A multifaceted look at time of admission and its impact on case-fatality among a cohort of ischaemic stroke patients
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A multifaceted look at time of admission and its impact on case-fatality among a cohort of ischaemic stroke patients

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ABSTRACT

Purpose Off-hours admissions have been associated with an increased risk of poor outcomes but results have been inconsistent, possibly due to different measures of off-hours care used. We examined, using a single condition and increasingly refined definitions of time of admission, the effect of off-hours admissions on 7-day stroke case-fatality.

Methods We studied a retrospective cohort of 82219 ischaemic stroke admissions to 115 Dutch hospitals between 2000 and 2004. Data were from the Dutch Medical Register and analysed using multivariable multilevel logistic regression. We adjusted for variables such as age, gender, Charlson—Deyo comorbidity score, urgency of admission, hospital teaching status and specialty of attending physician.

Results After adjustment, we observed higher 7-day death risk for weekend admissions when compared to weekday admissions (OR 1.27; 95% CI 1.20 to 1.34). Sunday displayed the highest risk of death (OR 1.31; 95% CI 1.20 to 1.44). With the Monday day-shift as a reference, the death odds were increased during the Sunday and Saturday day-shifts, the evening-shifts on Sunday and Monday, and during all night-shifts. The night-shift ORs ranged from 1.94 (95% CI 1.56 to 2.41) to 2.14 (95% CI 1.74 to 2.63). When compared to admission at 8:00 we observed increased death odds from midnight until 7:00 and decreased death odds from 14:00 until 18:00.

Conclusions Weekends represent a period of increased death risk for ischaemic stroke patients in the Netherlands. However, this increased risk appears to represent an exacerbation of an underlying night-time risk present during the weekdays.

INTRODUCTION

Studies have observed the increased death risk during the weekend, dubbed the ‘weekend effect’, and the increased risk at night-time for both in-patients and new admissions.1-11 The association extends beyond an increased death risk, to include increased risk of complications,12 treatment delays13 and restricted availability of some procedures.5 Outcomes for a number of conditions, such as stroke, pulmonary embolism, hip fractures and upper gastro-intestinal haemorrhage have shown this trend.2 4 8 9 14–16 However, the association has not been consistently observed. In some studies where an association between case-fatality and time of admission was not observed, methodological bias or specific interventions or protocols were cited as possible explanations. In addition, the definition of off-hours has varied from looking at weekend, defined as starting from the close of work on Friday2 15 or starting at midnight on Friday4 8 9 14 16 to including the day or hour of admission.6 These broad and fragmented pictures may have masked variation in death risk occurring during the off-hours.

Studies of the effect of off-hours admissions specific to stroke follow the pattern described above. Hasegawa et al6 found weekday admission to be a negative predictor of case-fatality among stroke patients; Saposnik et al8 observed higher risk adjusted case-fatality for patients admitted during the weekend. Luyt et al10 observed no association between off-hours admissions and case-fatality among stroke patients admitted to the intensive care unit. Albright et al11 observed no association between weekend admission and case-fatality in two comprehensive stroke centres.

In a graduated fashion, using increasingly refined definitions of time of admission, extending from the calendar definition of weekends and weekdays to the day-, shift- and hour-of-admission, we modelled the association between time of admission and 7-day case-fatality among ischaemic stroke patients admitted to all categories of hospitals in the Netherlands.

METHODS

Setting
This is a retrospective cohort study. We obtained data from the Dutch Medical Register (LMR) through the Central Bureau of Statistics, Netherlands (CBS), which, among other activities, links these hospital data to other data sources in the Netherlands such as the population and mortality registers.19 20 The LMR, collected since 1964, maintained by Prismant, Netherlands, contains over 99% of hospital admissions in the Netherlands. The quality of the data and linkage are ensured by Prismant and CBS.19 The data are coded using International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9 CM) standards. Using data from 1 January 2000 through 31 December 2004, we identified all patients with a discharge diagnosis of ischaemic stroke (ICD-9 CM codes 433, 434 and 436).21 We excluded admissions for patients younger than 45 y and those that could not be definitively identified in the population register. Admissions with missing data were excluded and patients transferred between hospitals noted.
Outcome
The primary outcome was 7-day case-fatality, defined as a death occurring up to 7 days from the day of admission, counting the day of admission as day 1. The linkage with the mortality register allowed us to identify deaths occurring outside the hospital. Stroke is an acute condition with a high short-term case-fatality and using 7-day case-fatality seems appropriate to capture the association between time-of-admission and case-fatality.

