J-ASPECT study
results of CSC score and mortality

2012/5/9→2012/6/8→2012/6/26
Kada NCVC

methods

- Hospital research (n=256)
  death from DPC data (n=64650)
- Create comprehensive stroke center(CSC) score according with components of a CSC (Alberts MJ, et.al. 2005)
- Hierarchical logistic regression analyses with hospital and patient level for mortality

Background, CSC score, Death

	脳梗塞 Cerebral infarction	非外傷性脳内血腫 Intracerebral hemorrhage	クモ膜下出血 Subarachnoid hemorrhage
Patients	42057	17475	5269
Female	17448 (41.5%)	7251 (41.5%)	3533 (67.1%)
Age	73.9 ± 12.2	70.7 ± 13.5	64.2 ± 14.8
MRS : 1-3	18892 (44.9%)	4870 (27.9%)	1400 (26.6%)
4	10901 (25.9%)	4309 (24.7%)	802 (15.2%)
5	9114 (21.7%)	7398(42.3%)	2632 (50.0%)
Hospital CSC total score	16.4 ± 3.6	16.6 ± 3.4	16.9 ± 3.2
CSC components:			
Personnel with expertise	3.7 ± 1.2	3.7 ± 1.2	3.8 ± 1.2
Diagnostic techniques	4.4 ± 1.1	4.5 ± 1.1	4.5 ± 1.0
Surgical/interventional therapies	4.4 ± 1.1	4.4 ± 1.0	4.5 ± 1.0
Infrastructure	2.6 ± 1.2	2.6 ± 1.1	2.7 ± 1.1
Education/research	1.4 ± 0.8	1.4 ± 0.8	1.4 ± 0.8
Death	2765 (6.6%)	2655 (15.2%)	1405 (26.7%)

N (%), mean ± SD

Mortality by gender

all	N	Death n (%)
Male	36478	3407(9.3%)
Female	28172	3396(12.1%)
total	64650	6803(10.5%)

脳梗塞	N	Death n (%)
Male	24609	1394(5.7%)
Female	17448	1371(7.9%)

非外傷性	N	Death n (%)
Male	10224	1575(15.4%)
Female	7251	1080(14.9%)

クモ膜下	N	Death n (%)
Male	1736	447(25.7%)
Female	3533	958(27.1%)

Analyses of mortality : cerebral infarction

Factor	β	SE	OR	95%CI	P value
male	-0.003	0.04	0.997	0.92 – 1.08	0.938
Age	**0.57**	**0.02**	**1.77**	**1.70 – 1.85**	**<0.001**
CSC total score	**-0.02**	**0.01**	**0.98**	**0.96 – 0.99**	**0.002**

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	**-0.07**	**0.03**	**0.93**	**0.89 – 0.98**	**0.005**
Diagnostic techniques	-0.01	0.03	0.99	0.93 – 1.04	0.598
Surgical/interventional therapies	-0.02	0.03	0.98	0.93 - 1.03	0.470
Infrastructure	**-0.07**	**0.03**	**0.93**	**0.89 – 0.98**	**0.009**
Education/research	**-0.15**	**0.04**	**0.86**	**0.80 – 0.92**	**<0.001**

Adjusted by gender and age

Analyses of mortality : Intracerebral hemorrhage

Factor	β	SE	OR	95%CI	P value
male	**0.18**	**0.05**	**1.19**	**1.09 – 1.30**	**<0.001**
Age	**0.22**	**0.02**	**1.25**	**1.21 – 1.29**	**<0.001**
CSC total score	-0.02	0.01	0.98	0.96 – 1.00	0.055

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.01	0.03	0.99	0.93 – 1.05	0.698
Diagnostic techniques	-0.05	0.03	0.95	0.90 – 1.01	0.126
Surgical/interventional therapies	-0.05	0.03	0.95	0.90 – 1.01	0.102
Infrastructure	-0.03	0.03	0.98	0.92 – 1.04	0.411
Education/research	**-0.10**	**0.04**	**0.91**	**0.84 – 0.99**	**0.023**

Adjusted by gender and age

Analyses of mortality : Subarachnoid hemorrhage

Factor	β	SE	OR	95%CI	P value
male	**0.21**	**0.07**	**1.24**	**1.07 – 1.43**	**0.004**
Age	**0.38**	**0.02**	**1.46**	**1.39 – 1.53**	**<0.001**
CSC total score	**-0.06**	**0.01**	**0.95**	**0.92 – 0.97**	**<0.001**

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.07	0.04	0.93	0.87 – 1.00	0.055
Diagnostic techniques	-0.04	0.04	0.96	0.89 – 1.05	0.391
Surgical/interventional therapies	**-0.16**	**0.04**	**0.85**	**0.78 – 0.92**	**0.001**
Infrastructure	**-0.12**	**0.04**	**0.89**	**0.82 – 0.96**	**0.005**
Education/research	**-0.21**	**0.05**	**0.81**	**0.73 – 0.90**	**0.001**

Adjusted by gender and age

Analyses of mortality : all 参考

Factor	β	SE	OR	95%CI	P value
male	**-0.17**	**0.03**	**0.84**	**0.80 – 0.89**	**<0.001**
Age	**0.22**	**0.01**	**1.25**	**1.22 – 1.27**	**<0.001**
CSC total score	-0.01	0.01	0.99	0.98 – 1.00	0.166

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.02	0.02	0.97	0.93 – 1.02	0.262
Diagnostic techniques	0.01	0.03	1.01	0.97 – 1.07	0.584
Surgical/interventional therapies	-0.02	0.02	0.99	0.94 – 1.03	0.497
Infrastructure	-0.02	0.02	0.98	0.94 – 1.03	0.485
Education/research	**-0.11**	**0.03**	**0.89**	**0.84 – 0.95**	**0.001**

Adjusted by gender and age

参考

- くも膜下出血:性別の影響
- MRS 1~4/ 5 を要因に加えた場合

くも膜下出血:単変量と多変量の解析で性別の影響の方向が変わったのは

クモ膜下	N	Death n (%)
Male	1736	447(25.7%)
Female	3533	958(27.1%)

75才未満	N	Death n (%)
Male	1495	329(22.0%)
Female	2295	444(19.3%)

75歳以上	N	Death n (%)
Male	241	118(49.0%)
Female	1238	514(41.5%)

