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

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To cite: Handel AE, Patel SV, Skingsley A, *et al*. Weekend admissions as an independent predictor of mortality: an analysis of Scottish hospital admissions. *BMJ Open* 2012;**2**:e001789. doi:10.1136/bmjopen-2012-001789

▸ Prepublication history and additional material for this paper are available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2012-001789).

Received 11 July 2012
Accepted 4 October 2012

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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 1.42, 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.

ARTICLE SUMMARY

Article focus

- Weekend admissions have been associated with excess mortality.
- This article addresses whether this excess mortality is seen in emergency admissions from National Health Service, Scotland between 1999 and 2009.

Key messages

- The risk of death associated with weekend emergency admissions is significantly higher than that of weekday emergency admissions.
- This risk persists even when adjusted for year of admission, gender, age, deprivation quintile and number of comorbidities.

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.

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.[1–5] 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.[5] Similar analyses of emergency admissions within multiple hospitals in England and Spain have shown a similar detrimental effect of weekend admissions on survival.[3 4] Increased mortality with weekend admissions is consistent across multiple pathologies suggesting a systematic failure of care.[6–9] One study from Canada suggested an increased rate of mortality for some causes of admission

(ruptured aortic aneurysm, pulmonary embolism and acute epiglottitis) but not others (acute myocardial infarction, hip fracture and intracranial haemorrhage),[1] although subsequent studies from the USA suggest that myocardial infarction presenting at weekends is associated with an increased mortality.[6] A similar effect was observed for acute kidney injury and stroke.[8 9]

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).[10–12] 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.[13 14]

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.nhsnss.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. χ^2 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

	Weekdays	Weekends	Total	Mortality (%)	OR	95% CI		p Values	Test for trend
						Lower limit	Upper limit		
Weekdays			4025845	4.77	1			<0.0001	N/A
Weekends			1245482	5.96	1.27	1.26	1.28		
Gender									
Male	1970465	638824	2609289	4.81	1			<0.0001	N/A
Female	2055380	606658	2662038	5.28	1.10	1.09	1.11		
Socioeconomic status (quintile)									
1	1155112	371259	1526371	4.50	1			<0.0001	<0.0001
2	936322	291406	1227728	5.22	1.17	1.16	1.18		
3	765169	232479	997648	5.34	1.20	1.18	1.21		
4	638357	192826	831183	5.37	1.20	1.19	1.22		
5	530885	157512	688397	5.15	1.15	1.14	1.17		
Number of comorbidities									
None	1124395	319905	1444300	3.92	1			<0.0001	<0.0001
1	1007851	327562	1335413	5.81	1.51	1.49	1.53		
2	673034	219715	892749	7.79	2.07	2.05	2.09		
3	463688	149129	612817	6.42	1.68	1.66	1.70		
4	307090	95809	402899	4.20	1.07	1.05	1.09		
5 or more	449787	133362	583149	1.05	0.26	0.25	0.27		
Year									
1999	347449	106811	454260	5.61	1			<0.0001	<0.0001
2000	344877	110367	455244	5.30	0.94	0.92	0.96		
2001	356045	111299	467344	5.24	0.93	0.91	0.95		
2002	353933	111143	465076	5.33	0.95	0.93	0.96		
2003	351200	109541	460741	5.41	0.96	0.95	0.98		
2004	357885	109013	466898	5.10	0.90	0.89	0.92		
2005	359495	109439	468934	5.17	0.92	0.90	0.93		
2006	374469	115083	489552	4.88	0.86	0.85	0.88		
2007	389490	118794	508284	4.71	0.83	0.82	0.85		
2008	399693	122287	521980	4.70	0.83	0.81	0.84		
2009	391309	121705	513014	4.28	0.75	0.74	0.77		
Age group (years)									
<5	261494	88143	349637	0.11	0.07	0.06	0.08	<0.0001	<0.0001
5–9	92314	31431	123745	0.09	0.05	0.04	0.06		
10–14	98947	32368	131315	0.10	0.06	0.05	0.07		
15–19	130618	57024	187642	0.19	0.12	0.11	0.13		
20–24	146214	59527	205741	0.21	0.13	0.11	0.14		
25–29	144387	53194	197581	0.26	0.16	0.14	0.17		
30–34	162363	55380	217743	0.40	0.25	0.23	0.26		
35–39	188940	62452	251392	0.65	0.40	0.38	0.42		
40–44	203361	64776	268137	1.03	0.63	0.60	0.66		
45–49*	207744	63986	271730	1.62	1				
50–54	220087	65356	285443	2.48	1.54	1.48	1.60		
55–59	237037	68203	305240	3.50	2.20	2.12	2.28		
60–64	267869	75438	343307	4.85	3.09	2.98	3.19		
65–69	298468	83581	382049	6.33	4.09	3.96	4.23		
70–74	339743	93689	433432	8.00	5.27	5.10	5.44		
75–79	359849	100280	460129	9.91	6.67	6.46	6.88		
80–84	318555	90036	408591	11.85	8.15	7.89	8.41		
≥ 85	347855	100618	448473	14.98	10.67	10.34	11.02		