Time of admission
We used five increasingly refined definitions of time of admission: weekday/weekend, day-of-admission, shift-of-admission, day-and-shift of admission and hour-of-admission. In our analysis, we took into account 10 holidays celebrated in the Netherlands, characterised by working hours/shifts similar to those used during the weekend.

In the weekday/weekend categorisation, weekends were defined as starting at midnight Friday and ending at 23:59 Sunday. Holidays were classified as weekends. All other admissions were considered weekday admissions. Weekday admissions were used as the reference category.

The day-of-admission was based on calendar definition of days, starting at midnight and ending 23:59 of each day. Holidays were coded on the day of the week they fell on. Monday admissions were used as the reference category.

Shift-of-admission was based on the regular working hours of physicians and consisted of three shifts on weekdays, and two on weekends. Accordingly, this resulted in five categories: weekday day-shift (Monday to Friday 8:00 to 16:59); weekday evening-shift (Monday to Friday 17:00 to 22:59); weekday night-shifts (Monday to Thursday 23:00 to 19:59 and Friday 23:00 to Saturday 7:59); weekend day-shift (Saturday and Sunday 8:00 to 19:59); and weekend night-shifts (20:00 Saturday to 7:59 Sunday and 20:00 Sunday to 7:59 Monday). The weekday day-shift was the reference category. In recognition of the uneven hours in each shift we also carried out an analysis in which the days were divided into three 8-h shifts (8:00 to 15:59; 16:00 to 23:59; midnight to 7:59).

The day-and-shift of admission was defined by applying the definition of shift-of-admission to each day of the week. Holidays were included as a separate category. This resulted in 21 categories, three each Monday to Friday (day, evening and night) and two each for Saturday, Sunday and holidays (day and night). The Monday day-shift was used as the reference category.

The hour-of-admission was based on the specific hour the patient presented in the hospital; thus, yielding 24 categories; 8:00 was used as the reference category.

Covariates
Based on the time of admission and stroke case-fatality literature, we included variables expected to influence the outcome or association between time of admission and 7-day case-fatality. These variables included age on admission, sex, socioeconomic status, type of insurance, ethnicity, urgency, previous stroke, Charlson–Deyo comorbidity score, attending physician specialty, year of admission, hospital teaching status and hospital location.

Age on admission was used as a continuous variable. Socioeconomic status was based on ranked postal code income data. Insurance was either public or private and serves as a more specific proxy for socioeconomic status. Ethnicity was defined by country of birth and divided into three groups—namely, ethnic Dutch or other Westerners, Turks or Moroccans, and Surinamese, Antilleans, or other non-Westerners.22 We suspected that ethnicity might have an influence on stroke death as has been seen in other conditions.23 Previous strokes were ascertained by looking back 6 y from the start of the study until January 1, 1994. Patients admitted more than once in the study period were considered as having had a previous stroke during their second and/or subsequent admission (s). We estimated the Charlson–Deyo score in the same manner as that used in a validation study among a cohort of ischaemic stroke patients.25 The score was categorised as 0, 1 or >1. Attending physician speciality, representing the specialist in charge of the case, consisted of two groups defined as neurologist/neurosurgeon or other speciality. We used the year of admission to capture advances in treatment protocols or treatments themselves.

At the hospital level we included hospital teaching status (academic, top clinical and general) and hospital location (rural or urban). Top clinical hospitals were general hospitals accredited for residency training. The hospital location was defined, by the degree of urbanisation using its address: less than 500 addresses per km² was classified as rural, from 500–1000 addresses as urban grade 1, from 1000–1500 addresses as urban grade 2, from 1500–2500 addresses as urban grade 3 and greater than 2500 addresses per km² as urban grade 4.

Statistical analysis
We carried out a descriptive analysis of our patient population separating them based on the weekend/weekday categorisation of time of admission.