性別による交絡

Analyses of mortality : cerebral infarction

Factor	β	SE	OR	95%CI	P value
male	0.14	0.05	1.15	1.05 – 1.26	0.003
Age	0.37	0.02	1.44	1.38 – 1.51	<0.001
MRS (5)	**2.04**	**0.05**	**7.69**	**7.00 – 8.44**	**<0.001**
CSC total score	-0.01	0.01	0.99	0.97 – 1.00	0.112
Univariate: male	**-0.35**	**0.04**	**0.71**	**0.65 – 0.76**	**<0.001**

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.08	0.03	0.92	0.87 – 0.98	0.007
Diagnostic techniques	-0.01	0.03	0.99	0.93 – 1.05	0.653
Surgical/interventional therapies	0.006	0.03	1.01	0.95 - 1.07	0.842
Infrastructure	-0.007	0.03	0.99	0.94 – 1.05	0.818
Education/research	-0.11	0.04	0.89	0.82 – 0.97	0.007

Adjusted by gender, age, and MRS(5)

Analyses of mortality : Intracerebral hemorrhage

Factor	β	SE	OR	95%CI	P value
male	0.37	0.05	1.46	1.32 – 1.61	<0.001
Age	0.21	0.02	1.23	1.18 – 1.28	<0.001
MRS (5)	**2.88**	**0.07**	**17.6**	**15.4 – 20.2**	**<0.001**
CSC total score	-0.02	0.01	0.99	0.96 – 1.01	0.219
Univariate: male	**0.05**	**0.04**	**1.05**	**0.96 – 1.14**	**0.277**

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.04	0.04	0.96	0.89 – 1.03	0.246
Diagnostic techniques	-0.05	0.04	0.95	0.88 – 1.03	0.206
Surgical/interventional therapies	-0.03	0.04	0.97	0.90 – 1.05	0.402
Infrastructure	0.02	0.04	1.02	0.94 – 1.10	0.637
Education/research	-0.08	0.05	0.92	0.83 – 1.03	0.143

Adjusted by gender, age, and MRS(5)

Analyses of mortality : Subarachnoid hemorrhage

Factor	β	SE	OR	95%CI	P value
male	0.34	0.08	1.40	1.19 – 1.65	<0.001
Age	0.27	0.03	1.32	1.25 – 1.39	<0.001
MRS (5)	2.45	0.10	11.6	9.57 – 14.0	<0.001
CSC total score	-0.05	0.02	0.95	0.92 – 0.98	0.001
Univariate: male	-0.09	0.07	0.92	0.80 – 1.05	0.192

Factor	β	SE	OR	95%CI	P value
Personnel with expertise	-0.11	0.04	0.89	0.82 – 0.98	0.011
Diagnostic techniques	-0.02	0.05	0.98	0.89 – 1.09	0.762
Surgical/interventional therapies	-0.16	0.05	0.85	0.77 - 094	0.002
Infrastructure	-0.08	0.05	0.92	0.84 – 1.02	0.107
Education/research	-0.17	0.07	0.84	0.74 – 0.96	0.009

Adjusted by gender, age, and MRS(5)

Analyses of mortality : all

Factor	β	SE	OR	95%CI	P value
male	0.08	0.03	1.09	1.02 – 1.15	0.007
Age	0.13	0.01	1.14	1.11 – 1.16	<0.001
MRS (5)	2.62	0.04	13.8	12.8 – 14.7	<0.001
CSC total score	-0.007	0.009	0.99	0.98 – 1.01	0.447
Univariate: male	-0.29	0.03	0.75	0.71 – 0.79	<0.001

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Weekends: A Dangerous Time for Having a Stroke?

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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

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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 (%) Weekday Admissions	Mortality, n (%) Weekend Admissions	Weekend Effect OR (95% CI)
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.

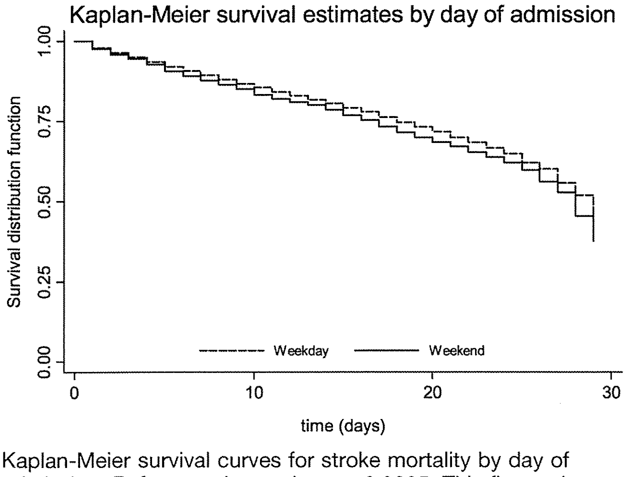
*Major medical complications included pneumonia, urinary tract infection, and pulmonary embolism.

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.

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Disclosures

None.

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Effect of Weekend Compared With Weekday Stroke Admission on Thrombolytic Use, In-Hospital Mortality, Discharge Disposition, Hospital Charges, and Length of Stay in the Nationwide Inpatient Sample Database, 2002 to 2007

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Effect of Weekend Compared With Weekday Stroke Admission on Thrombolytic Use, In-Hospital Mortality, Discharge Disposition, Hospital Charges, and Length of Stay in the Nationwide Inpatient Sample Database, 2002 to 2007

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Background and Purpose—A stroke "weekend effect" on mortality has been demonstrated in other countries with a possible slight effect in the United States. We studied patients with stroke in the Nationwide Inpatient Sample database for a weekend effect on thrombolytic use, in-hospital mortality, discharge disposition, hospital charges, and length of stay.

Methods—The Nationwide Inpatient Sample 2002 to 2007 was searched for all emergency room admissions for International Classification of Diseases, 9th Revision codes corresponding to ischemic stroke. Generalized estimated equations for generalized linear models were performed, adjusting for gender, age, race, season, median income level, payer, comorbidity score, hospital region, hospital location, teaching status, bed size, and hospital annual stroke case volume to compare weekend versus weekday stroke admission incidence of thrombolytic use, in-hospital mortality, discharge disposition, hospital charges, and length of stay. The same analysis was performed using the International Classification of Diseases, 9th Revision codes for ischemic stroke AND transient cerebral ischemia to check internal validity for coding irregularities that may occur in differentiating stroke from transient ischemic attack.

