

A study of community mortality at the weekend versus during the week. Is there a correlation with in-hospital mortality?

**Abstract**

**Background**

A so-called 'weekend effect' has been described in which mortality among those admitted to hospital at a weekend is higher than among those admitted on weekdays. The causes for the weekend effect remain unclear. This study examined patterns of community mortality to explore whether a shift from the community to hospital may account for observed differences in hospital mortality rates across the week.

**Methods**

The annual number of deaths in the community was compared to that in hospitals in England and Wales during 2012 to 2014 using data from the Office for National Statistics. Analyses included the mean annual deaths, by age group and by cause of death in the community and hospital and comparison of the proportion of deaths on each day of the week to the expected number of deaths.

**Results**

The observed and expected total number of deaths in the community was broadly similar on the weekend and weekday ( $p=0.386$ ). There was no difference between observed and expected rates when comparing average daily weekday deaths to the average daily weekend deaths in the community ( $p=0.434$ ). In addition, there was no difference in the proportion of deaths in the community on the weekend when compared to the expected rate for those aged under 65, 75-84 and 85+ years. People were more likely to die on the weekend (rather than the weekday) in the community from neoplasms ( $p=0.009$ ) but less likely from cardiovascular disease ( $p=0.012$ ) as were those aged 65-74 years.

**Conclusion**

We found no evidence of a significant difference from the expected community mortality rates at the weekend versus during the week, or between the observed and expected deaths on each day. The lower weekend community death rate from cardiovascular disease and in the 65-74 year old age group and the higher rate from neoplasms are of interest but marginal. We found no evidence of a shift in deaths from the community to hospital at weekends.

## Background

The so-called 'weekend effect', in which weekend hospital admissions are associated with a higher mortality rate, has been at the centre of intense debate in medical literature and media<sup>(1, 2)</sup>. In England, findings from a study by Freemantle et al.<sup>(1)</sup> were used by the government to make the case for expanded seven day services in National Health Service (NHS) hospitals<sup>(3)</sup>. Freemantle et al. highlighted a "clear association between weekend admission and worse patient outcomes", with an estimated 11,000 more people dying each year in England within 30 days of admission to NHS English hospitals on Friday through to Monday compared with other days of the week. Evidence of a weekend effect has been supported by a number of large studies (>100,000 patients), albeit some exceptions.<sup>(4)</sup> An increased risk of mortality for those admitted at the weekend compared to those admitted mid-week has been demonstrated across medical<sup>(5)</sup> and surgical conditions<sup>(6)</sup>, including myocardial infarction,<sup>(7)</sup> upper gastrointestinal haemorrhage<sup>(8)</sup> and acute kidney injury.<sup>(9)</sup>

The causes for the weekend effect remain inadequately understood. In England, policy debate has linked increased mortality for those admitted on weekends to staffing levels or differences in the services available in hospitals although there are currently no data that would allow for this direct link to be made. Freemantle et al.<sup>(1)</sup> suggested that the observed effect likely reflects an increased proportion of higher risk ('sicker') patients being admitted on a Saturday and Sunday, when services both within the hospital and in the community are reduced. This highlights the need for better understanding of the type of services that would need to be improved at the weekends to address the observed increased risk of mortality.

Literature has primarily focused on estimating the relative risk of dying if admitted on a weekend day compared to admission on a week day. To our knowledge there have been no studies so far that have explored weekly variation of mortality outside of hospital, i.e. in the community, and what, if any, role this might have on weekly variation of mortality inside hospital. This study seeks to contribute to closing this gap by analysing daily variation in mortality in the community and so assess whether there exists a shift from community to hospital settings. That is, populations that would normally die in the

community are admitted to hospital to die instead, accounts for observed differences in hospital mortality rates across the week. Clearly, data on deaths in the community will only allow us to explore the day of death rather than day of admission as a contribution to the weekend effect. The equivalent of 'admission day' in the community would be the day of the onset of a terminal event or illness or perhaps the day of the week that medical advice was sought. However, data that are available do not record the date on which the terminal event or illness commenced in the community. While we recognise this limitation, our approach allows analysing any shift in mortality that could explain the degree of in-hospital variation of day of death not yet explored in previous studies.