We modelled the association between time of admission and 7-day case-fatality using multivariable multilevel logistic regression to account for the clustering of outcomes. We built the model in stages for each definition of time of admission. We started with an unadjusted model and then progressed to one containing all covariates with the exception of attending physician. We only added this variable later as we thought that the attending physician might serve as an explanatory variable as opposed to being a confounder. We then included interactions between the time of admission and each of hospital type, Charlson–Deyo comorbidity score, urgency of admission and attending physician to test if the association between time of admission and case-fatality differed by levels of these covariates. Significant interactions, identified using the likelihood ratio test, were included in a single model. For the day-and-shift of admission and hour-of-admission categorisations, we omitted the test of interactions due to the large number of categories involved and separately included the variables weekend admission and day of admission. We also carried out stratified analysis modelling of the hour-of-admission stratified by weekend and weekday admissions because of the previously highlighted differences between work patterns.

As a sensitivity analysis, we excluded all patients transferred between hospitals and repeated our analysis. This removes the potential bias in the case-fatality rates if more severe patients were transferred to more advanced hospitals.

Regression results were displayed as ORs and 95% CIs. The variation between hospitals is expressed as the proportional change in variance (PCV) and intraclass correlation coefficient (ICC). All analyses were carried out using the xtlogit command in STATA Version 9.2.
RESULTS
We identified 89,447 ischaemic stroke admissions to 115 Dutch hospitals from 2000 through 2004. We excluded 4118 admissions because the individuals were not traceable in the dataset, 2998 were for individuals under the age of 45 y and 112 had missing values in one of the variables included in the model (2 for ethnicity, 85 for type of insurance and 25 for the postcode-based socioeconomic status). These exclusions resulted in a study population of 82,219, including 21,599 admissions noted as referrals.

Table 1 displays a description of the characteristics of the patients included in the study. The mean age was 73 y. The majority of admissions was to top clinical hospitals and occurred during the daytime.

Table 2 displays the results of the association between weekend/day, day-of-admission, and shift-of-admission, and stroke case-fatality. Weekday admissions accounted for 76.7%, the observed 7-day case-fatality was 7.3% on weekdays and 10.1% during the weekend. Compared to weekday admissions, weekend admissions were associated with an increased stroke case-fatality with an unadjusted OR of 1.42 (95% CI 1.34 to 1.50) but an adjusted OR of 1.26 (95% CI 1.19 to 1.34).

In the association between day-of-admission and stroke case-fatality (table 2), Monday accounted for the largest proportion of admissions (18.0%) while Saturday accounted for the smallest (10.3%). The observed case-fatality is highest on Sunday and Saturday at 10.3% and 10.0%, respectively. From Monday to Friday, the observed case-fatality ranged from 6.8% to 7.8%. The unadjusted model showed an increase in the odds of stroke case-fatality on Sunday, Friday and Saturday. Despite further adjustments the odds of case-fatality remained high on Saturday (OR 1.20; 95% CI, 1.09 to 1.31) and Sunday (OR 1.51; 95% CI, 1.20 to 1.84).

Table 2 also displays the results of the categorisation based on the shift-of-admission. The weekday day-shift accounted for the majority of admissions (51.4%), while the observed case-fatality ranged from 6.4% to 10.9% over all shifts. The multivariate analysis for the shifts showed an increase in case-fatality odds for all other shifts when compared to the weekday day-shift in all models. In all categorisations, the models excluding the attending physician were not significantly different from the final model. The inclusion of the covariates reduced the total variance by between 26 and 28%. The ICC for all models was 1.8%.

Figure 1 shows the adjusted association between the day-and-shift-of-admission and stroke case-fatality. The overall pattern is one of increased case-fatality odds during the evening and night-shifts, and the day-shifts of Saturday and Sunday. The results of the analysis using three 8-hour shifts per day did not differ significantly from this (see online appendix table A11).

Figure 2 shows the adjusted association between hour-of-admission and stroke case-fatality. The overall pattern is one of increased case-fatality odds during the evening and night-shifts, and the day-shifts of Saturday and Sunday. The results of the analysis using three 8-hour shifts per day did not differ significantly from this (see online appendix table A14).

Table 3 shows the influence of hour-of-admission on death stratified by weekends and weekdays. There were persistently higher case-fatality odds during the nighttime hours and the protective effect for weekday admissions only.
Sensitivity analysis, including 60,620 admissions, showed results were not materially altered by the exclusion of referred patients (see online appendix tables A1–A7). The online appendix (tables A8–A14) also displays the complete results for all models in the main analysis.

