

ONLINE FIRST

Dying for the Weekend

A Retrospective Cohort Study on the Association Between Day of Hospital Presentation and the Quality and Safety of Stroke Care

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Objective: To examine the association between day of admission and measures of the quality and safety of the care received by patients with stroke.

Design: Retrospective cohort study of patients admitted to hospitals with stroke (codes I60-I64 from the *International Statistical Classification of Diseases and Related Health Problems, Tenth Version*) from April 1, 2009, through March 31, 2010.

Setting: English National Health Service public hospitals.

Patients: Patients during the study period accounted for 93 621 admissions. We used logistic regression to adjust the outcome measures for case mix.

Main Outcome Measures: Quality and safety measurements using 6 indicators spanning the hospital care pathway, from timely brain scans to emergency readmissions after discharge.

Results: Performance across 5 of the 6 measures was significantly lower on weekends (confidence level, 99%). One of the largest disparities was seen in rates of same-

day brain scans, which were 43.1% on weekends compared with 47.6% on weekdays (unadjusted odds ratio, 0.83 [95% CI, 0.81-0.86]). In particular, the rate of 7-day in-hospital mortality for Sunday admissions was 11.0% (adjusted odds ratio, 1.26 [95% CI, 1.16-1.37], with Monday used as a reference) compared with a mean of 8.9% for weekday admissions.

Conclusions: Strong evidence suggests that, nationally, stroke patients admitted on weekends are less likely to receive urgent treatments and have worse outcomes across a range of indicators. Although we adjusted the results for case mix, we cannot rule out some of the effect being due to unmeasured differences in patients admitted on weekends compared with weekdays. The findings suggest that approximately 350 in-hospital deaths each year within 7 days are potentially avoidable, and an additional 650 people could be discharged to their usual place of residence within 56 days if the performance seen on weekdays was replicated on weekends.

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PREVIOUS STUDIES FROM A range of countries have identified higher mortality in patients admitted on weekends across a range of medical conditions, a phenomenon termed the *week-end effect*.¹⁻⁵ This phenomenon calls into question the idea that quality of care is equal irrespective of when you present at the hospital. Similarly, a small number of international studies have investigated the effect specifically in stroke care and have suggested poorer access to treatments and worse outcomes on weekends, including increased mortality and fewer patients returning to their usual place of residence.⁶⁻¹¹ However, other studies have not identified a significant association between the day of admis-

sion and mortality rates due to stroke.^{4,12-14} Therefore, debate remains concerning the existence and extent of the weekend effect in stroke care. The studies on stroke care outside regular weekday hours are limited in number, and most of these studies focus primarily on short-term mortality and therefore do not capture wider aspects of the quality and safety of care.¹⁵

The present study is unique in providing a comprehensive and current assessment of the degree to which the quality and safety of stroke care are affected by whether a patient is admitted during the weekend. The study uses national routine hospital admissions data and thereby highlights the potential for identifying clinically important issues using this readily available resource.

METHODS

We performed a literature review to identify indicators of stroke care that had been applied to administrative data, and we chose 6 indicators to cover the hospital pathway. The only amendment made to these indicators, for the purpose of this study, was to use 7-day rather than 30-day mortality in keeping with the suggestion that the shorter time frame is more appropriate to evaluate the association between day of admission and mortality.⁶ The indicators include the following process and outcome measures:

1. Brain scan on the day of admission;
2. Thrombolysis treatment;
3. Diagnosis of aspiration pneumonia (a complication) in the hospital;
4. Seven-day in-hospital mortality;
5. Discharge to usual place of residence within 56 days; and
6. Thirty-day emergency readmission (all causes).

The details of stroke admissions from April 1, 2009, through March 31, 2010, were extracted from the Hospital Episode Statistics database. The indicator definitions were applied to the extract to obtain denominators and numerators, categorized for day of admission for stroke. The weekend was defined as the period from midnight on Friday to midnight on Sunday, with all other times defined as weekdays (the time of admission is not captured in the Hospital Episode Statistics). We included the following variables expected to influence the outcome of the association between the quality and safety indicators and day of admission: age, sex, socioeconomic deprivation quintile (derived from the index of multiple deprivation based on the Super Output Area geographical level), number of previous admissions, comorbidities (Charlson index with weights derived from all admissions in England),¹⁶ month of discharge, ethnic group, source of admission, and stroke type.