## **Methods**

This study compares community deaths and hospital deaths in England and Wales. A community death is defined as death occurring in a person's own home or in a residential care home (includes homes for the chronic sick; nursing homes; homes for people with mental health problems and non-NHS multi-function sites) and hospital deaths as those occurring in NHS or private hospitals.

### ***Data source***

Our dataset, sourced from the Office for National Statistics (ONS)<sup>(10)</sup>, consisted of all deaths in the three years from 2012 to 2014 with details on day of death, gender, age group, cause of death and place of death (i.e. home, residential care home, NHS hospital, and private hospital). Deaths attributed to hospice (approximately 27,500 deaths/year), other communal establishments (around 10,500 deaths/year) and elsewhere (around 9,000 deaths/year) were omitted from the analyses, as patients in a hospice have an existing terminally illness, meaning transfers to hospital are rare and multifactorial, whilst 'other' and 'elsewhere' cannot be accurately categorised as in the community or hospital. These deaths represented relatively small numbers.

Information on the day of admission and duration of any stay in hospital prior to the day of death was not available from this dataset.

### ***Analysis***

We calculated the average number of deaths per year (total deaths over three years divided by three) occurring in the community and in hospital. To explore mortality shifts from the community to hospital,

we estimated the risk of dying on the weekend (rather than the weekday) in the community as a proportion of deaths in the community with 95% confidence intervals (CI). We compared this rate to the expected daily death rate, i.e. assuming all deaths occur uniformly throughout the days of the week, using forest plots. We compared the average number of annual deaths, by age group (<65, 65-74, 75-84 and 85+) - based on data groups collated by the ONS, with those under 65 combined due to low numbers - and by broad cause of death groups (neoplasm, cardiovascular system disorders, respiratory diseases and mental and behavioural disorders). These groups, based on ICD-10 definitions – represent by far the 3 commonest causes of deaths, plus mental and behavioural disorders - another large group of interest, selected as deemed potentially susceptible to contrasting weekend practices.

We used chi-squared testing with 6 degrees of freedom to assess the association between the place of death (hospital or community) and the day of the week the death occurs.

Data on the number of deaths by place of death and day of the week for 2012, 2013 and 2014 are available in an online supplement.

## Results

Table 1 shows the (average yearly) observed and expected numbers of death in hospital and in the community and the estimated risk of dying in either place.

*Table 1: The number of hospital and community deaths each day of the week for a year as well as the expected number of deaths each day and the risk of dying on given days. (In bold are those that are higher than expected).*

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Observed <b>Hospital</b>	<b>35,280</b>	<b>35,611</b>	<b>35,304</b>	<b>35,196</b>	<b>35,526</b>	34,512	34,339	245,767
Expected <b>Hospital</b>	35,110	35,110	35,110	35,110	35,110	35,110	35,110	245,767
Observed <b>Community</b>	<b>31,205</b>	30,967	31,039	30,990	<b>31,725</b>	<b>31,312</b>	30,802	218,039
Expected <b>Community</b>	31,148	31,148	31,148	31,148	31,148	31,148	31,148	218,039
Observed <b>Total</b>	<b>66,485</b>	<b>66,578</b>	<b>66,343</b>	66,185	<b>67,251</b>	65,823	65,141	463,806
Expected <b>Total</b>	66,258	66,258	66,258	66,258	66,258	66,258	66,258	463,806
Risk of death in hospital	<b>0.1435</b>	<b>0.1449</b>	<b>0.1436</b>	<b>0.1432</b>	<b>0.1445</b>	0.1404	0.1397	
Risk of death in community	<b>0.1431</b>	0.1420	0.1424	0.1421	<b>0.1455</b>	<b>0.1436</b>	0.1413	

Statistical testing points to a strong association between the place of death (hospital or community) and the day of the week on which death occurs ( $p=0.003$ ). Compared to the expected daily death rate, which assumes that all deaths are equally spread throughout the week irrespective of place of death (calculated at 0.1429), there was a lower risk of dying in the community from Tuesday to Thursday and on Sunday. In hospital, the observed death rate was higher than the expected rate on all days except on Saturday and Sunday. With the exception of a marginal increased risk of dying in both hospital and the community on Monday, the risk of dying in the community was fairly constant from Tuesday to Thursday. Risk of dying increased markedly on Friday for both community and hospital and remained higher for Saturday in the community.