Results—There were 599 087 emergency room admissions for ischemic stroke: 159 906 weekend admissions and 439 181 weekday admissions. Generalized estimated equation for generalized linear model analysis was performed and demonstrated weekend compared with weekday patients with stroke were slightly more likely to receive thrombolytics (OR=1.114; 95% CI=1.039 to 1.194; P=0.003); incur slightly higher total hospital charges (effect ratio=1.011; 95% CI=1.006 to 1.017; P<0.001); and have slightly longer lengths of stay (effect ratio=1.021; 95% CI=1.015 to 1.027; P<0.001). There was no difference in in-hospital mortality or discharge disposition.

Conclusions—There is a slight stroke weekend effect on thrombolytic use, total hospital charges, and length of stay, but no difference in in-hospital mortality or discharge disposition. (*Stroke*. **2010;41:2323-2328.**)

Key Words: hospital charges ■ ischemic stroke ■ length of hospitalization ■ mortality ■ outcome ■ thrombolytic ■ weekend

Hospital admission for ischemic stroke over the weekend compared with a weekday is associated with higher mortality in Canada,[1] Sweden,[2] Japan,[3] and Taiwan.[4] In England, Wales, and Northern Ireland, patients with stroke admitted on weekends wait longer to be admitted into a stroke unit and are less likely to have a brain scan within 24 hours.[5] In the United Kingdom, weekend patients with stroke are less likely to receive thrombolytics,[6] whereas in Germany, they are more likely.[7]

Studies of the stroke "weekend effect" in the United States, however, have been inconsistent. In the Get With the Guidelines–Stroke Program, off-hour ischemic stroke presentation (weekends and weeknights) is associated with slightly higher in-hospital mortality.[8] The difference was small (0.6%), however, with a number of 166 needed to harm.[8] In North Carolina, patients with acute ischemic stroke admitted on weekends wait longer to undergo a CT scan.[9]

In Virginia, weekend patients with stroke are more likely to receive tissue plasminogen activator, albeit with no improvement in mortality.[10] In a study of 2 comprehensive stroke centers, there was no difference in discharge disposition, discharge, or 90-day modified Rankin score or 90-day mortality between patients with stroke admitted on weekends compared with weekdays.[11]

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We studied the stroke "weekend effect" on thrombolytic use, in-hospital mortality, discharge disposition, hospital charges, and length of stay using the Nationwide Inpatient Sample (NIS) database for the years 2002 to 2007. The NIS is the largest all-payer hospital inpatient database in the United States and contains data approximating a 20% stratified sample of US hospitals. The NIS includes data for approximately 8 million hospital admissions each year, approximately one fifth of all inpatient admissions to US nonfederal hospitals.

Methods

We obtained the NIS database from the Agency for Healthcare Quality and Research's Healthcare Cost and Utilization Project (Rockville, Md). For more information regarding the NIS database, see www.hcup-us.ahrq.gov/nisoverview.jsp.

Hospitalizations for ischemic stroke from 2002 to 2007 were collected from the NIS by International Classification of Diseases, 9th Revision codes 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 437.1. International Classification of Diseases, 9th Revision code 436 was not included because it is defined as "excludes: cerebrovascular accident, CVA (ischemic), embolic, hemorrhagic, thrombotic, postoperative cerebrovascular accident, stroke (ischemic), embolic, hemorrhagic, thrombotic." A secondary analysis was performed adding hospitalizations with International Classification of Diseases, 9th Revision codes for transient cerebral ischemia 435.0, 435.1, 435.2, 435.3, 435.8, and 435.9 to check internal validity for coding irregularities that may occur in differentiating stroke from transient ischemic attack.

The NIS contains data on which hospitalizations were weekend admissions (Saturday to Sunday). Only admissions through the emergency room were included, because NIS data for transferred patients do not include the admission day to the initial facility. Weekend stroke admissions were compared with weekday stroke admissions for 5 end points: hospital mortality, discharge disposition (home or short-term facility versus long-term facility versus death), thrombolytic use, total hospital charges, and length of hospitalization.

The NIS contains data on discharge disposition, which we grouped into the 3 following outcomes: (1) home or short-term facility (routine, short-term hospital, against medical advice, home intravenous provider, another rehabilitation facility, another institution for outpatient services, this institution for outpatient services, discharged alive, destination unknown) versus (2) long-term facility (skilled nursing facility, intermediate care, hospice home, hospice medical facility, long-term care hospital, certified nursing facility) versus (3) death (died in the hospital, died at home, died in a medical facility, died in place unknown).

The analysis was adjusted for the following patient-specific factors, which are coded in the NIS database: gender, age, race, season (winter, spring, summer, fall), median income level in patient's postal (zip) code (<\$36 000, \$36 000 to \$44 999, ≥\$45 000), payer (Medicare, Medicaid, private insurance, self-pay, or no charge), and a comorbidity score defined as the summation of the number of comorbidities entered for each patient in the NIS.[12] The models also accounted for hospital-level factors: hospital region (Northeast, Midwest, South, West), hospital location (rural, urban nonteaching, urban teaching), bed size (small, medium, large), and hospital annual case volume of stroke admissions.

For each sampled hospital, all inpatient admissions for the year are contained in the NIS, permitting annual case volumes for hospitals to be calculated. Hospital annual case volume of stroke admissions was determined by the ranking of total stroke admissions across all sampled hospitals. For each year from 2002 to 2007, each individual hospital's case volume of stroke admissions was defined as high if the number of total stroke admissions equaled or exceeded the third quartile of total stroke admissions across all sampled hospitals and defined as low if otherwise.

To simultaneously account for hospital- and patient-level variation in each of the 5 end points, generalized linear models with the use of generalized estimated equations were chosen to compare and make inferences about the differences between charges for weekend and weekday stroke admissions. In multivariate models such as the ones we used, it is possible to detect separate effects at the individual hospital level (eg, that certain hospitals provide expensive or inexpensive care across all patients treated) and at the level of specific procedures across different hospitals. The models accounted for data correlations by assuming exchangeability among admissions from the same hospital. Management (thrombolytic use, total hospital charges, or length of hospitalization) and outcomes (discharge disposition or in-hospital death) of patients with stroke admitted to the same hospital were likely to be correlated, and the correlation was assumed to be a constant within a hospital. Given a mixed scale of measurements for the 5 focused end points, generalized linear models used an integrated approach to facilitate comparison between weekday and weekend stroke admissions at the same time as adjusting for hospital- and patient-level characteristics.