We performed a descriptive analysis of the patients, categorized by weekday or weekend admission for stroke. Initially, unadjusted (crude) rates for each of the 6 indicators were calculated for weekday and weekend admissions. We used multiple logistic regression analysis to account for the covariates and estimated adjusted odds, across each indicator, for weekend compared with weekday admissions. All variables were retained unless they threatened model convergence, allowing for consistency in the case-mix adjustment across the different measures. We present the unadjusted rates for the process measures when only 1 such figure is quoted. Results were also displayed by plotting odds ratios (ORs) and 95% CIs by day of the week of admission for stroke, using Monday as a reference.

We repeated the regression analysis on weekday admissions only to derive probabilities of (1) in-hospital death and (2) discharge to the usual place of residence dependent on the different patient characteristics. By matching these probabilities for each weekday admission based on the patient's characteristics, we calculated indirectly standardized estimates for the outcomes as if those weekend patients had had rates similar to their weekday counterparts. By comparing the estimated rates with the actual rates, we approximated the annual excess mortality and unfavorable discharge at weekends.

To investigate one of the possible organizational factors for variations in the performance against the process and outcome measures, we also calculated an additional indicator, specialty of responsible consultant, as a proxy for whether a patient was admitted to a designated stroke unit.

We performed statistical analyses using commercially available software (SAS, version 9.2, using the PROC LOGISTIC procedure for regression analyses [SAS Institute Inc]). We did not adjust for the clustering of patients within the hospital because the hospital-level effects were small.

The Hospital Episode Statistics database contains details of all admissions to National Health Service (NHS) hospitals in England. The database includes more than 14 million records every year, with each entry covering the continuous period when the patient is under the care of a consultant (finished consultant episode). These finished consultant episodes are linked together into hospital spells that can be further linked to any spells resulting from the transfer of a patient to another NHS hospital to form "superspells" (referred to as admissions). Diagnoses are recorded using the *International Statistical Classification of Diseases, 10th Revision*, and procedures are coded using the Office of Population Censuses and Survey's *Classification of Surgical Operations and Procedures, Fourth Revision*.¹⁷

RESULTS

Across English NHS hospitals, we identified 93 621 stroke admissions during the study period. Of these, 8722 (9.3%) died in the hospital within 7 days of admission and 16 013 (17.1%) died within 30 days. Of those patients meeting the inclusion criteria for each indicator, 46.5% underwent scanning of the brain on the day of admission, 2.6% received thrombolysis, 5.2% had aspiration pneumonia, 72.6% were discharged to their normal place of residence, and 11.0% were readmitted within 30 days of discharge.

Of the stroke admissions, 23 297 (24.9%) were admitted on weekends. The number of stroke patients admitted declined throughout the week from 15.6% on Monday to 12.4% on Sunday. **Table 1** describes the characteristics of the study patients.

Table 2 shows the results of the association between weekday/weekend admission and performance in the 6 measures of quality and safety. We found statistically significant associations in 5 indicators (the exception being readmissions), all of which were consistent with lower treatment levels and poorer outcomes at weekends. The largest effects were seen in the lower rates of same-day brain scans (unadjusted OR, 0.83 [95% CI, 0.81-0.86]) and thrombolysis (unadjusted OR, 0.82 [95% CI, 0.73-0.92]) and higher rates of in-hospital mortality (adjusted OR, 1.18 [95% CI, 1.12-1.24]) for weekend strokes.

As described in the "Methods" section, we calculated that approximately 350 potentially avoidable in-hospital deaths occur within 7 days each year and that an additional 650 people could be discharged to their usual place of residence within 56 days if the performance seen on weekdays was replicated on weekends.