Examining the combined risk of dying in the community on the weekend compared to the risk of dying on a weekday, we find that the risk was marginally lower on the weekend, at 0.285 (62114/218039) [95% CI: 0.283, 0.287], compared to on a weekday (0.286 95% CI: 0.284, 0.288). Assuming that deaths occur uniformly throughout the week, the expected death rate on the weekend for all individuals and irrespective of place of death would be  $2/7 = 0.286$  (number of weekend days divided by the total number of days in the week). This rate is similar to the observed rate in the community on the weekend. The observed and expected number of deaths in the community were broadly similar on the weekend and weekday ( $p=0.386$ ) (see online supplement for total figures). There was also no statistically significant difference between the observed and expected death rates in the community when comparing average daily weekday deaths with the average daily weekend deaths ( $p=0.434$ ) (Table 1).

Table 2 shows the patterns of risk of dying in the community by age group and major cause of death, further illustrated in Figure 1. Looking at age group first, we find that there was no significant difference in the risk of dying in the community on the weekend when compared to the expected rate by major age group. Among those aged 65-74 years, the risk of dying in the community on the weekend was lower than the expected rate ( $p=0.014$ ).

Table 2: The number of average annual weekend and weekday community deaths as well as a comparison of the risk of dying in the community with the expected rate for weekend deaths split by age group and cause of death.

Age group	Cause of death	Total weekend deaths	Total weekday deaths	Risk of dying in community on weekend [95% CI]	Difference compared to expected rate (0.286) [p-value]
Under 65		7,865	20,100	0.281 [0.276, 0.287]	-0.005 [0.098]
65-74		8,560	22,082	0.279 [0.274, 0.284]	-0.006 [0.014]
75-84		17,178	42,730	0.287 [0.283, 0.290]	0.001 [0.579]
85+		28,416	71,036	0.286 [0.283, 0.289]	0 [0.994]
	Neoplasm	18,354	44,842	0.290 [0.287, 0.294]	0.005 [0.009]
	Cardiovascular system disorders	16,823	43,034	0.281 [0.278, 0.285]	-0.005 [0.012]
	Mental and behavioural disorders	7,569	18,924	0.286 [0.280, 0.291]	0 [0.995]
	Respiratory diseases	6,892	17,435	0.283 [0.278, 0.289]	-0.002 [0.406]

Shaded cells indicate grouping into age or cause of death, but are not further subdivided

Turning to causes of death, our analysis shows that risk of death on the weekend in the community was higher for neoplasms (p=0.009) but lower for cardiovascular diseases (p=0.012) (Table 3).