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.

Table 2 Results of a logistic regression analysis of emergency department admissions and mortality

	OR	95% CI Lower limit	95% CI Upper limit	p Values
Weekdays	1			
Weekends	1.42	1.40	1.43	<0.0001
Year				
1999	1.00			
2000	0.94	0.93	0.96	<0.0001
2001	0.95	0.93	0.97	
2002	1.00	0.98	1.02	
2003	1.03	1.02	1.05	
2004	1.02	1.00	1.04	
2005	1.05	1.03	1.07	
2006	0.97	0.96	0.99	
2007	0.91	0.90	0.93	
2008	0.89	0.87	0.91	
2009	0.81	0.80	0.83	
Age group (years)				
<5	0.06	0.06	0.07	
5–9	0.05	0.04	0.06	<0.0001
10–14	0.05	0.05	0.07	
15–19	0.11	0.10	0.12	
20–24	0.12	0.11	0.13	
25–29	0.15	0.14	0.16	
30–34	0.24	0.22	0.25	
35–39	0.39	0.37	0.41	
40–44	0.62	0.59	0.65	
45–49*	1			
50–54	1.56	1.50	1.62	
55–59	2.28	2.20	2.36	
60–64	3.31	3.20	3.42	
65–69	4.54	4.39	4.69	
70–74	6.08	5.89	6.28	
75–79	8.00	7.75	8.26	
80–84	10.19	9.88	10.52	
≥85	13.77	13.35	14.20	
Gender				
Male	1			
Female	0.85	0.84	0.85	<0.0001
Socioeconomic status (quintile)				
1	1			
2	1.00	0.99	1.01	<0.0001
3	0.98	0.97	0.99	
4	0.97	0.96	0.99	
5	0.93	0.92	0.95	
Number of comorbidities				
None	1			
1	1.24	1.23	1.26	<0.0001
2	1.34	1.32	1.35	
3	0.90	0.89	0.91	
4	0.50	0.49	0.51	
5 or more	0.11	0.10	0.11	

The adjusted 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. 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 theage group of 45–49 were used as the baseline group for the calculation of OR.

Table 3 Odds of mortality of those admitted during weekends, compared with those admitted during weekdays, stratified by year

Year	OR	95% CI Lower limit	95% CI Upper limit	p Values
1999	1.46	1.41	1.50	<0.001
2000	1.38	1.34	1.42	<0.001
2001	1.38	1.34	1.43	<0.001
2002	1.44	1.40	1.49	<0.001
2003	1.42	1.38	1.46	<0.001
2004	1.47	1.42	1.51	<0.001
2005	1.44	1.39	1.48	<0.001
2006	1.40	1.36	1.45	<0.001
2007	1.44	1.39	1.48	<0.001
2008	1.40	1.36	1.44	<0.001
2009	1.35	1.31	1.40	<0.001

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 reflects 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.[6 7 15] However, in a recent study from Australia it was noted that, of the conditions they assessed (myocardial infarction, chronic obstructive

Table 4 Top 50 causes of death

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 septicaemia	3656	22.16	Other septicaemia	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

Table 4 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.

Table 5 Previous studies of emergency admissions and mortality for weekdays and weekends admissions

Study First author	Year	OR	95% CI Lower	95% CI Upper	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 (Sat vs Wed)	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.
	(Sun vs Wed)	1.14	1.12	1.16	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.

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.[16] 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.[9] 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.[17] 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.

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 profile of emergency department admissions.[18 19] 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.

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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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