The **Figure** shows the ORs by day of admission for the 6 indicators, with Monday as a reference. For the measure of same-day brain scans, the highest-performing day was Friday, with 49.8% of patients undergoing a scan (unadjusted OR, 1.16 [95% CI, 1.11-1.22], with Monday as the reference), whereas Sunday had the lowest rate at 42.0% (unadjusted OR, 0.85 [95% CI, 0.81-0.89]). For thrombolysis, the best-performing day was Wednesday, when 2.9% of stroke patients received the treatment (unadjusted OR, 1.16 [95% CI, 0.98-1.37]), with Sunday the worst at 2.2% (unadjusted OR, 0.82 [95% CI, 0.68-0.99]); however, this latter result was no longer statistically significant when adjusted for case mix (adjusted OR, 0.84 [95% CI, 0.70-1.02]).

Rates of aspiration pneumonia were higher on Saturdays and Sundays (both 5.7%) than the Monday reference

Table 1. Characteristics of the Study Population

| Characteristic | Admissions ^a | | P Value ^b |
|---|---------------------------------|---------------------------------|----------------------|
| | Weekday (n = 70 324) [75.1%] | Weekend (n = 23 297) [24.9%] | |
| Age at admission, mean (SD), y | 73.8 (14.8) | 74.5 (14.6) | .048 |
| Sex | | | |
| Male | 34 096 (48.5) | 10 990 (47.2) |] <.001 |
| Female | 36 228 (51.5) | 12 307 (52.8) | |
| Index of multiple deprivation quintile ^c | | | |
| 1 | 11 836 (16.8) | 3947 (16.9) |] .98 |
| 2 | 14 507 (20.6) | 4817 (20.7) | |
| 3 | 15 048 (21.4) | 4958 (21.3) | |
| 4 | 14 706 (20.9) | 4903 (21.0) | |
| 5 | 13 668 (19.4) | 4491 (19.3) | |
| 6 | 559 (0.8) | 181 (0.8) | |
| Charlson index of comorbidity ^{d,e} | | | |
| 0 | 32 034 (45.6) | 10 573 (45.4) |] .10 |
| 1-4 | 9715 (13.8) | 3256 (14.0) | |
| 5-9 | 6050 (8.6) | 1991 (8.5) | |
| 10-14 | 13 138 (18.7) | 4385 (18.8) | |
| 15-24 | 6629 (9.4) | 2168 (9.3) | |
| 25-50 | 2758 (3.9) | 924 (4.0) | |
| No. of admissions in previous 12 mo | | | |
| 0 | 48 960 (69.6) | 16 327 (70.1) |] .16 |
| 1 | 13 586 (19.3) | 4484 (19.2) | |
| 2 | 4650 (6.6) | 1444 (6.2) | |
| 3 | 3128 (4.4) | 1042 (4.5) | |
| Source of admission ^d | | | |
| Admitted from home | 62 755 (89.2) | 20 939 (89.9) |] <.001 |
| Hospital transfer | 6799 (9.7) | 2115 (9.1) | |
| Other or unknown | 770 (1.1) | 243 (1.0) | |
| Emergency admission ^f | | | |
| 0 | 3925 (5.6) | 645 (2.8) |] .001 |
| 1 | 66 399 (94.4) | 22 652 (97.2) | |
| Stroke diagnosis ^g | | | |
| Subarachnoid hemorrhage | 3570 (5.1) | 1175 (5.0) |] .04 |
| Intracerebral hemorrhage | 7864 (11.2) | 2738 (11.8) | |
| Other nontraumatic intracranial hemorrhage | 4376 (6.2) | 1352 (5.8) | |
| Cerebral infarction | 41 188 (58.6) | 13 628 (58.5) | |
| Stroke, not specified as hemorrhage or infarction | 13 326 (18.9) | 4404 (18.9) | |
| Length of stay, mean (IQR), days | 25.1 (4.0-33.0) | 25.3 (4.0-33.0) | |

Abbreviation: IQR, interquartile range.

^aUnless otherwise indicated, data are expressed as number (percentage) of cases. Percentages have been rounded and might not total 100.

^bCalculated using the χ^2 test for association.

