# Weekends: A Dangerous Time for Having a Stroke?

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***Background and Purpose***—Weekend admissions are associated with higher in-hospital mortality. However, limited information is available concerning the "weekend effect" on stroke mortality. Our aim was to evaluate the impact of weekend admissions on stroke mortality in different settings.

***Methods***—We analyzed all hospital admissions for ischemic stroke from April 2003 to March 2004 through the Hospital Morbidity Database. The Hospital Morbidity Database is a national database that contains patient-level sociodemographic, diagnostic, procedural, and administrative information including all acute care facilities across Canada. The major inclusion criterion was admission to an acute care facility with a principal diagnosis of ischemic stroke. Clinical variables and facility characteristics were included in the analysis.

***Results***—Overall, 26 676 patients were admitted to 606 hospitals for ischemic stroke. Weekend admissions comprised 6629 (24.8%) of all admissions. Seven-day stroke mortality was 7.6%. Weekend admissions were associated with a higher stroke mortality than weekday admissions (8.5% vs 7.4%; odds ratio, 1.17; 95% CI, 1.06 to 1.29). Mortality was similarly affected among patients admitted to rural versus urban hospitals or when the most responsible physician was a general practitioner versus specialist. In the multivariable analysis, weekend admissions were associated with higher early mortality (odds ratio, 1.14; 95% CI, 1.02 to 1.26) after adjusting for age, sex, comorbidities, and medical complications.

***Conclusions***—Stroke patients admitted on weekends had a higher risk-adjusted mortality than did patients admitted on weekdays. Disparities in resources, expertise, and healthcare providers working during weekends may explain the observed differences in weekend mortality. **(*Stroke*. 2007;38:1211-1215.)**

**Key Words:** hospital volume ■ mortality ■ outcomes research ■ stroke



The incidence of stroke increases during weekends and some other stressful days.[1–3] However, hospitals face shortages of staff and specialized services during those periods. Previous studies have shown increased mortality for different conditions or procedures such as cancer, aortic aneurysm, duodenal ulcer, epiglottitis, and pulmonary embolism, among others, during weekend admissions.[4,5] This phenomenon was defined by some authors as the "weekend effect."[5] However, limited information is available regarding ischemic stroke. It is possible that stroke care is not homogenous across the week, thus affecting the outcome.

We hypothesized that (1) stroke mortality increases for weekend admissions and (2) this weekend effect varies by facility type, location, and physician specialty. Our aim was to examine the effect of weekend admissions and their impact on in-hospital stroke mortality in a large population-based study across Canada. The identification of factors associated with in-hospital mortality for weekend admissions can contribute to implementation of quality improvement initiatives.

## Subjects and Methods

We identified all stroke patients admitted to acute care hospitals between April 1, 2003, and March 31, 2004, through the Hospital Morbidity Database (HMDB) managed by the Canadian Institute for Health Information. HMDB is a national database that contains patient-level sociodemographic, diagnostic, procedural, and administrative information across Canada. Inclusion criteria included admission to an acute care facility due to ischemic stroke as identified through the patient's principal diagnosis recorded according to the International Classification of Diseases, either the ninth (ICD-9) or 10th (ICD-10) revision (ICD-9 codes 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91 and ICD-10 codes I63, I64). Validation studies have also established a high accuracy rate for these codes.[6,7] All provinces and territories except Manitoba and Quebec use ICD-10 codes. The first 7 days after admission are crucial for acute stroke management, preventing complications, identifying the stroke mechanism, and discharge planning.[8,9] This was the rationale for using the 7-day case-fatality indicator to analyze the impact of weekend admissions. In addition, this indicator has the advantages of high case ascertainment and limited influence of length of stay when comparing different facilities. Patients with transient ischemic attack and hemorrhagic stroke were excluded owing to major prognostic differences. We also

Received September 3, 2006; final revision received October 7, 2007; accepted October 18, 2006.

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***Stroke*** **is available at http://www.strokeaha.org** **DOI: 10.1161/01.STR.0000259622.78616.ea**

excluded records containing an invalid health card number or missing discharge disposition.