For each stroke admission, 5 models (thrombolytic use, in-hospital mortality, discharge disposition, total hospital charges, and length of stay) were fitted. Bonferroni correction for multiple tests resulted in a probability value <0.01 (0.05/5) being considered statistically significant. In comparing total hospital charges across the 6 years from 2002 to 2007, we assumed a 3% annual inflation rate for each year and used the adjusted charges in the generalized estimated equation for generalized linear models to evaluate differences between procedures. To meet the distributional requirements of a generalized linear model, we used the logarithm of length of hospital stay and the logarithm of total inflation-adjusted charges as targeted outcomes in analyses. For patients who stayed in the hospital for <1 day, a 1-day stay was assumed.

Results

A search in the NIS database years 2002 to 2007 yielded a total of 599 087 emergency room admissions for ischemic stroke: 159 906 weekend admissions and 439 181 weekday admissions. The patient demographic and hospital characteristics of the weekend and weekday patients with ischemic stroke are shown in Table 1.

Descriptive statistics for the incidence of thrombolytic use, in-hospital mortality, discharge disposition, hospital charges, and length of hospital stay for weekend compared with weekday stroke admission are shown in Table 2. These demonstrate no crude difference between weekend and weekday stroke admissions for the end points studied; however, these comparisons are unadjusted for hospital-specific and patient-specific factors and may not be inferential given the potential substructures of weekend and weekday stroke populations, which can be introduced by hospital and patient characteristics.

To make valid inferences about the association between weekend versus weekday stroke admission and the targeted end points, we used generalized estimated equation for generalized linear models to account for both hospital- and patient-level variation (Table 3) and found that weekend compared with weekday stroke admission patients were slightly more likely to receive thrombolytics (OR=1.114; 95% CI=1.039 to 1.194; P=0.003); incur slightly higher total hospital charges (effect ratio=1.011; 95% CI=1.006 to 1.017; P<0.001); and have slightly longer lengths of stay (effect ratio=1.021; 95% CI=1.015 to 1.027; P<0.001). The mean hospital charge for weekend admissions was higher by 1.1% of the mean hospital charge for weekday admissions,

Table 1. Patient Demographics and Hospital Characteristics for 159 906 Weekend and 439 181 Weekday Patients With Ischemic Stroke

	Weekend (N=159 906)	Weekday (N=439 181)
Age, years (mean±SD)	72.9±13.5	72.8±13.6
Gender: female	87 257 (54.6%)	240 020 (54.7%)
Race: white	87 693 (74.2%)	243 241 (74.2%)
Season		
Fall	33 900 (24.0%)	91 587 (23.6%)
Spring	36 222 (25.6%)	101 096 (26.1%)
Summer	35 669 (25.2%)	97 237 (25.1%)
Winter	35 527 (25.2%)	97 705 (25.2%)
Median income level		
<$36 000	42 816 (27.4%)	116 572 (27.2%)
$36 000 to $44 999	41 376 (26.4%)	112 499 (26.2%)
≥$45 000	72 197 (46.2%)	200 328 (46.6%)
Payer		
Medicaid	8821 (5.5%)	24 926 (5.7%)
Medicare	117 926 (73.8%)	321 755 (73.3%)
No charge	557 (0.4%)	1580 (0.4%)
Private	27 192 (17.0%)	75 788 (17.3%)
Self-pay	5220 (3.3%)	14 614 (3.3%)
Hospital region		
Midwest	35 918 (22.4%)	97 332 (22.1%)
Northeast	31 150 (19.5%)	89 874 (20.5%)
South	64 561 (40.4%)	174 627 (39.8%)
West	28 277 (17.7%)	77 348 (17.6%)
Hospital location		
Rural	22 074 (13.8%)	58 276 (13.3%)
Urban nonteaching	78 054 (48.9%)	216 020 (49.2%)
Urban teaching	59 632 (37.3%)	164 497 (37.5%)
Bed size		
Large	102 277 (64.0%)	280 783 (64.0%)
Medium	39 795 (24.9%)	109 055 (24.8%)
Small	17 688 (11.1%)	48 955 (11.2%)
Hospital stroke volume		
High	109 887 (68.7%)	302 542 (68.9%)
Low	50 019 (31.3%)	136 639 (31.1%)
Tracheostomy	254 (0.2%)	574 (0.1%)
Gastrostomy	6908 (4.3%)	18 200 (4.1%)

whereas the mean length of stay for weekend admissions was higher by 2.1% of the mean length of stay for weekday admissions. There was no difference in in-hospital mortality or discharge disposition.

There is a concern that coding irregularities may occur in differentiating ischemic stroke from transient ischemic attack in the database. Therefore, to check the internal validity of the results found, a secondary analysis was performed adding hospitalizations with International Classification of Diseases, 9th Revision codes for transient cerebral ischemia: 435.0, 435.1, 435.2, 435.3, 435.8, and 435.9. This secondary analysis demonstrated the same effects and magnitude of effects as the primary analysis on thrombolytic use, total hospital charges, lengths of stay, in-hospital mortality, and discharge disposition (Table 4).

Table 2. Thrombolytic Use, In-Hospital Mortality, Discharge Disposition, Hospital Charges, and Length of Stay for Weekend Compared With Weekday Ischemic Stroke Admission

	Weekend (N=159 906)	Weekday (N=439 181)
Thrombolytic use	2537 (1.6%)	6454 (1.5%)
In-hospital mortality	10 154 (6.4%)	27 830 (6.4%)
Discharge disposition		
Home or short-term facility	72 977 (63.2%)	201 013 (63.7%)
Long-term facility	28 417 (24.6%)	77 066 (24.4%)
Dead	7 ,361 (6.4%)	20 092 (6.4%)
Hospital charges*	33 918±51 124	33 969±50 188
Length of stay†	6.2±7.3	6.2±7.2

*Expressed as mean±SD dollars.
†Expressed as mean±SD days.

Discussion

Stroke is the third leading cause of death and the leading cause of disability in the United States. There are 795 000 people who have a stroke in the United States each year; every 40 seconds someone has a stroke.[13] Outcomes from stroke treatment are thought to be time-dependent like myocardial infarction, in which "door-to-balloon" time is critical. Recent analysis has demonstrated that weekend admission for myocardial infarction is associated with higher mortality and that this is due to lower weekend access to cardiac invasive procedures.[14] This has been described as the "weekend effect."