^cOne indicates least deprived; 6, unclassified.

^dGrouped for the purposes of this table.

^eZero indicates no comorbidity; 25 to 50, highest comorbidity.

^fZero indicates nonemergency; 1, emergency.

^gIndicates codes I60 through I64 from the *International Statistical Classification of Diseases, 10th Revision*.

^hCalculated using the Wilcoxon Mann-Whitney test for association.

Table 2. Association Between Weekday/Weekend Admission and Indicators of Quality and Safety of Care

| Measure | Admission Rate ^a | | | | P Value | OR (95% CI) ^c |
|--|-----------------------------|--------------------------|---------------------|--------------------------|--------------------|-------------------------------|
| | Weekday | | Weekend | | | |
| | Unadjusted, No. (%) | Adjusted, % ^b | Unadjusted, No. (%) | Adjusted, % ^b | | |
| Same-day brain scan | 32 521 (47.6) | 47.8 | 9778 (43.1) | 42.6 | <.001 ^d | 0.83 (0.81-0.86) ^d |
| Thrombolysis | 1152 (2.7) | 2.7 | 313 (2.3) | 2.2 | .001 ^d | 0.82 (0.73-0.92) ^d |
| Aspiration pneumonia | 3545 (5.0) | 5.1 | 1329 (5.7) | 5.6 | .003 | 1.11 (1.04-1.18) |
| 7-d In-hospital mortality | 6250 (8.9) | 9.0 | 2472 (10.6) | 10.3 | <.001 | 1.18 (1.12-1.24) |
| Discharge to usual place of residence within 56 d | 40 692 (73.0) | 72.9 | 12 746 (71.3) | 71.3 | <.001 | 0.92 (0.88-0.95) |
| 30-d Emergency readmissions | 6165 (11.0) | 11.1 | 1971 (11.0) | 11.0 | .80 | 0.99 (0.94-1.05) |

Abbreviation: OR, odds ratio.

^aNumbers quoted are the numerator for each cell; the denominators, which can be derived from the unadjusted rates and numbers, vary by measure because of differences in patient inclusion/exclusion criteria.

^bPatient-level case-mix adjustment for factors listed in the "Methods" section.

^cWeekday indicates the reference value.

^dUnadjusted rate given. The P value and OR for the other measures are for adjusted rates.