Canada's healthcare system includes universal government-funded insurance coverage. This study evaluated all stroke admissions from 606 hospitals across Canada, which represent a comprehensive range of facilities, including academic and community hospitals located in metropolitan and rural areas. Similar to other studies, weekend was defined as the period from midnight on Friday to midnight on Sunday. All other times were defined as weekdays.[4]

In this analysis, the influence of the following variables on early stroke outcome was assessed: age (categorized as <65, 65 to 74, 75 to 84, and ≥85 years old), sex, comorbid conditions, major medical complications, socioeconomic status, facility type by location (rural/urban), teaching status, most responsible physician (general practitioner/specialist), length of hospital stay, and discharge disposition (dead, home, residential/nursing home, or other transfer to another hospital). For patients transferred between hospitals, the day of admission was defined as the day they presented to the initial acute care facility.

We used the Charlson-Deyo index to quantify patients' comorbidities.[10] This index is a summary score based on the presence or absence of 17 medical conditions. A score of 0 means that no comorbid index is present, and higher scores indicate a greater burden of comorbidity. The Charlson-Deyo index was classified as having none, 1, 2, or >3 comorbidities.[11,12]

Socioeconomic status was estimated through an approach developed by Statistics Canada that assigns neighborhoods to 5 equally sized quintiles based on income data reported on the 2001 census.[13] A higher quintile value of a residential area is associated with higher socioeconomic status of residents in that area. Teaching status was defined according to the Association of Canadian Academic Healthcare Organizations.[14]

Each hospital in the HMDB is assigned a unique, encrypted identifier. This identifier was used to determine the annual acute ischemic stroke volume for each hospital that contributed to the database. As expected in administrative-clinical databases, no specific data were available for estimating acute neurological status (National Institutes of Health Stroke Scale) or measures of functional disability such as the Barthel index and modified Rankin scale. We were able, however, to adjust for some other important clinical predictors, including age, sex, comorbid illnesses, and major medical complications in the multivariable analysis.

## Statistical Analysis

Descriptive statistics were used to assess the effect of various patient and hospital characteristics on 7-day in-hospital mortality. Multivariable logistic-regression analysis was used to calculate odds ratios (ORs) and the corresponding 95% CIs. Multivariable regression analysis of in-hospital mortality was performed by entering all relevant patient and hospital variables into the model. The estimated weekend effect was adjusted for patient age, sex, Charlson-Deyo index, and complications.

The presence of potential interactions between age and sex, hospital type (teaching status, location), and intensive care unit (ICU) admission were tested by adding interaction terms to the regression model. Except for the interactions between ICU and teaching status and ICU and hospital location (rural/urban), the remaining ones were not statistically significant. A Kaplan-Meier estimated survival function of the time from hospital admission to hospital death was plotted to determine the weekend effect.

Statistical analysis was performed with a commercially available software package (SAS statistical software, version 9; SAS Institute Inc; and STATA version 8.2, Stata Corp LP). All tests were 2 tailed, and probability values <0.05 were considered significant.

## Ethics

The design of the study was approved by the ethics review board at the University of Western Ontario, London, Canada. Because the identity of the patients was completely anonymous, no specific informed consent was required. The data pooling center was blinded to hospital identities.

## Data Quality

According to a reabstraction study conducted after implementation of ICD-10 by the Canadian Institute for Health Information for quality assurance, diagnosis in the abstract coincides with diagnosis in the chart in 92% of stroke cases. The reliability of the coding of data collected for day of admission was 97% and for death was >99%. Nonmedical and sociodemographic data elements in this study had agreement rates ranging from 96% to 100%.[15]

Other Canadian studies on hospital coding of stroke and vascular risk factors according to ICD-9 and ICD-10 showed a high accuracy rate.[16,17] On the whole, ICD-9 coding was excellent, with 90% (95%