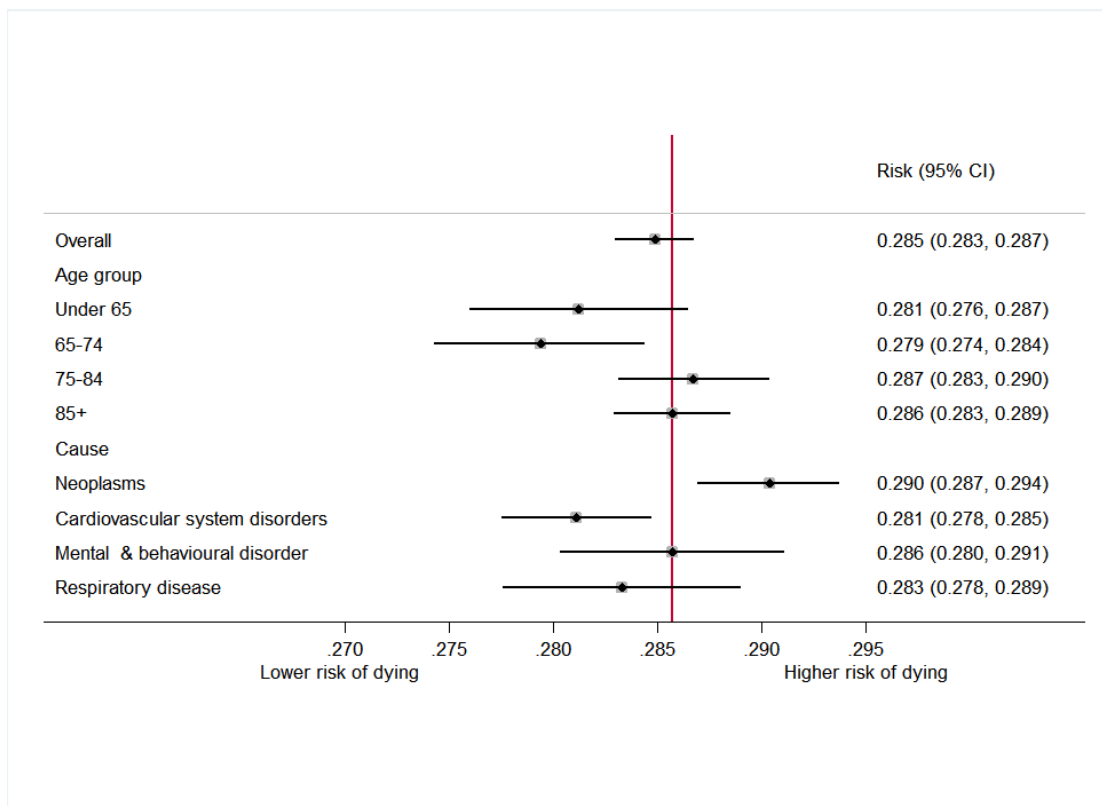


Figure 1: The risk of dying on the weekend in the community overall, by age group and cause of death (expected: 0.286).

Examining patterns of death for these two cause groups further, Figure 2 shows the risk of death for neoplasms by age group. Except for those aged 75-84, our analysis did not find evidence that the risk of death from neoplasms on the weekend in the community differed substantially from the expected rate, differences should not be over-interpreted as they are marginal.

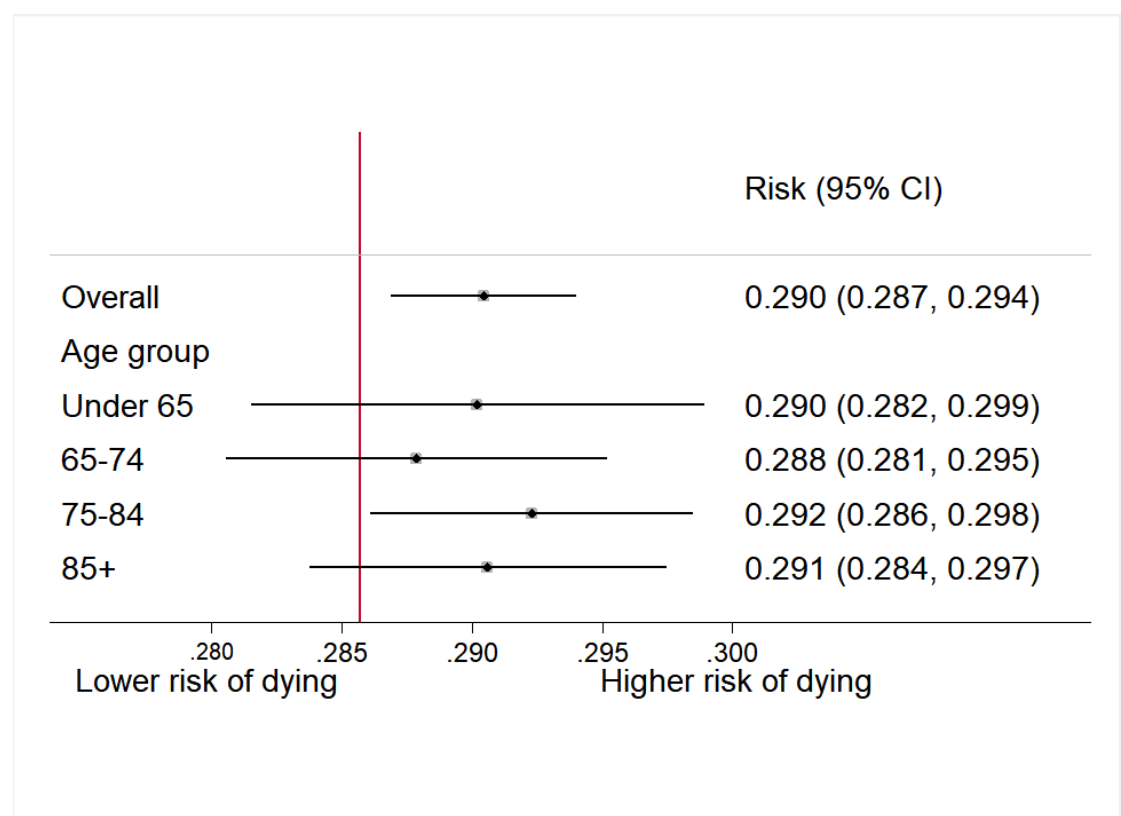


Figure 2: The risk of dying from neoplasm on the weekend in the community by age group (expected: 0.286)