**DISCUSSION**

Using progressively more refined definitions of time of admission, this study demonstrates not only the presence of a harmful weekend effect but also a stronger night-time effect and a protective effect for admissions from 15:00 to 18:00 on weekdays in a cohort of ischaemic stroke patients in the Netherlands. The observed night-time effect presented itself as higher 7-day case-fatality odds during the night-shifts and among patients admitted from midnight until 7:00. This study has a number of strengths and limitations; the study sample was based on admission to most Dutch hospitals thus providing a unique snapshot of ischaemic stroke patients in

### Table 2 Association between weekday/weekend, day and shift of admission and stroke case-fatality

<table>
<thead>
<tr>
<th>Time of admission</th>
<th>Number of admissions (%)</th>
<th>Observed 7-day case-fatality (%)</th>
<th>Unadjusted OR (including attending physician)</th>
<th>Adjusted OR (including attending physician)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weekend/weekday admission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>63072 (76.7)</td>
<td>7.3</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Weekend</td>
<td>19147 (23.3)</td>
<td>10.1</td>
<td>1.42 (1.34 to 1.50)*</td>
<td>1.27 (1.20 to 1.34)*</td>
</tr>
<tr>
<td>PCV</td>
<td>—</td>
<td>—</td>
<td>Reference</td>
<td>–26%</td>
</tr>
<tr>
<td>ICC</td>
<td>—</td>
<td>—</td>
<td>0.024</td>
<td>0.018</td>
</tr>
<tr>
<td><strong>Day of admission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td>9283 (11.2)</td>
<td>10.3</td>
<td>1.47 (1.34 to 1.61)*</td>
<td>1.31 (1.20 to 1.44)*</td>
</tr>
<tr>
<td>Monday</td>
<td>14835 (18.0)</td>
<td>7.1</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Wednesday</td>
<td>12693 (15.4)</td>
<td>6.8</td>
<td>0.95 (0.87 to 0.94)</td>
<td>0.94 (0.83 to 1.03)</td>
</tr>
<tr>
<td>Thursday</td>
<td>22360 (15.0)</td>
<td>7.6</td>
<td>1.05 (0.96 to 1.15)</td>
<td>1.02 (0.93 to 1.12)</td>
</tr>
<tr>
<td>Friday</td>
<td>11360 (13.8)</td>
<td>7.8</td>
<td>1.09 (1.00 to 1.20)</td>
<td>0.99 (0.90 to 1.08)</td>
</tr>
<tr>
<td>Saturday</td>
<td>8507 (10.3)</td>
<td>10.0</td>
<td>1.42 (1.29 to 1.56)*</td>
<td>1.20 (1.09 to 1.31)*</td>
</tr>
<tr>
<td>PCV</td>
<td>—</td>
<td>—</td>
<td>Reference</td>
<td>–26%</td>
</tr>
<tr>
<td>ICC</td>
<td>—</td>
<td>—</td>
<td>0.025</td>
<td>0.018</td>
</tr>
<tr>
<td><strong>Shift of admission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday day</td>
<td>42240 (51.4)</td>
<td>6.4</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Weekday evening</td>
<td>13873 (16.9)</td>
<td>8.3</td>
<td>1.31 (1.22 to 1.41)*</td>
<td>1.09 (1.01 to 1.17)*</td>
</tr>
<tr>
<td>Weekday night</td>
<td>6959 (8.4)</td>
<td>10.3</td>
<td>1.71 (1.57 to 1.87)*</td>
<td>1.71 (1.56 to 1.87)*</td>
</tr>
<tr>
<td>Weekend day</td>
<td>13645 (16.6)</td>
<td>9.7</td>
<td>1.56 (1.45 to 1.67)*</td>
<td>1.33 (1.24 to 1.43)*</td>
</tr>
<tr>
<td>Weekend night</td>
<td>5502 (6.7)</td>
<td>10.9</td>
<td>1.77 (1.61 to 1.94)*</td>
<td>1.54 (1.40 to 1.70)*</td>
</tr>
<tr>
<td>PCV</td>
<td>—</td>
<td>—</td>
<td>Reference</td>
<td>–28%</td>
</tr>
<tr>
<td>ICC</td>
<td>—</td>
<td>—</td>
<td>0.025</td>
<td>0.018</td>
</tr>
</tbody>
</table>

*p Value <0.005.

ICC, intraclass correlation coefficient; PCV, proportional change in variance.

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**Figure 1** Association between day-and-shift-of-admission and stroke case-fatality.