**TABLE 1. Comparison of Clinical Characteristics Between Stroke Admissions on Weekends and Weekdays**

| Variables | Weekday Admissions, n=20 047 (%) | Weekend Admissions, n=6629 (%) | *P* Value |
|---|---|---|---|
| Mean age (SD), y | 73.8 (13) | 74.7 (13) | <0.001 |
| Age groups, y | | | <0.001 |
| Age <65, % | 4176 (21) | 1264 (19) | |
| Age 65–74, % | 4799 (24) | 1487 (22) | |
| Age 75–84, % | 7215 (36) | 2452 (37) | |
| Age ≥85, % | 3857 (19) | 1426 (22) | |
| Sex, male, % | 10 368 (52) | 3309 (50) | 0.01 |
| Charlson-Deyo comorbidity index | | | 0.1 |
| 0 | 13 793 (69) | 4634 (70) | |
| 1 | 2629 (13) | 860 (13) | |
| 2 | 1872 (9) | 607 (9) | |
| ≥3 | 1753 (9) | 528 (8) | |
| Facility type, % | | | 0.9 |
| Teaching hospitals | 3895 (19) | 1284 (19) | |
| Nonteaching hospitals | 16 152 (81) | 5345 (81) | |
| Facility location, % | | | 0.8 |
| Rural | 4823 (24) | 1524 (23) | |
| Urban | 15 224 (76) | 5105 (77) | |
| Cases requiring ICU | 650 (3.2) | 221 (3.3) | 0.1 |
| Physician type | | | 0.7 |
| General practitioner | 3378 (17) | 1133 (17) | |
| Specialist | 16 669 (83) | 5496 (83) | |
| Neighborhood income, quintiles* | | | 0.3 |
| 1 | 4325 (22) | 1427 (21) | |
| 2 | 4165 (21) | 1308 (20) | |
| 3 | 3960 (20) | 1285 (19) | |
| 4 | 3480 (17) | 1179 (18) | |
| 5 | 3044 (15) | 1055 (16) | |
| Unknown postal code | 1073 (5) | 375 (6) | |
| Major medical complications | | | |
| Pneumonia | 691 (3.4) | 223 (3.4) | 0.8 |
| Urinary tract infection | 650 (3.2) | 221 (3.3) | 0.7 |
| Pulmonary embolism | 102 (0.5) | 40 (0.6) | 0.4 |
| Mean length of stay (SD), d | 16.1 (32) | 16.0 (24) | 0.7 |

*Corresponds to 5 equally sized quintiles of neighborhood income based on the 2001 Canadian census data.

**TABLE 2. Outcome Measures and Weekend Effect**

| Outcomes | Weekday Admissions, n=20 047 (%) | Weekend Admissions, n=6629 (%) | Weekend Effect OR (95% CI) |
|---|---|---|---|
| Discharge to place of residence | 9777 (48.7) | 2972 (44.8) | 0.85 (0.80–0.90) |
| Mortality at 7 days | 1476 (7.4) | 563 (8.5) | 1.17 (1.06–1.29) |
| Mortality at discharge | 3077 (15.3) | 1088 (16.4) | 1.08 (1.004–1.17) |

CI, 86% to 92%), and ICD-10 was similarly good, with 92% (95% CI, 88% to 95%) of strokes correctly coded.[7]

## Results

Among 26 676 patients hospitalized for ischemic stroke at 606 centers across Canada, 6609 (24.8%) were admitted during weekends. Patients admitted on weekends were older and more frequently male. There were no statistically significant differences in the remaining baseline characteristics, including major medical complications, between patients admitted on weekends versus weekdays in the univariable analysis (Table 1).

Overall, 7-day case fatality was 7.6% (2039/26676), whereas mortality at discharge was 15.6% (4165/26676). Early stroke mortality was higher among patients admitted on weekends (8.5%) compared with weekdays (7.4%) (OR 1.17; 95% CI, 1.06 to 1.29). Similar results were observed for mortality at discharge (16.4% versus 15.3%; OR 1.08; 95% CI, 1.004 to 1.17). Patients admitted on weekends were less likely to be discharged to the same place of residence ($P<0.001$; OR 0.85; 95% CI, 0.80 to 0.90; Table 2).

The analysis of stroke mortality on weekends by facility characteristics is shown in Table 3. The weekend effect was larger in rural hospitals (OR 1.26; 95% CI, 1.02 to 1.54) compared with urban hospitals (OR 1.14; 95% CI, 1.02 to 1.28) and when the most responsible physician was a general practitioner (OR 1.17; 95% CI, 1.06 to 1.29). For weekend admissions, early stroke mortality was significant in nonteaching hospitals (OR 1.15, 95% CI, 1.03 to 1.29) and for ICU hospitalizations (OR 1.52; 95% CI, 1.23 to 1.88). Two interaction terms (ICU admission×nonteaching hospital, $P<0.001$; and ICU admission×rural location, $P<0.001$) were significant, suggesting higher mortality for patients requiring ICU admission in nonteaching and rural hospitals.