A number of studies have been performed analyzing a weekend effect for stroke in other countries. A recent study of the Hospital Morbidity Database of Canada found in 26 676 patients admitted to 606 hospitals in Canada for ischemic stroke from April 2003 to March 2004 that weekend admissions (6609 [24.8%]) had significantly higher 7-day mortality

Table 3. The Effects of Weekend Ischemic Stroke Admission on Thrombolytic Use, In-Hospital Mortality, and Discharge Disposition After Accounting for Patient-Specific and Hospital-Specific Confounding Factors

	Effect Ratio	95% CI	*P*
Thrombolytic use*	1.114	1.039–1.194	0.003
In-hospital mortality*	1.000	0.972–1.029	0.993
Discharge disposition*			
Home or short-term facility	1.003	0.981–1.025	0.802
Long-term facility	1.003	0.981–1.025	0.802
Dead (reference)			
Hospital charges†	1.011	1.006–1.017	<0.001
Length of stay‡	1.021	1.015–1.027	<0.001

*OR: odds for weekend/odds for weekday.
†Mean charge (in dollars) for weekend/mean charge for weekday.
‡Mean length (in days) for weekend/mean length for weekday.

Table 4. The Effects of Weekend Ischemic Stroke and Transient Ischemic Attack Admission on Thrombolytic Use, In-Hospital Mortality, and Discharge Disposition After Accounting for Patient-Specific and Hospital-Specific Confounding Factors

	Effect Ratio	95% CI	*P*
Thrombolytic use*	1.109	1.037–1.186	0.003
In-hospital mortality*	1.000	0.970–1.026	0.876
Discharge disposition*			
Home or short-term facility	1.000	0.980–1.019	0.959
Long-term facility	1.000	0.980–1.019	0.959
Dead (reference)			
Hospital charges†	1.011	1.006–1.016	<0.001
Length of stay‡	1.029	1.024–1.035	<0.001

*OR: odds for weekend/odds for weekday.
†Mean charge (in dollars) for weekend/mean charge for weekday.
‡Mean length (in days) for weekend/mean length for weekday.

than their age-, gender-, comorbidity-, and major medical complication-adjusted weekday counterparts.[1]

Similarly, weekend versus weekday patients with stroke were studied in the Swedish Hospital Discharge Register for the time periods 1968 to 1979 (6048 weekend versus 23 323 weekday patients); 1980 to 1989 (15 278 versus 52 226); 1990 to 1999 (39 033 versus 122 924); and 2000 to 2005 (27 179 versus 81 390).[2] Age- and gender-adjusted weekend patients had significantly higher mortality and were significantly less likely to be discharged to their same place of residence.

In a prospective study of 1134 patients with stroke across 10 centers in Japan, weekday admission was an independent negative predictor of case fatality and a positive predictor of favorable outcome from acute stroke units; and for patients in rehabilitative therapy, weekday admission was associated with favorable outcome.[3] The authors attributed this to the fact that in most acute stroke units in Japan, staffing level is lower on weekends and holidays and provision of rehabilitative services occurs only on weekdays.

In a study of 34 347 patients with ischemic stroke admitted to 245 hospitals in Taiwan in the Taiwanese National Health Insurance Research Database in 2005, weekday patients with stroke had decreased 30-day mortality than their gender-, age-, comorbidity-, surgery-, physician age-, physician specialty-, hospital ownership-, accreditation level-, teaching status-, geographic location-, regional resources-, and competition-adjusted weekend counterparts.[4]

Data from the 2004 National Stroke Audit from 246 hospitals in England, Wales, and Northern Ireland demonstrated that patients with stroke admitted on weekends waited longer to be admitted into a stroke unit and were less likely to have a brain scan within 24 hours.[5] Data from the United Kingdom centers in the Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST) project were analyzed and demonstrated weekend patients with stroke were less likely to receive thrombolytics.[6]

A few studies have demonstrated no weekend effect of stroke. Four year-data of 37 396 patients with stroke (2003 to 2006), from a prospective, hospital-based stroke registry for the federal state Hesse, Germany, demonstrated that patients admitted during nonoffice hours (weekend or nighttime) did not have different outcome or mortality than patients admitted during office hours after adjustment for clinical state and admission latency.[7] Nonoffice hour patients, however, were more likely to receive thrombolytics. This is similar to the findings in the present study.

An analysis of 1578 patients with stroke in the Takashima Stroke Registry from 1988 to 2003 demonstrated that weekend day of admission, not the day of stroke onset, affected stroke fatality rates (although this did not reach statistical significance), suggesting that the "weekend effect" of stroke deaths is an artifact of referral bias.[15] Our study eliminated this artifact by only including emergency room admissions and excluding hospital transfers.

Most of the studies of the stroke weekend effect, however, were conducted in other countries where the healthcare delivery system is different than the United States. There have been relatively few studies conducted in the United States. One such study analyzed 187 669 acute ischemic stroke admissions to 857 hospitals participating in The Get With the Guidelines–Stroke Program from 2003 to 2007 and demonstrated that off-hour admissions (weekends and weeknights) were associated with slightly higher in-hospital mortality than office-hour admissions: 5.8% versus 5.2%, respectively ($P<0.001$). The small 0.6% absolute difference translated into 166 number needed to harm.[8]

A multiple linear regression analysis of 20 374 patients with stroke enrolled in the North Carolina Collaborative Stroke Registry from January 2005 to April 2008 to study predictors of delay time from hospital arrival until CT scan found that among other factors, weekend and evening time arrival were associated with delay in CT scan.[9]

A study of 78 657 patients with acute ischemic stroke in the Virginia Patient Data System from January 1, 1998, to June 30, 2006, demonstrated weekend patients were more likely to receive tissue plasminogen activator but had no difference in mortality than their weekday counterparts.[10] Prospective data on 2211 patients with stroke admitted to 2 comprehensive stroke centers were analyzed and showed that weekend patients had no difference in discharge disposition, discharge, or 90-day modified Rankin score or 90-day mortality than weekday patients.[11]

In this present study, we found no weekend effect on in-hospital mortality or discharge disposition, the same findings as the Albright study,[11] and similar to The Get With the Guidelines–Stroke study, which only found a slight difference.[8] We only included emergency room admissions for stroke to eliminate the artifact from patients transferred from other hospitals on days other than their day of admission that was found in the Takashima Stroke Registry study.[15] We chose to only study ischemic stroke, because there have been previous studies using the NIS database to analyze a weekend effect on intracerebral hemorrhage[16] and subarachnoid hemorrhage.[17]

Interestingly, in this present study, we found that weekend patients with stroke were slightly more likely to receive thrombolytics but there was no difference in in-hospital mortality, which is similar to the findings from the Virginia