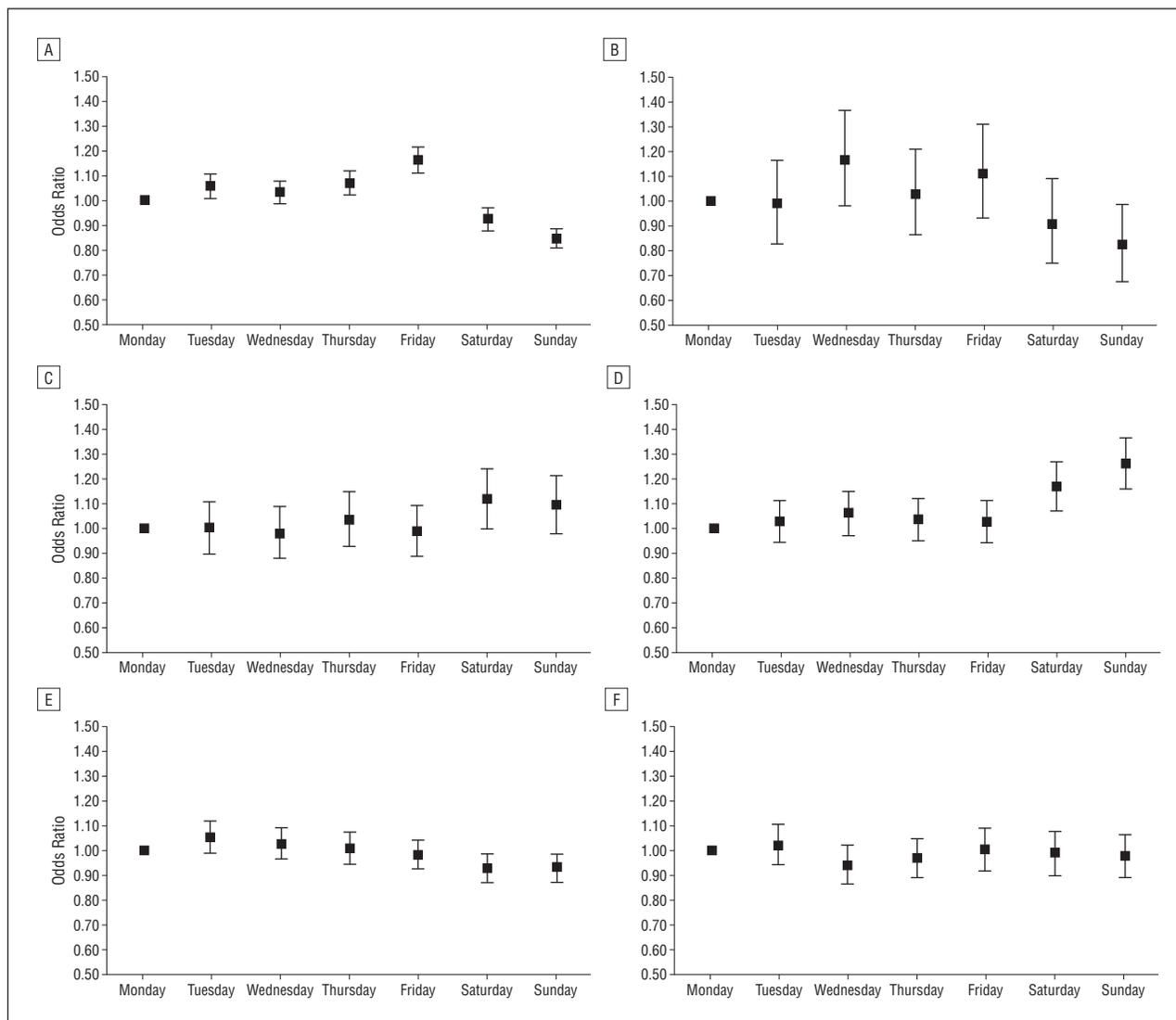


Figure. Performance of stroke care (odds ratios) by day of admission. A, Unadjusted rates of same-day brain scans. B, Unadjusted rates of thrombolysis. C, Adjusted rates of pneumonia. D, Adjusted rates of deaths within 7 days. E, Adjusted rates of discharge to usual place of residence. F, Adjusted rates of emergency readmissions. Data points represent odds ratios, with Monday used as a reference (1.00); vertical ranges, 95% confidence intervals.

(5.0%); however, this difference was not significant at the 5% level ($P = .12$ and $P = .05$, respectively). The highest rate of 7-day in-hospital mortality was for patients admitted for stroke on Sundays (adjusted OR, 1.26 [95% CI, 1.16-1.37]) at 11.0% compared with a mean for weekday admissions of 8.9%. Saturday (adjusted OR, 0.93 [95% CI, 0.87-0.99]) and Sunday (0.93 [0.87-0.99]) had lower rates of discharge to the usual place of residence within 56 days at 71.4% and 71.2%, respectively, with a mean rate for weekday admission of 73.0% (although these differences were only just significant at the 95% confidence level). The association between day of admission and emergency readmission rates was not significant ($P = .60$).

Some evidence also suggests that the weekend effect might be more pronounced for certain patient groups, with a more prominent effect on 7-day in-hospital mortality for patients aged 0 to 44 years (adjusted OR, 1.61 [95% CI, 1.23-2.12]) than for patients 85 years or older (1.13 [1.03-1.23]) (**Table 3**).