**Figure 2** Association between hour-of-admission and stroke case-fatality.
Table 3 Association between hour-of-admission and stroke case-fatality stratified by weekday and weekend*

<table>
<thead>
<tr>
<th>Hour of admission</th>
<th>Weekday admissions only (n = 63072)</th>
<th>Weekend admissions only (n = 19147)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted OR (95% CI)</td>
<td>Adjusted OR (95% CI)</td>
</tr>
<tr>
<td>8:00</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>9:00</td>
<td>0.90 (0.70 to 1.14)</td>
<td>1.27 (0.81 to 2.02)</td>
</tr>
<tr>
<td>10:00</td>
<td>1.08 (0.86 to 1.34)</td>
<td>1.22 (0.80 to 1.87)</td>
</tr>
<tr>
<td>11:00</td>
<td>0.96 (0.77 to 1.19)</td>
<td>1.06 (0.70 to 1.60)</td>
</tr>
<tr>
<td>12:00</td>
<td>0.90 (0.72 to 1.12)</td>
<td>1.08 (0.71 to 1.63)</td>
</tr>
<tr>
<td>13:00</td>
<td>0.87 (0.69 to 1.08)</td>
<td>0.85 (0.56 to 1.29)</td>
</tr>
<tr>
<td>14:00</td>
<td>0.80 (0.64 to 1.00)</td>
<td>0.75 (0.50 to 1.14)</td>
</tr>
<tr>
<td>15:00</td>
<td>0.74 (0.59 to 0.92)</td>
<td>0.73 (0.48 to 1.12)</td>
</tr>
<tr>
<td>16:00</td>
<td>0.71 (0.56 to 0.89)</td>
<td>0.78 (0.51 to 1.21)</td>
</tr>
<tr>
<td>17:00</td>
<td>0.69 (0.54 to 0.87)</td>
<td>0.79 (0.51 to 1.22)</td>
</tr>
<tr>
<td>18:00</td>
<td>0.85 (0.66 to 1.08)</td>
<td>0.75 (0.48 to 1.17)</td>
</tr>
<tr>
<td>19:00</td>
<td>0.97 (0.76 to 1.23)</td>
<td>0.83 (0.54 to 1.29)</td>
</tr>
<tr>
<td>20:00</td>
<td>1.05 (0.82 to 1.35)</td>
<td>0.79 (0.51 to 1.23)</td>
</tr>
<tr>
<td>21:00</td>
<td>1.11 (0.86 to 1.42)</td>
<td>0.71 (0.45 to 1.12)</td>
</tr>
<tr>
<td>22:00</td>
<td>1.13 (0.87 to 1.45)</td>
<td>0.95 (0.61 to 1.47)</td>
</tr>
<tr>
<td>23:00</td>
<td>1.18 (0.91 to 1.53)</td>
<td>1.01 (0.65 to 1.60)</td>
</tr>
<tr>
<td>0:00</td>
<td>1.43 (1.10 to 1.89)</td>
<td>1.16 (0.73 to 1.85)</td>
</tr>
<tr>
<td>1:00</td>
<td>1.85 (1.39 to 2.45)</td>
<td>1.20 (0.74 to 1.94)</td>
</tr>
<tr>
<td>2:00</td>
<td>1.83 (1.32 to 2.52)</td>
<td>1.47 (0.87 to 2.48)</td>
</tr>
<tr>
<td>3:00</td>
<td>1.62 (1.13 to 2.34)</td>
<td>1.40 (0.80 to 2.47)</td>
</tr>
<tr>
<td>4:00</td>
<td>1.72 (1.18 to 2.49)</td>
<td>1.52 (0.84 to 2.74)</td>
</tr>
<tr>
<td>5:00</td>
<td>1.99 (1.38 to 2.87)</td>
<td>1.75 (0.97 to 3.14)</td>
</tr>
<tr>
<td>6:00</td>
<td>1.98 (1.36 to 2.88)</td>
<td>2.06 (1.16 to 3.68)*</td>
</tr>
<tr>
<td>7:00</td>
<td>0.94 (0.67 to 1.30)</td>
<td>1.47 (0.83 to 2.60)</td>
</tr>
</tbody>
</table>

*These analyses are adjusted for all covariates, including attending physician.
†p Value <0.05.