Figure 3 shows the risk of death for cardiovascular disease by age group. The overall confidence interval was strongly influenced by the younger age groups, most notably those aged under 65 and those aged 65-74. Except for those aged 65-74, the risk of death from cardiovascular disease on the weekend did not differ from the expected rate. Although, as noted, the overall risk of death from cardiovascular disease on the weekend (compared to the expected rate) was higher, the difference was small.

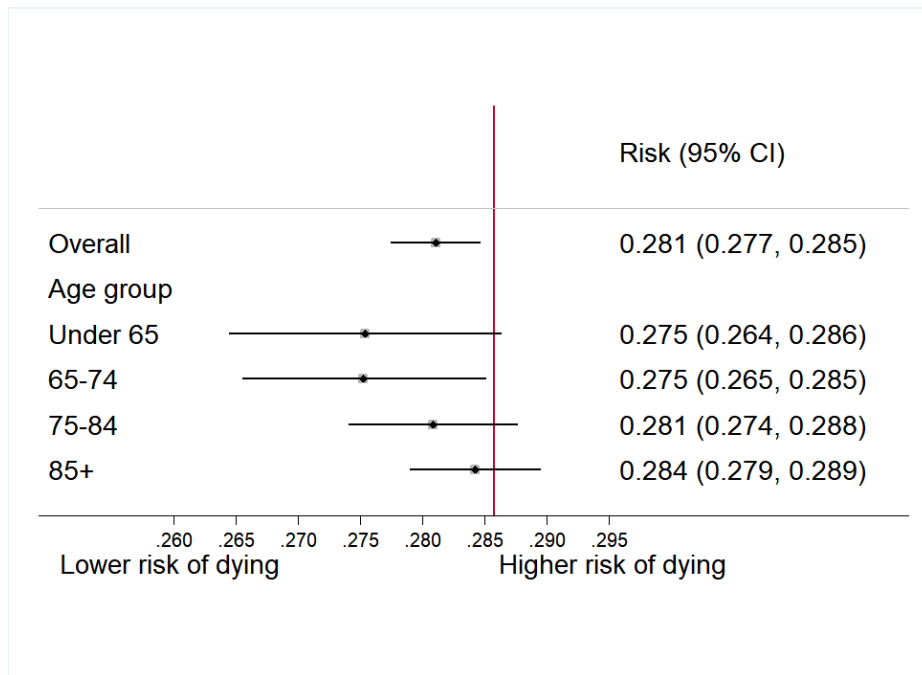


Figure 3: The risk of dying from cardiovascular system disorders on the weekend in the community by age group (expected: 0.286)

We also examined patterns of death in hospital by age group and major cause of death. This found that the observed risk of dying in hospital at the weekend was lower than would have been expected for all age groups and for deaths from neoplasms and cardiovascular disease (Figure 4).

