoma (CCS 38)	7992	13.8 (927)	17.1 (221)	0.001*	1.33 (1.12 to 1.57)
Secondary malignancies (CCS 42)	15 828	22.7 (2981)	29.6 (803)	<0.001†	1.48 (1.35 to 1.63)
Surgical					
Aortic, peripheral and visceral artery aneurysms (CCS 115)	5573	34.0 (1453)	42.9 (555)	<0.001†	1.45 (1.26 to 1.66)
Biliary tract disease (CCS 149)	46 889	2.3 (818)	1.8 (195)	0.047*	0.85 (0.72 to 1.00)
Fracture of neck of femur (hip) (CCS 226)	53 153	13.4 (5232)	12.9 (1820)	0.490	0.98 (0.92 to 1.04)
Intestinal obstruction without hernia (CCS 145)	17 328	10.9 (1452)	11.4 (460)	0.760	1.02 (0.90 to 1.15)
Intracranial injury (CCS 233)	9165	13.2 (829)	12.8 (371)	0.011*	1.20 (1.04 to 1.38)
Other fractures (CCS 231)	24 974	4.9 (875)	4.8 (344)	0.291	1.08 (0.94 to 1.23)
Superficial injury, contusion (CCS 239)	83 086	1.3 (745)	1.1 (297)	0.400	1.06 (0.92 to 1.22)

CCS, Clinical Classification System.
Adjustment was made for age, sex, IMD2004 and comorbidity. For all admissions, CCS group was also included in the adjustment.
*p<0.05.
†p<0.001.
‡ORs are for death among patients admitted on a weekend as compared with those admitted on a weekday. CI denotes 95% confidence interval.

systematically coded differently at the weekend compared with weekdays.

There could have been differences in case mix between patients admitted during the week and at weekends. We attempted to take some account of case mix in our model, but there may be still some residual confounding, which could lead to either an overestimation or underestimation of risk. There were indeed fewer patients admitted on average at the weekend, and this might point to a different case mix for which we have not adequately adjusted. However, assuming patients who might otherwise have been admitted on a weekend are admitted eventually on a Monday or Tuesday (after sitting out the weekend at home), if their mortality was higher because of less timely intervention, they might be expected to contribute to the weekday mortality, and thus, if anything, dilute the difference in mortality between weekend and weekday. As a counter to this, there may be a body of patients admitted during the week who are prematurely discharged to increase hospital capacity for the weekend, only to be readmitted at the weekend, contributing to the increase in the odds of death in that cohort.

We were unable to account for out-of-hospital deaths occurring after discharge because these were not included in the data set we hold. This could represent a bias if patients are more or less likely to be discharged home to die after admission at the weekend versus a weekday. Although we believe that patients are less likely to be discharged at the weekend compared with a weekday, being discharged home to die is likely to predominantly affect longer-stay patients and therefore not be related to the day of the week of their admission. We believe therefore that this is unlikely to explain our findings. It should be remembered, however, that longer-term deaths may be equally important in examining variations in quality of care for some diagnoses, and analysis of administrative data linked with death certificate data is now possible for some historical data sets in the UK.

Assuming our findings are not artefactual, we have shown that mortality is higher for patients admitted at the weekend for some common conditions. Our study is the largest study of its kind, and as a consequence has been able to examine a variety of different diagnoses. A possible explanation is that there is poorer access to services on the weekend. Staffing at the weekend varies considerably from the staffing during the rest of the week and fewer people generally work in hospitals on weekends compared with weekdays.[19 20] Hospitals generally operate a reduced medical shift system at weekends, with fewer senior staff available and less direct specialist input. This reduction in staffing could in turn lead to shortfalls in quality and timeliness of care. Other factors, such as how expeditiously the initial diagnosis was made and timeliness of access to diagnostics and therapeutic interventions, could also influence the outcome of an admission.

Patients presenting as a medical emergency represent the largest group admitted to hospital beds, and of the top 32 medical causes of death, eight clinical groups had a significantly higher mortality at the weekend. All medical conditions as a group are also the greatest cause of death. Myocardial infarction, a condition with established therapeutic interventions and guidelines, also had a significantly greater mortality at weekends. This result is in agreement with a recent US study that also showed higher mortality rates for myocardial infarction at weekends but additionally found lower use of invasive cardiac procedures at weekends. The authors speculated that better access to care on weekends could improve outcomes for myocardial infarction.[2] Other common medical conditions such as stroke also had higher weekend mortality. Although there were two medical conditions with lower odds of death at the weekend ($p<0.05$), none were significant at $p<0.001$. A surprising finding was that 8 of the 22 malignant conditions contributing to the top 50 causes of death had significantly higher odds of death at the weekend (at $p<0.001$). This group of patients with malignancy presenting as an emergency will be a heterogeneous group including new diagnosis, patients receiving active treatment with complications, unexpected clinical deterioration and palliative care. Cancer services have been the subject of much recent work, and these findings should merit further study to understand this issue. The differences at weekends may reflect differing quality of care within the hospital but could also reflect poorer access to community and primary care services at weekends and as such may be a whole health system problem. For example, some end-stage patients may be admitted to hospital at the weekend to die, when better access to support services may have allowed them to die in their own homes.

Surgical conditions are the smallest group of conditions in the top 50 common causes of death in relation to emergency hospital admissions. Of the seven surgical groups, only aortic, peripheral and visceral artery aneurysms had significantly higher odds of death at the weekends ($p<0.001$). Ruptured abdominal aortic aneurysm made up most of the cases within the aneurysm group and is a catastrophic condition for which emergency arrangements and other aspects of care have been criticised in a recent UK report.[21] A Canadian study also found that ruptured abdominal aortic aneurysms had significantly higher mortality for patients admitted at the weekend.[1] In addition, longer-term outcomes, such as one-year survival, may be a more appropriate measure in this group.

Of the previous UK studies we identified, the Scottish study looked at only one hospital and six defined common clinical conditions with an overall mortality of 10%, but with only 332 deaths in total, may have lacked power to detect a true difference in mortality. The authors suggest that the implementation of an acute medical admissions unit with consistent staffing levels 7 days per week and 24-h access to diagnostics may have helped address the discrepancy in care suggested by other studies.[6] The second UK study focused on ICUs, which necessarily are differently organised from the rest of the general hospital wards; ICUs tend to have more continuous coverage by consultants, a high nurse-to-patient ratio, easy access to specialists and priority access to tests.

A trend towards shorter working hours[22] is both a challenge and an opportunity for the health systems to modernise their services. Despite relatively constant demand for acute care, hospitals faced with economic constraints and problems of employee satisfaction generally reduce staffing and availability of services during the weekend. This study reflects data obtained after the introduction of reduced working hours, but the results are consistent with other published studies.[1 2] This suggests we need to further understand why there appear to be adverse outcomes for patients at weekends, even for common conditions.

CONCLUSION

Patients should expect the same standard of emergency care, whatever day of the week they are admitted. Good emergency care must include the immediate treatment and ongoing care during the early phase of illness within an acute medical or surgical admission. We have identified an excess in mortality for those patients admitted at a weekend compared with the weekday that may reflect differences in quality of care. If this is the case, hospitals will have to change their patterns of care and reappraise the level of services available at weekends.

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