Multivariable analysis for 7-day case fatality showed that patients admitted on weekends had 13% higher odds of dying compared with patients admitted during weekdays (OR 1.14; 95% CI, 1.02 to 1.26) after adjusting for age, sex, Charlson-Deyo comorbidity index, and medical complications (pneumonia, respiratory tract infection, and pulmonary embolism; Table 4). Kaplan-Meier curves demonstrated a significantly lower 30-day survival function for patients admitted on weekends than for weekday admissions (log-rank=0.0005; the Figure).

## Discussion

Our study shows that stroke patients admitted on weekends had an increased mortality rate and were less likely to be discharged to the same place of residence than those admitted on weekdays. After adjusting for age, sex, comorbidities, and major medical complications, weekend admissions increased the risk of death by 14%. The effect of weekend admissions may be greater in nonteaching hospitals and for patients requiring ICU admission. Although the weekend effect affected patients admitted to both rural and urban hospitals and those treated by general practitioners versus specialists, the effect may be larger in patients admitted to rural hospitals and when the most responsible physician is a general practitioner (Table 3). In agreement with prior studies that examined the weekend effect in other medical conditions,[4,5,18–21] our study demonstrated a significant impact on several stroke outcomes, including visit disposition, 7-day case fatality, and mortality at discharge.

In a large study analyzing the weekend effect in the top 100 causes of hospital death, Bell and Redelmeier[4] found that weekend admissions for any condition were associated with a 4% increase in mortality and that 23% of causes were

**TABLE 3. Weekend Effect for Early Stroke Mortality by Facility Characteristics**

| Variables | Admissions | Mortality, n (%) | | Weekend Effect OR (95% CI) |
|---|---|---|---|---|
| | | Weekday Admissions | Weekend Admissions | |
| Facility type | | | | |
| Nonteaching | 21 497 (80.6) | 1231 (7.6) | 464 (8.7) | 1.15 (1.03–1.29) |
| Teaching | 5179 (19.4) | 245 (6.3) | 99 (7.7) | 1.24 (0.98–1.6) |
| Hospital location | | | | |
| Rural | 6347 (19.4) | 363 (7.5) | 141 (9.3) | 1.26 (1.02–1.54) |
| Urban | 20 329 (80.6) | 1113 (7.3) | 422 (8.3) | 1.14 (1.02–1.28) |
| Most responsible provider | | | | |
| General practitioner | 4511 (16.9) | 236 (6.9) | 34 (8.6) | 1.27 (1.00–1.63) |
| Specialist | 22 165 (83.1) | 1240 (7.5) | 469 (8.5) | 1.14 (1.02–1.28) |
| Admission to ICU | | | | |
| Yes | 3304 (12.4) | 337 (13.4) | 149 (19) | 1.52 (1.23–1.88) |
| No | 23 372 (87.6) | 1139 (6.5) | 414 (7.1) | 1.10 (0.98–1.23) |

**TABLE 4. Adjusted Risk of Early Stroke Mortality for Weekend Admissions**

| 7-Day Mortality | Adjusted OR | 95% CI | |
|---|---|---|---|
| Weekend admission | 1.14 | 1.02 | 1.26 |
| Age, y | 1.04 | 1.04 | 1.05 |
| Female sex | 1.01 | 0.92 | 1.11 |
| Charlson comorbid score=0 | Ref | ... | ... |
| 1 or 2 | 1.03 | 0.92 | 1.15 |
| >3 | 1.14 | 0.97 | 1.33 |
| Major medical complications* | 1.07 | 0.89 | 1.28 |

Ref indicates reference group.

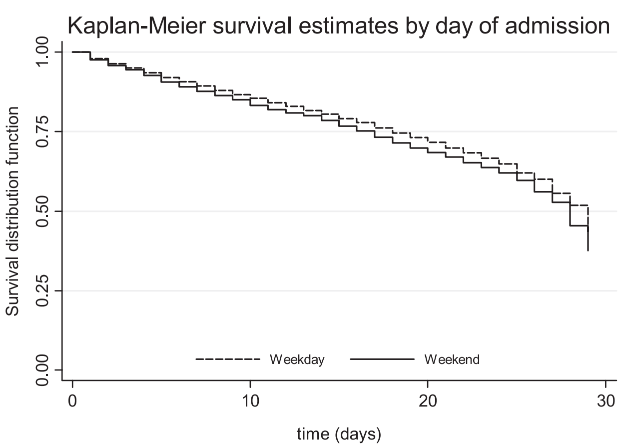
*Major medical complications included pneumonia, urinary tract infection, and pulmonary embolism.