Patient Data System.[10] There are several possible explanations for the increased likelihood for thrombolytic treatment on weekends. One possibility suggested by Kazley et al is that weekend patients with acute ischemic stroke present to hospitals earlier because they are unencumbered by work or traffic issues. This may translate to a higher proportion of these patients presenting within the 3-hour window for administration of intravenous tissue plasminogen activator.[10] Another possibility suggested by Kazley et al is that elective surgical procedures at hospitals on weekends are rare; therefore, weekend patients with stroke may have quicker access to diagnostic imaging and tests and possibly quicker evaluation and determination of treatment.[10] Still, another possibility is that physicians may be busy on weekdays with clinics and other clinical obligations, whereas on weekends, they may be more readily available to treat patients with acute ischemic stroke.[10] An alternative explanation is that weekend patients with stroke have more severe strokes and that physicians are more willing to use thrombolytics for patients with severe strokes. A recent study of patients with acute coronary syndrome found that weekend patients tended to have a higher rate of ST-elevation myocardial infarction.[18] Still, that thrombolytic use is greater on the weekend than the weekday might not intuitively make sense, and this finding may be affected by the study limitations of administrative data coding for severity of stroke and accurate reporting of thrombolytic use. Further studies such as prospective stroke registries or other large nationwide hospital data sets are needed to confirm this finding.

Although there was no weekend effect on in-hospital mortality and discharge disposition, there was a slight weekend effect on total hospital charges and length of hospitalization. One explanation is that although hospitals may be able to administer acute treatments such as thrombolytics or intensive care management on weekends, other services such as physical therapy, occupational therapy, nutritional services, speech/swallow therapy, and case management and discharge disposition services may be shorter staffed on weekends, contributing to longer hospitalizations and thus higher total charges. Another explanation is that weekend patients were more likely to receive thrombolytics, adding to hospital charges and potentially to length of hospitalization.

There are several limitations to the present study. The first limitation is the retrospective nature of the study, which has significant potential for selection bias. However, by nature, a study of the weekend effect cannot be a prospective randomized controlled trial; one cannot randomize a patient to weekend versus weekday. The second limitation is the risks inherent to coding error. In a large database such as the NIS, there is significant potential for coding error or variability in coding. We attempted to address one possible coding artifact by performing a secondary analysis adding the International Classification of Diseases, 9th Revision codes for transient ischemic attack to check for internal validity with coding irregularities that may occur in differentiating ischemic stroke from transient ischemic attack and found the statistical inference results to be the same. Another possibility for coding error is potential underreporting of recombinant tissue plasminogen activator use as was reported by Kleindorfer et al in an analysis of the Medicare Provider and Analysis Review data set and The Premier Hospital data set.[19] This group estimated that the true rate of recombinant tissue plasminogen activator use in the United States is 1.8% to 2.1%, which is slightly higher than the 1.5% to 1.6% we found in our analysis. Nevertheless, if recombinant tissue plasminogen activator use is underreported, it should be equally underreported for weekday versus weekend admission patients with stroke and therefore should not affect our analysis of differences between weekday versus weekend stroke admission. The third limitation is that the NIS does not contain data on the neurological condition of patients; therefore, the analysis could not be adjusted for severity of stroke, a source for significant bias. A fourth limitation is that the NIS contains data on day of the week admission, which allows for an analysis of weekday versus weekend admission but does not allow an analysis of statutory holidays. Statutory holidays only account for 10 days of a 365-day year (2.7%), so the effect of this artifact is likely to be small.

The findings of this present study will hopefully lead to further analysis of the differences in diagnostic evaluation, imaging, and treatment provided on weekends compared with weekdays for patients with ischemic stroke. A careful analysis may reveal that stroke treatment across healthcare centers will need to more closely follow current stroke guidelines whether during the week or weekend, leading to overall improvement in stroke care and outcomes.

Summary

In the NIS database, 2002 to 2007, weekend patients with stroke were slightly more likely to receive thrombolytics, had slightly higher total hospital charges, and slightly longer length of hospitalization but no difference in in-hospital mortality or discharge disposition than weekday patients.

Disclosures

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Off-Hour Admission and In-Hospital Stroke Case Fatality in the Get With The Guidelines-Stroke Program

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Off-Hour Admission and In-Hospital Stroke Case Fatality in the Get With The Guidelines-Stroke Program

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Background and Purpose—Previous reports have shown higher in-hospital mortality for patients with acute stroke who arrived on weekends compared with regular workdays. We analyzed the effect of presenting during off-hours, defined as weekends and weeknights (versus weekdays), on in-hospital mortality and on quality of care in the Get With The Guidelines (GWTG)-Stroke program.

Methods—We analyzed data from 187 669 acute ischemic stroke and 34 845 acute hemorrhagic stroke admissions who presented to the emergency departments of 857 hospitals that participated in the GWTG-Stroke program during the 4-year period 2003 to 2007. Off-hour presentation was defined as presentation anytime outside of 7:00 AM to 6:00 PM on weekdays. Quality of care was measured using standard GWTG quality indicators covering acute, subacute, and discharge measures. The relationship between off-hour presentation and in-hospital case fatality was examined using generalized estimating equation logistic regression adjusting for demographics, risk factors, arrival mode, and hospital characteristics.

Results—Half of ischemic stroke admissions and 57% of hemorrhagic stroke admissions presented during off-hours. Among ischemic stroke admissions, the in-hospital case fatality rate was 5.8% for off-hour presentation compared with 5.2% for on-hour presentation ($P<0.001$). For hemorrhagic stroke admissions, in-hospital case fatality was 27.2% for off-hour presentation compared with 24.1% for on-hour presentation ($P<0.001$). After adjusting for patient-level and hospital-level factors, presentation during off-hours was significantly associated with higher in-hospital mortality for both ischemic stroke (adjusted OR, 1.09; 95% CI, 1.03 to 1.14) and hemorrhagic stroke admissions (adjusted OR, 1.19; 95% CI, 1.12 to 1.27). No differences were observed between off-hour presentation and any of the quality of care measures.

Conclusions—Off-hour presentation was associated with an increased risk of dying in-hospital, although the absolute effect was small for ischemic stroke admissions (0.6% difference; number needed to harm=166) and moderate for hemorrhagic stroke (3.1% difference; number needed to harm=32). Reducing the disparity in hospital-based outcomes for admissions that present during off-hours represents a potential target for quality improvement efforts, although evidence of differences in the quality of care by time of presentation was lacking. (***Stroke*. 2009;40:569-576.**)

Key Words: acute stroke ■ outcomes ■ quality improvement ■ quality of health care

Whether there are adverse consequences for patients who present to the hospital outside of regular working hours, most notably weekends, has been the focus of several large studies over recent years. Studies of acute hospital admissions in Ontario demonstrated an increased mortality risk for weekend arrival in 23 of 100 conditions[1] as well as delays in the timing of some critical procedures.[2] However, a large study from California found limited evidence of a "weekend effect" with only 3 of 50 conditions evaluated having a significantly higher mortality with weekend admission.[3] Two studies of acute myocardial infarction found an elevated mortality risk for weekend admissions,[4,5] and in both reports, the magnitude of the weekend effect was attenuated after the use and/or delayed timing of specific cardiac procedures were accounted for.