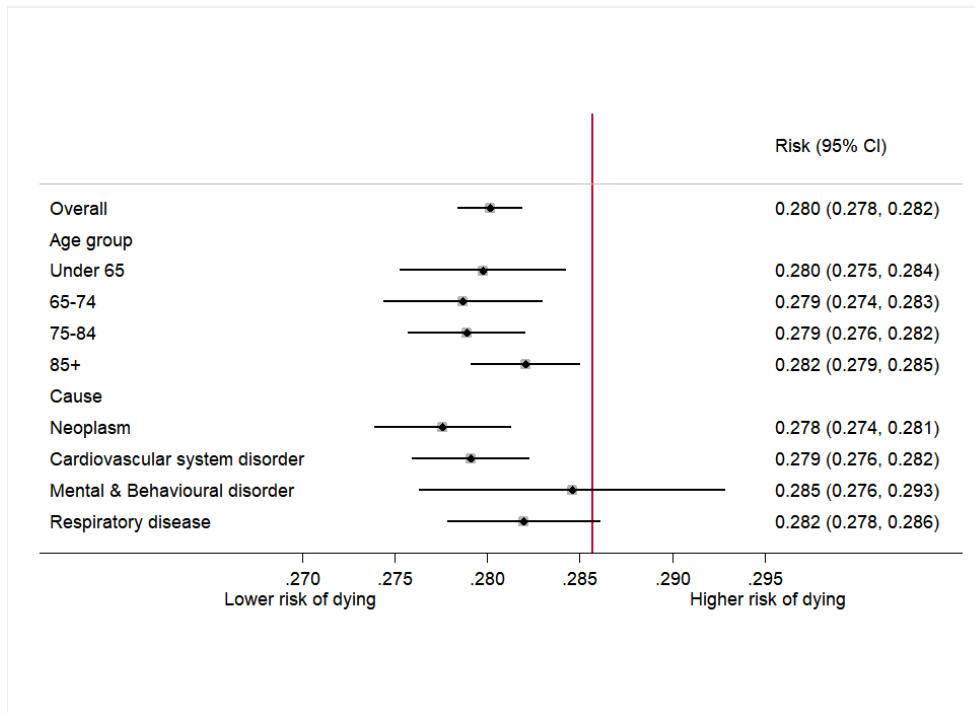


Figure 4: The risk of dying on the weekend in hospital overall, by age group and cause (expected: 0.286)



Comparing patterns of death in the community (Figure 1) and in hospital (Figure 4) does not reveal any obvious complementary shifts among subgroups. Specifically, observed versus expected death rates from cardiovascular disease and those among people aged 65-74 years were lower on the weekend both in the community and in hospital, with no indication of a shift from one setting to another.

## **Discussion**

This study showed that, in England and Wales, during 2012-2014, the risk of dying in the community at the weekend was similar to the risk of dying during the week. We did not observe an obvious shift in deaths away from the community to hospital. Furthermore, we did not observe substantial differences in the risk of dying in the community at the weekend compared to what would have been expected. The only exceptions were for those aged 65-74 years and for neoplasm or cardiovascular deaths, but these appeared to be small and should be interpreted with caution. In concordance with current literature<sup>(1,6)</sup>, unadjusted in-hospital mortality was lower at the weekend than on the weekdays, likely influenced by much less elective surgery conducted on a weekend; planned procedures carry a risk of death.

This study represents an analysis of all deaths in England and Wales (463,860 per annum) across three years from 2012 to 2014 and is well powered to reject a true difference in observed and expected death rates. We analysed numbers of deaths in the community, using national ONS data. The scope of analysis for comparison with hospital data was thus limited to day of death rather than day of admission.

Community deaths analysed here only included deaths in people's own homes or in a care home. Eliminating other locations of community mortality introduces potential for selection bias, however this is a small proportion of the total (<2.5%). In addition, we did not have the underlying population at risk of dying in the community or in hospital, so the interpretation of risk is solely with regards to deaths rather than mortality rates and comparing the proportion of deaths (or death rate) with what would be expected if there was no difference.

No other studies have examined community death rates across the week in comparison to those in hospital. Meacock et al (2017)<sup>(11)</sup> observed higher in-hospital mortality rates for patients admitted with cardiovascular conditions at weekends, and attributed that to a higher Emergency Department admission threshold and hence fewer community admissions. As only aggregate data is available from ONS it was not possible to explore the subgroups in more detail. We consider the subgroup analysis to be hypothesis generating and would need further investigating in prospective studies where it would be possible to include the relevant denominators.

This study has shown no clear observable difference in community mortality rates in the weekend versus during the week. We have not however established whether there are limited community services at the weekend or the impact that changing service provision may have on mortality rates. Further research is needed to understand the complex interplay between community and hospital services across the week and throughout the NHS.