the Dutch health system. Variations in the quality of care between on- and off-hours have been identified as a potential explanation for the identified weekend effect.55 Specific clinical data on treatments received were unavailable in this administrative database; however, the quality of care received by stroke patients in the Netherlands receives high marks.27,28 The 6-month case-fatality rate in the Netherlands compared favourable to those in the United Kingdom, Australia, Italy, Sweden and Norway.29 In 2005, 50-day mortality rate among Dutch stroke patients (9.2%) was below the Organization for Economic Cooperation and Development (OECD) average (10.2%).30 Data on specific stroke units were unavailable; however, in 2002 the majority of Dutch hospitals have stroke units or was affiliated with a stroke service.31 The administrative nature of the database restricted the amount of clinical information available on severity for use in case-mix adjustment. Nonetheless, we used numerous variables, such as the perceived urgency of the admission, prior stroke and the Charlson–Deyo index, to mitigate this drawback. The relatively short-term outcome makes length of stay an unlikely predictor of mortality; this has been observed in an analysis of hospital volume-mortality association.32 The inclusion of all categories of hospitals in rural and urban locations and the speciality of the physician in charge of the case was advantageous for statistical adjustments. By using various definitions, we shed more light on the complex association between time of admission and case-fatality.

The results of the classification of time of admission as weekdays and weekends and by day of admission agreed with those studies that have demonstrated increased death for weekend admissions and for Saturday and Sunday admissions. A superficial look at the shift-of-admission showed increased odds of death during all shifts compared to the weekday day-shift. A deeper look at the day-and-shift-of-admission showed a common pattern of increased night-time death odds on all days that extended to the other shifts on Saturday and Sunday. The hour-of-admission categorisation provided an interesting pattern of increased case-fatality from midnight until 7:00. It also revealed a protective effect from 15:00 until 18:00 that persisted when analysis was restricted to weekday admissions. This latter period coincided with the handover period when the day-shift ended and the evening-shift began.

Studies attribute the observed higher case-fatality risk among off-hours admission in part due to the expectation of more severe patients presenting at these times. Although our study cannot firmly dispute such conclusions, a study of stroke patients showed no difference in clinical features between patients admitted during the on- and off-hours.53 In our data, a larger proportion of admissions designated urgent occurred during the weekend. This designation of urgent represents an assessment on admission of the severity of admission. Non-urgent admissions represent those who made appointments or presented and were deemed non-emergencies; thus they could be slowly developing or mild strokes. We adjusted for this and other factors, and still observed an increase in the case-fatality odds for night-time and weekend admissions. On its own, the urgency of admission was highly predictive of the case-fatality odds (see online appendix). The ICC indicates that only 1.8% of the total variation is attributed to differences between hospitals included in this study.

Quality of care is said to be reduced during the off-hours. Studies have highlighted decreased adherence to guidelines, reduced to investigations and procedures, less experienced and fewer staff members available to patients during the off-hours. In our study, the speciality of the physician in charge of the case did seem systematically related to off-hours care. The speciality and experience of the point of first contact might be a more influential factor. The lower death risk observed among patients admitted during the handover period could represent the benefits of temporary increase in staff numbers and greater attention to detail that would occur during the period.

An important finding is that we observe what appears to be a baseline night-time risk. A possible explanatory factor not commonly addressed is human nature. The human circadian rhythm is such that cognitive performance varies throughout the day.34 At night, in the absence of light, cognitive performance suffers leading to increased medical errors.35 Studies of shift workers have shown that prolonged exposure to altered work patterns yielded some degree of adaptation.36 However, the relatively short and irregular nature of night shifts in hospitals makes this less likely to occur. It also does not take into account the different chronotypes, as some individuals can adapt better to the alternating conditions than others can.37 The adjustment of total resident working hours has reduced daytime fatigue and medical errors, but little attention is paid to the natural fatigue experienced during a night shift.38–40

This study moves beyond the classical weekend/weekday classification; we demonstrated what appears to be the presence of a baseline night-time risk exacerbated during the weekend. The protective effect during the handover period would seem to reinforce that the number of staff available matters. Our study points to the need for further analysis of the influence of the effects of night-time work on medical staff and patients, and an approach to labour planning in hospitals that goes beyond patient-to-provider ratios and total on/off-hours.

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Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES
A multifaceted look at time of admission and its impact on case-fatality among a cohort of ischaemic stroke patients


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