Evidence for a "weekend effect" among acute stroke admissions has also been inconsistent. Studies from Ontario and California found no evidence of a weekend effect on in-hospital mortality for any stroke subtype,[1,3] whereas a large Canadian study did find an elevated mortality risk among ischemic stroke admissions.[6] Also, a Japanese study based on cases admitted to stroke units found that weekend admission was associated with both a higher risk of in-hospital mortality and poorer functional outcomes at discharge.[7] However, in both the Canadian and Japanese studies, the absolute increase in mortality associated with weekend

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admission was small; the 7-day mortality was increased by 1.1% in the Canadian study and approximately 0.5% in the Japanese study. Using data generated from hospitals that participated in the Get With The Guidelines (GWTG)-Stroke program, a voluntary national quality improvement program, our objectives were to first examine the effect of presentation outside of regular working (termed off-hour presentation) on in-hospital mortality among acute stroke admissions and second, to compare the quality of care (QOC) provided to subjects who presented during either off- or on-hours.

Methods

The GWTG-Stroke quality improvement program has been in development since 2000.[8] An initial pilot quality improvement intervention that involved specific regions within 8 states (Massachusetts, Michigan, Ohio, Florida, Arizona, California, Pennsylvania, Georgia) was first conducted between April 2003 and March 2004. All hospitals within these regions were invited to participate. Starting in April 2004, the program was expanded and made available to any hospital in the United States. Individual hospitals could have joined the program at any time between April 2003 and April 2007 (when this particular data set was closed). The duration of hospital participation, defined as the number of consecutive quarters of participation after a hospital submitted data on a baseline set of 30 cases, therefore varied between hospitals. Each participating institution received human research approval to enroll subjects in GWTG-Stroke without requiring individual patient consent or a waiver of authorization and exemption from Institutional Review Board review based on the use of deidentified records and absence of direct patient contact.

Case Identification and Data Abstraction

Trained hospital personnel were instructed to ascertain consecutive acute ischemic stroke (IS) and hemorrhagic stroke (HS) admissions. Case ascertainment was conducted by prospective clinical identification, retrospective identification using International Classification of Diseases-9 discharge codes, or a combination of the 2 approaches. Exact methods used for prospective identification varied according to the size and organization of the hospital but would have included a combination of regular surveillance of presenting symptoms and chief complaints in the emergency department and review of ward census logs and/or neurological consultations.[9] Retrospective identification of IS admissions involved use of International Classification of Diseases-9 codes 433, 434, or 436, whereas HS admissions were identified using International Classification of Diseases-9 codes 430 and 431. The eligibility of each acute stroke admission was confirmed at chart review before abstraction.

Data were abstracted by hospital personnel using an Internet-based Patient Management Tool (Outcome Inc, Cambridge, Mass). All users received either online or telephone-based training in the use of the tool. Abstracted data included patient demographics, medical history, initial head CT findings, in-hospital treatment and events, discharge treatment and counseling, and discharge destination. The data collection tool supports both concurrent data collection as well as retrospective data entry and includes predefined logic features, range checks, and user alerts to identify potentially invalid values. Patient confidentiality was maintained on this web-based system by the use of passwords, deidentified data sets, and secure data transmission techniques.

Data on hospital-level characteristics, ie, bed size, academic or nonacademic status (as defined by the American Hospital Association),[10] annual volume of stroke discharges, and geographical region, were collected at the time of initial hospital enrollment.

Sample Population

We obtained data on 365 186 stroke admissions who presented to 857 hospitals that participated in the program during the 4-year period between April 2003 and April 2007. We excluded subjects that were not acute admissions (n=56 641), that did not arrive through the emergency department (n=883), or that had unreliable or missing data for any of the following variables: date of arrival (n=3485), time of arrival (n=52 774), length of stay (n=1086), or vital status at discharge (n=6701). The combined effect of these deletions was a final data set of 300 961 acute stroke admissions (82% of the original total), of which 62% were IS, 12% were HS, 23% were transient ischemic attack, and 3% were stroke of uncertain type. After excluding the last 2 groups, the final data set included 187 699 and 34 845 IS and HS admissions, respectively.

Exposure and Quality of Care Definitions

On-hour presentation was defined as presenting to the hospital emergency department between 7:00 AM to 6:00 PM on any weekday. Off-hour presentation was defined as presenting any other time, including evenings, nights, and weekends and during national holidays. The following 8 performance measures[8] and one safety measure were used to quantify the quality of care (QOC) provided to the IS admissions.

Acute and Subacute Measures

- Intravenous tissue plasminogen activator in patients who arrive <2 hours after symptom onset;
- Antithrombotic medication within 48 hours of admission (early antithrombotics);
- Deep vein thrombosis prophylaxis within 48 hours of admission; and
- Screening for dysphagia before oral intake.

Discharge Measures

- Antithrombotic medication;
- Anticoagulation for atrial fibrillation;
- Treatment for low-density lipoprotein >100 mg/dL; and
- Counseling or medication for smoking cessation.

Safety Measure

- Symptomatic intracranial hemorrhage within 36 hours after intravenous tissue plasminogen activator.

For HS admissions, QOC was quantified using the following 3 performance measures: deep vein thrombosis prophylaxis, screening for dysphagia, and discharge smoking cessation.

Statistical Analysis

All statistical analyses were performed using SAS Version 9.1 software (SAS Institute, Cary, NC). Contingency tables were generated to explore the relationship between important covariates, including demographics, clinical variables, medical history, and hospital-level characteristics, and time of presentation, ie, off-hour versus on-hour presentation. Similarly, contingency tables were generated to explore the relationship between QOC measures and in-hospital complications and off-hour versus on-hour presentation. χ^2 test for nominal data and Wilcoxon rank sum tests for ordinal and continuous data were used as tests for statistical associations. It should be noted that given the large sample size that even small absolute differences (ie, <1%) reach statistical significance (ie, $P<0.05$).