Table 3. Variation in Weekend Effect Across Different Age Groups

| Age Group, y | 7-d In-hospital Mortality Unadjusted Rate for Admissions, No. (%) ^a | | OR (95% CI) ^b |
|--------------|--|-------------|--------------------------|
| | Weekday | Weekend | |
| 0-44 | 3221 (5.4) | 986 (8.8) | 1.61 (1.23-2.12) |
| 45-54 | 4523 (6.2) | 1414 (9.3) | 1.46 (1.17-1.83) |
| 55-64 | 8344 (6.5) | 2527 (7.4) | 1.10 (0.92-1.31) |
| 65-74 | 14 075 (7.3) | 4565 (8.3) | 1.11 (0.98-1.26) |
| 75-84 | 22 809 (9.3) | 7660 (10.9) | 1.21 (1.11-1.32) |
| ≥85 | 17 352 (12.3) | 6145 (13.9) | 1.13 (1.03-1.23) |

Abbreviation: OR, odds ratio.

^aNumbers quoted are the denominator for each cell; the numerator (number of patients dying) can be derived from the unadjusted rates and numbers.

^bAdjusted for patient-level factors listed in the "Methods" section. The weekday rate for each age group indicates the reference value.

Table 4. Specialty of the First Responsible Consultant After Onset of Stroke

| Specialty | Admissions, No. (%) ^a | | |
|---------------------------------|----------------------------------|---------------|----------------------|
| | Weekday | Weekend | Total |
| Neurology | 2034 (2.9) | 629 (2.7) | 2663 (2.8) |
| Neurosurgery | 3029 (4.3) | 1029 (4.4) | 4058 (4.3) |
| Geriatric medicine | 18 583 (26.4) | 6022 (25.8) | 24 605 (26.3) |
| Accident and emergency medicine | 2151 (3.1) | 782 (3.4) | 2933 (3.1) |
| General medicine | 33 749 (48.0) | 11 277 (48.4) | 45 026 (48.1) |
| Other | 10 778 (15.3) | 3558 (15.3) | 14 336 (15.3) |

^aPercentages have been rounded and might not total 100.

The most common specialty of consultants responsible for the first episode of care in the hospital after a patient's stroke was general medicine (48.1%), followed by geriatric medicine (26.3%). **Table 4** provides the difference in specialty of responsible consultants between weekday and weekend strokes, with the latter more likely to be the responsibility of a general medicine specialist or a neurosurgeon and less likely to be the responsibility of a geriatric medicine specialist. Aggregating the specialties into 2 groups provided some evidence to suggest that stroke patients admitted on the weekend were less likely than those with weekday admissions to be the initial responsibility of a neurologist or a geriatric medicine specialist (compared with general medicine, accident and emergency medicine, and other specialties) at 33.0% compared with 33.6% ($P = .06$).

COMMENT

We examined more than 90 000 consecutive patients admitted for stroke in England during a 1-year period. The study highlights that stroke patients admitted on weekends have lower rates of receiving urgent treatments and experience poorer outcomes.

One explanation could be unmeasured differences in the case mix and severity of strokes. We found no significant differences in the levels of deprivation and comorbidities or in the number of previous admissions between patients admitted on weekends and weekdays. For differences in patients' characteristics—in sex, source and type of admission, type of stroke, and age—we were able to adjust rates by using patient-level regression models. Despite these efforts to mitigate for any bias in case mix, the underlying data have only limited information on the severity of stroke (such as patients' level of consciousness), which has been suggested to be conceivably worse on weekends and, therefore, to affect treatment decisions and outcomes.¹⁸ As a result, we cannot evaluate how much, if any, of the weekend effect can be attributed to differences in stroke severity. However, some of the measures that reveal a significant disparity, particularly same-day brain scan rates, are less likely to be affected by variations in stroke severity.

The evidence of lower performance across process and outcome measures on weekends suggests that care for patients admitted on weekends was inferior. The evidence of effect in the longer-term measures, such as discharge destination, adds weight to the importance of the urgent aspects of stroke care.