#### Appendix

*Table A1: Total number of deaths that occurred in 2012 by location and day of the week.*

<b>2012</b>	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
At home	15,714	15,638	15,756	15,650	16,088	15,569	15,689
Residential care home	14,484	14,596	14,838	14,905	14,974	14,897	14,470
NHS hospitals	35,377	35,769	35,686	35,517	35,529	34,748	34,394
Private hospitals	109	89	110	110	92	95	106
<b>Total</b>	<b>70,845</b>	<b>71,390</b>	<b>71,891</b>	<b>71,707</b>	<b>72,360</b>	<b>70,993</b>	<b>70,136</b>

*Table A2: Total number of deaths that occurred in 2013 by location and day of the week.*

<b>2013</b>	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
At home	16,451	16,033	16,195	16,139	16,391	16,028	15,834
Residential care home	15,185	15,073	15,125	15,224	15,706	15,570	15,207
NHS hospitals	35,593	35,841	35,223	35,342	35,898	34,687	34,889
Private hospitals	104	108	102	132	119	102	98
<b>Total</b>	<b>72,740</b>	<b>72,352</b>	<b>72,032</b>	<b>72,365</b>	<b>73,793</b>	<b>72,113</b>	<b>71,394</b>

*Table A3: Total number of deaths that occurred in 2014 by location and day of the week.*

<b>2014</b>	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
At home	16,929	16,604	16,205	15,941	16,425	16,260	16,209
Residential care home	14,852	14,956	14,998	15,110	15,659	15,611	14,998
NHS hospitals	34,577	34,923	34,701	34,406	34,838	33,810	33,425
Private hospitals	79	103	90	80	102	93	105
<b>Total</b>	<b>71,791</b>	<b>72,039</b>	<b>71,588</b>	<b>71,095</b>	<b>72,873</b>	<b>71,758</b>	<b>70,256</b>

*Table A4: A comparison of the observed and expected number of deaths during the weekend and weekday for a year in the community.*

	Total weekend deaths	Total weekday deaths	Total
Observed community	62,114	155,925	218,039
Expected community	62,297	155,742	218,039

## References

1. Freemantle N, Ray D, McNulty D, Rosser D, Bennett S, Keogh BE, et al. Increased mortality associated with weekend hospital admission: a case for expanded seven day services? *BMJ*. 2015;351:h4596.
2. Meacock R, Sutton M. Elevated mortality among weekend hospital admissions is not associated with adoption of seven day clinical standards. *Emerg Med J*. 2018;35(2):108-13.
3. NHS England. Seven Days a Week Forum. Evidence base and clinical standards for the care and onward transfer of acute inpatients 2013 [Available from: <http://www.england.nhs.uk/wp-content/uploads/2013/12/evidence-base.pdf>]
4. Abougergi MS, Travis AC, Saltzman JR. Impact of day of admission on mortality and other outcomes in upper GI hemorrhage: a nationwide analysis. *Gastrointest Endosc*. 2014;80(2):228-35.
5. Ricciardi R, Nelson J, Francone TD, Roberts PL, Read TE, Hall JF, et al. Do patient safety indicators explain increased weekend mortality? *J Surg Res*. 2016;200(1):164-70.
6. Aylin P, Alexandrescu R, Jen MH, Mayer EK, Bottle A. Day of week of procedure and 30 day mortality for elective surgery: retrospective analysis of hospital episode statistics. *BMJ*. 2013;346:f2424.
7. Kostis WJ, Demissie K, Marcella SW, Shao YH, Wilson AC, Moreyra AE, et al. Weekend versus weekday admission and mortality from myocardial infarction. *N Engl J Med*. 2007;356(11):1099-109.
8. Weeda ER, Nicoll BS, Coleman CI, Sharovetskaya A, Baker WL. Association between weekend admission and mortality for upper gastrointestinal hemorrhage: an observational study and meta-analysis. *Intern Emerg Med*. 2017;12(2):163-9.
9. James MT, Wald R, Bell CM, Tonelli M, Hemmelgarn BR, Waikar SS, et al. Weekend hospital admission, acute kidney injury, and mortality. *J Am Soc Nephrol*. 2010;21(5):845-51.
10. Office for National Statistics. Deaths by Day and Place of Occurrence, 2012 to 2014, England and Wales 2016 [Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/006094deathsbydayandplaceofoccurrence2012to2014englandandwales>]
11. Meacock R, Anselmi L, Kristensen SR, Doran T, Sutton M. Higher mortality rates amongst emergency patients admitted to hospital at weekends reflect a lower probability of admission. *J Health Serv Res Policy*. 2017;22(1):12-9.