The relationship between off-hour presentation and in-hospital mortality was examined using multivariable logistic regression models.[11] To account for possible within-hospital clustering, generalized estimating equation methods were used to generate both unadjusted and adjusted models.[12] Given the large size of the data set, traditional statistical approaches to model-building that identify candidate confounders on the basis of statistical significance were not used. Instead, the final models were adjusted for several prespecified patient-level and hospital-level variables that were regarded as potential confounders. These included age, race, gender, body mass index, arrival mode, and medical history and risk factors (including atrial fibrillation, previous stroke/transient ischemic attack, coronary heart disease or prior myocardial infarction, carotid stenosis, diabetes, peripheral vascular disease, hypertension, dyslipidemia, and current smoking), and length of stay. Hospital-level characteristics included bed size, academic hospital, and region.

We undertook 2 analyses to explore interaction effects on the relationship between off-hour presentation and mortality. First, under the hypothesis that the duration of participation in GWTG program might reduce the disparity related to off-hours presentation, we tested the significance of the interaction between off-hours presentation and the duration of hospital participation. Second, under the hypothesis that larger teaching hospitals may have more staffing during off-hours, which could reduce the effect of off-hours presentation on mortality, we tested interaction effects between off-hours presentation and hospital size and teaching status. These analyses was done separately for both IS and HS admissions.

Results

Ischemic Stroke

Of 187 669 IS admissions, half (n=94 008) arrived during off-hours. Table 1 compares the characteristics of IS admissions who presented during off-hours with those who presented during on-hours. The off-hour presentation group was slightly younger than the on-hour group (median age, 74 versus 75 years) and were more likely to arrive by emergency medical services from the scene (56.2% versus 53.6%) or to be transferred by emergency medical services from another hospital (6.2% versus 4.0%). However, despite the presence of several statistically significant ($P<0.05$) associations, there were no other clinically important differences between the 2 groups in terms of gender, race, medical history, risk factors, or hospital characteristics (Table 1).

Clinically important differences in the quality of care provided to patients who presented during off- or on-hours were small to nonexistent (Table 2) The proportion of patients who arrived within 2 hours who were treated with intravenous tissue plasminogen activator was slightly lower during off-hours (56.4% versus 58.8%), but deep vein thrombosis prophylaxis rates were slightly higher in the off-hour group (67.4% versus 65.6%). In terms of in-hospital complications, the proportion of patients treated for pneumonia was slightly higher in the off-hour group (6.1% versus 5.5%).

A total of 10 326 IS admissions died in-hospital resulting in an overall case fatality rate of 5.5%. The in-hospital case fatality rate was higher for admissions that arrived in the off-hours (5494 of 94 008 [5.8%]) compared with those that arrived during regular work hours (4832 of 93 661 [5.2%]). The absolute difference in mortality (0.6%) translates into number needed to harm of 166 for off-hour presentation. As expected, subjects who died during hospitalization were older than those that survived (median age, 80 versus 74 years) and were more likely to be female (57.6% versus 53.0%), white (78.1% versus 74.1%), to have a medical history of atrial fibrillation (34.1% versus 16.9%) or heart disease (34.8% versus 26.6%), to have been transported by emergency medical services (88.5% versus 58.3%), and to require treatment for pneumonia during hospitalization (18.7% versus 5.1%). Subjects who died in-hospital were less likely to be current smokers (10.9% versus 17.5%) or to have a history of dyslipidemia (26.0% versus 34.1%). The in-hospital mortality rate was higher in larger, academic hospitals (5.7% academic versus 5.1% nonacademic).

The median length of stay was 4 days (interquartile range, 3 to 7) for both off-hour and on-hour presentations. Among the 177 343 IS subjects discharged alive from the hospital, 48.3% were discharged home, 22.9% to a nursing home, 21.5% to rehabilitation, 3.4% were transferred to another acute care facility, and 3.4% were discharge to hospice. Slightly fewer admissions who arrived during off-hours were discharged home (47.0%) compared with those who presented during on-hours (49.5%; $P<0.001$).

Hemorrhagic Stroke

Of 34 845 HS admissions, 79.5% (n=27 710) had intracerebral hemorrhage and the remainder subarachnoid hemorrhage. Just over half of the HS admissions (56.7% [n=19 767]) arrived during off-hours. Table 3 compares the demographic and clinical characteristics of HS admissions who presented during off- and on-hours. Subjects who presented during off-hours were a little younger than the on-hour group (median age, 69 versus 71 years) and were more likely to arrive by emergency medical services hospital transfer (22.1% versus 16.2%). Whites were slightly more likely to present during on-hours and blacks were slightly more likely to present during off-hours, but no other clinically important differences were noted between off- and on-hour presentations among the HS admissions (Table 3).

Similar to IS admissions, clinically important differences in the QOC provided to patients with HS who presented during off- or on-hours were small to nonexistent (Table 4). Among the quality indicators relevant to HS care, the proportion of patients who received dysphagia screening was slightly lower in the off-hour group (40.2% versus 41.2%). The proportion of patients treated for pneumonia was slightly higher in the off-hour group (10.0% versus 8.9%).

The case fatality rate for all HS cases was 25.9%, whereas the rates for intracerebral hemorrhage and subarachnoid hemorrhage were 26.6% and 22.9%, respectively. The in-hospital case fatality rate was higher for admissions that arrived in the off-hours (5368 of 19 767 [27.2%]) compared with those that arrived during regular work hours (3640 of 15 078 [24.1%]). The 3.1% absolute difference in mortality translates into a number needed to harm of 32 for off-hour presentation. As expected, subjects who died during hospitalization were older than those that survived (median age, 74 versus 69 years), and they were also more likely to arrive by emergency medical services (72.9% versus 51.6%) and to have a medical history of atrial fibrillation (16.9% versus 12.2%) or heart disease (22.0% versus 18.1%). Similar to IS cases, they were less likely to smoke or report a history of dyslipidemia.

The median length of stay was 5 days (interquartile range, 2 to 11) for both off-hour and on-hour presentations. Among the 25 837 HS subjects discharged alive from the hospital, 35.8% were discharged home, 24.2% to a nursing home, 24.3% to rehabilitation, 8.6% were transferred to another acute care facility, and 6.6% were discharge to hospice. Similar to the IS cases, slightly fewer admissions who arrived during off-hours were discharged home (34.9%) compared with on-hour admissions (36.9%; $P<0.001$).

Multivariable Analysis of the Effect of Off-Hour Presentation on In-Hospital Mortality

The crude and adjusted OR estimates with 95% CIs for off-hour presentation compared with on-hour presentation