This study represents, to our knowledge, the most multifaceted evaluation of the association between day of admission and the quality of stroke care. The individual findings, such as fewer weekend strokes and the weekend effect on mortality, discharge destination, and pneumonia, however, are consistent with some previous international studies, including those from Finland,¹⁹ Sweden,¹¹ Canada,⁷ and the United States.^{8,9} International comparisons also provide grounds for optimism. A longitudinal Swedish study identified substantial reductions over time, from levels similar to those currently seen in England, in the disparities in mortality and discharge destination between stroke patients admitted on weekdays and weekends.¹¹

One strength of the study is the use of a combination of process and outcome measures (the former are often more sensitive to differences in the quality of care, and the latter benefit from greater intrinsic interest and reflect more aspects of care, such as operator skill).²⁰ The Hospital Episode Statistics database has the advantages of being longitudinal and timely, covering all hospital admissions, and of being relatively cheap, costing £1 per record to collect compared with approximately £10 to £60 per record for clinical registers.²¹ The use of administrative data to investigate this issue also overcomes a commonly cited limitation of the data—that there is variation between hospitals in coding practice and accuracy—because there is unlikely to be any bias in how details from weekend and weekday admissions are coded.

A limitation of the study derives from the inability to differentiate time of admission, with date being the lowest disaggregation of time; as a result, we were unable to identify whether there is poorer quality and safety for all off-hour periods during the week, including bank holidays and weekday evenings and nights. A Dutch study, for instance, found that, when compared with the Monday day shift, stroke mortality rates were higher during Sunday and Monday evening shifts and during all night shifts.⁶ As such, the off-hour periods during weekdays mask some actual variation in care identified in this study.

To date, the most comprehensive and high-profile study to benchmark stroke care in English hospitals has been the National Stroke Sentinel Audit. The present study has a number of strengths compared with the National Stroke Sentinel Audit given the latter's reliance on self-reported data, 2-year reporting cycle coupled with time lag before publication, and small sample size of approximately 60 consecutive patients per hospital. However,

many of the findings are consistent with the National Stroke Sentinel Audit, which in 2010 suggested that nursing practice could lead to more complications on weekends and that 43% of sites providing thrombolysis services, on or off site, were not able to offer the service 24 h/d, 7 d/wk.²²

The results have significant implications; in the NHS in England, stroke is the largest cause of adult disability and costs £3 billion a year for direct care.²³ Several possible explanations for these findings include fewer clinical staff working in hospitals on weekends, with those who do work often having less experience and lower familiarity with the patients^{4,9}; less accessibility of resources,^{2,23} such as radiologists to operate the scanners; and higher-severity strokes among patients admitted at weekends. This study provides some evidence to support previous findings that contributing factors might include a decreased proportion of stroke patients on weekends being admitted under the responsibility of stroke specialists or having access to fast-track discharge pathways.^{24,25}

Solutions have been proposed to address the weekend effect, such as maintaining more consistent levels of activity on weekends, which can be economical even if hospital staff are paid at higher levels²; using comprehensive stroke centers; and participating in stroke clinical improvement programs.^{8,13,14} In particular, regional reconfigurations represent a promising strategy for providing consistent levels of access to stroke care. Across London, a major reconfiguration of acute stroke services implemented since February 2010 has resulted in all patients with acute stroke being admitted to 1 of 8 hyperacute stroke units where thrombolysis and consultant-led care are available 24 h/d, 7 d/wk. Early results indicated that, within 6 months, thrombolysis rates increased 4-fold compared with the same period in the previous year.²⁶

Further work is needed to understand what organizational factors, such as workforce schedules, resource availability, and staffing ratios, might influence the weekend effect and to investigate centers that have reduced the disparities in access and outcome in care outside regular weekday hours. This analysis can also be extended to other countries because the method could be applied in any nation with similar administrative hospital data or applied to other specialties, with similar results having also been found in a limited number of other clinical areas.⁶ A greater understanding of the issue will also require better data, and the inclusion of an after-hours admission flag and a specific stroke category for consultant specialty for hospital administrative data should be considered.

The policy implications from this work need to be taken in the context of the overall shortcomings in performance on some of the measures, irrespective of day of admission. For most measures, no clinical consensus or guidelines for acceptable levels of care exist, with the exception of scanning rates, for which even weekday performance does not meet the expectations that all patients should undergo brain imaging “within a maximum of 24 hours after onset of symptoms.”²⁷

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