Results were similar if the multivariable model was not adjusted by major medical complications.

associated with a statistically significant weekend effect. This is 1 of the largest and best-conducted studies analyzing the weekend-outcome relation. However, the authors did not analyze the weekend effect on admissions due to ischemic stroke.

Another large study conducted in acute care hospitals in California found that weekend admissions were associated with a 3% higher chance of mortality after adjusting for covariates.[5] Cancer of the ovary/uterus, duodenal ulcer, and cardiovascular symptoms were the conditions associated with a significant weekend effect. They found that the weekend effect was larger in major teaching hospitals compared with nonteaching hospitals (OR=1.13 vs 1.03; $P$=0.03). Interestingly, they also included 24 565 patients with ischemic stroke but found no significant difference in the mortality rate between weekend and weekday admissions. Differences in the overall proportion of patients admitted on weekends (28%), the length of hospital stay, or resource availability on weekends might explain the discrepancy with our study.

The weekend effect was also observed in a few studies conducted in different settings (pediatric hospitals, ICUs, stroke units).[18–21] As expected, the magnitude of the weekend effect diminished when stroke mortality decreased. Therefore, variations in the definition of hospital mortality (short versus long term), which is highly influenced by the length of stay, may explain differences among studies.




Kaplan-Meier survival curves for stroke mortality by day of admission. Reference: log-rank test=0.0005. This figure shows that stroke survival on weekend admissions is significantly lower than on weekday admissions in a 30-day time period.

Important factors need to be considered to interpret the underlying mechanisms for the weekend effect. In a cohort study including 723 stroke patients, recent alcohol intake (1 to 40 g and >40 g of alcohol consumption during the previous 24 hours) was associated with the onset of brain infarction during weekends and holidays ($P$<0.01). High alcohol drinking and drug use on weekends may have an impact on stroke mortality.[22] Another potential explanation is that patients admitted on weekends might have more severe strokes or comorbid conditions and consequently worse prognoses than those admitted on weekdays. Although we have no information on stroke severity on admission, the weekend effect remained significant after adjusting for other variables (age, comorbid conditions, and major medical complications) that affect mortality in the same direction as stroke severity.

Interestingly, we found no significant difference in the medical complication rate between weekend and weekday admissions. Although variations in the processes of care may explain our findings, we do not have information on fluctuations in staff level, coverage, differences in expertise, or availability of stroke consultants.

There are some strengths as well as limitations of our study. First, as in most studies that involve administrative-clinical databases, no information was available on stroke severity and the results of brain imaging. Second, the possibility of errors in recording demographic data, mortality date, or diagnostic codes cannot be excluded. However, there is no reason to believe that potential recording errors would be higher for weekend admissions. Third, it is possible that comorbid conditions and medical complications were underreported, thus limiting the adjustment in the multivariable analysis for the weekend effect. On the other hand, our results were consistent among the outcomes measured, and our use of a national database allowed comprehensive coverage of all stroke-related hospitalizations across the country.

In summary, stroke patients admitted on weekends had a higher risk-adjusted mortality than did patients admitted on weekdays. Even in a country with universal health insurance coverage, disparities in resources, expertise, or the number of healthcare providers working during weekends may be present and may explain the observed differences in weekend mortality between facilities. The understanding of factors affecting the processes of care may provide new avenues to implement quality improvement initiatives.

## Acknowledgments

We thank the Canadian Institute for Health Information for providing the data. We appreciate the support of the Research Department and the Regional Stroke Center at St. Michael Hospital, Toronto. The authors thank Drs Bob Hyland and Art Slutzky for their support.

## Sources of Funding

This research was supported in part by a grant from the Heart Stroke Foundation of Canada (HSFC) and the Canadian Institute for Health Research (CIHR) given to Dr Gustavo Saposnik. The grant was obtained on the basis of competitive applications after publication of grant advertisements. The investigators acted as sponsors of the study. Neither the HSFC nor the CIHR had input on the design, access to the data, analyses, interpretation, or publication of the study.

## Disclosures

None.

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