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

Mathew J. Reeves, Eric Smith, Gregg Fonarow, Adrian Hernandez, Wenqin Pan and Lee H. Schwamm

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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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on behalf of the GWTG-Stroke Steering Committee & Investigators

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

Table 1. Association Between Demographics and Clinical Characteristics and Off-Hour versus On-Hour Presentation for IS Admissions

Variable	Level	Total N	(%)	Off-Hour N	(%)	On-Hour N	(%)	*P* Value*
Total		187 669	(100)	94 008	(50.1)	93 661	(49.9)	
Demographics								
Age	Median	187 669	(74.0)	94 008	(74.0)	93 661	(75.0)	<0.0001
	Mean		(71.5)		(71.2)		(71.8)	
Gender†	Male	87 506	(46.6)	44 105	(46.9)	43 401	(46.3)	0.0122
	White	139 549	(74.3)	69 341	(73.8)	70 208	(75.0)	<0.0001
Race†	Black	28 189	(15.0)	14 471	(15.4)	13 718	(14.7)	
	Hispanic	7155	(3.8)	3584	(3.8)	3571	(3.8)	
	Other	12 484	(6.6)	6474	(6.8)	6010	(6.4)	
Arrival mode	EMS from scene	103 080	(54.9)	52 868	(56.2)	50 212	(53.6)	<0.0001
	EMS hospital transfer	9531	(5.0)	5787	(6.2)	3744	(4.0)	
	Other	67 996	(36.2)	31 846	(33.9)	36 150	(38.6)	
	Not documented	3760	(3.7)	1832	(3.7)	1928	(3.8)	
Medical history								
Atrial fibrillation†	Yes	33 449	(17.8)	17 136	(18.2)	16 313	(17.4)	<0.0001
Previous stroke/transient ischemic attack†	Yes	58 106	(31.0)	28 728	(30.6)	29 378	(31.4)	0.0002
Coronary artery disease/prior myocardial infarction†	Yes	50 810	(27.0)	25 732	(27.4)	25 078	(26.8)	0.0036
Carotid stenosis†	Yes	8640	(4.6)	4261	(4.5)	4379	(4.7)	0.1399
Diabetes mellitus†	Yes	55 372	(29.5)	27 883	(29.7)	27 489	(29.4)	0.1400
PVD†	Yes	9414	(5.0)	4651	(5.0)	4763	(5.1)	0.1711
Hypertension†	Yes	137 854	(73.5)	69 057	(73.5)	68 797	(73.5)	0.9803
Dyslipidemia†	Yes	63 083	(33.6)	31 349	(33.4)	31 734	(33.9)	0.0142
Current smoker†	Yes	32 071	(17.1)	16 175	(17.2)	15 896	(17.0)	0.1780
Hospital characteristics								
No. of beds	Median	168 929	(401.0)	84 641	(403.0)	84 288	(400.0)	<0.0001
	Mean		(448.0)		(450.5)		(445.5)	
Hospital type	Missing	18 896	(10.1)	9432	(10.0)	9464	(10.1)	<0.0001
	Academic	82 867	(44.1)	42 111	(44.8)	40 756	(43.5)	
	Nonacademic	85 906	(45.8)	42 465	(45.2)	43 441	(46.4)	
No. of stroke discharges	Missing	28 601	(15.2)	14 328	(15.2)	14 273	(15.2)	0.0189
	0–100	15 051	(8.0)	7406	(7.9)	7645	(8.2)	
	101–300	69 126	(36.8)	34 534	(36.7)	34 592	(36.9)	
	301+	74 891	(39.9)	37 740	(40.2)	37 151	(39.7)	
Region†	Northeast	49 984	(26.6)	24 820	(26.4)	25 164	(26.9)	0.0256
	Midwest	38 307	(20.4)	19 096	(20.3)	19 211	(20.5)	
	South	65 282	(34.8)	32 946	(35.1)	32 336	(34.5)	
	West	33 880	(18.0)	17 060	(18.2)	16 820	(18.0)	

**P* values are based on Pearson χ^2 tests for categorical row variables or χ^2 rank-based group means score statistics for continuous/ordinal variables.
†Missing observations were <2% of the total.
EMS indicates emergency medical services; PVD, peripheral vascular disease.

are shown in the Figure for both IS and HS admissions. In unadjusted analyses, presentation during off-hours increased the odds of in-hospital mortality by 13% (OR, 1.13; 95% CI, 1.09 to 1.18) and 17% (OR, 1.17; 95% CI, 1.11 to 1.23) for IS and HS, respectively. These results changed little after adjustment for a wide range of patient-level and hospital-level characteristics; off-hours presentation was associated with a 9% elevated odds of in-hospital mortality among IS admissions (OR, 1.09; 95% CI, 1.03 to 1.14) and an 19% elevated odds for HS admissions (OR, 1.19; 95% CI, 1.12 to 1.27). Full multivariable model results for both IS and HS admissions can be found in Supplemental Tables I and II, available online at http://stroke.ahajournals.org.

Table 2. Association Between QOC Indicators and Complications and Off-Hour versus On-Hour Presentation for IS Admissions

Variable	Level	Total N	(%)	Off-Hour N	(%)	On-Hour N	(%)	*P* Value*
Total		187 669	(100)	94 008	(50.1)	93 661	(49.9)	
Quality indicators								
Intravenous tPA <2 hours arrival‡	Yes	7598	(57.5)	4078	(56.4)	3520	(58.8)	0.0062
Early antithrombotics§	Yes	148 519	(94.8)	73 793	(94.7)	74 726	(94.9)	0.1638
Screening for dysphagia†‖	Yes	104 262	(55.6)	52 415	(55.8)	51 847	(55.4)	<0.0001
DVT prophylaxis¶	Yes	124 811	(66.5)	63 381	(67.4)	61 430	(65.6)	<0.0001
D/C antithrombotics**	Yes	155 465	(7.6)	77 264	(97.5)	78 201	(97.7)	0.0666
D/C anticoagulation for atrial fibrillation††	Yes	17 616	(97.0)	9064	(97.0)	8552	(97.0)	0.9642
D/C cholesterol-reducing treatment‡‡	Yes	80 048	(79.6)	39 919	(79.6)	40 129	(79.6)	0.8330
D/C smoking cessation§§	Yes	22 106	(77.7)	11 088	(77.6)	11 018	(77.8)	0.7319
Symptomatic ICH <36 hours after IV tPA (safety measure)‖‖	Yes	526	(5.1)	299	(5.4)	227	(4.8)	0.1742
Complications								
Treatment for pneumonia	Yes	10 887	(5.8)	5707	(6.1)	5180	(5.5)	<0.0001

**P* values are based on Pearson χ^2 tests for categorical row variables or χ^2 rank-based group means score statistics for continuous/ordinal variables.
†Missing observations were <2% of the total.
‡Patients presenting within 2 hours of symptom onset who receive IV recombinant tPA within 3 hours of symptom onset.
§Antithrombotic therapy prescribed within 48 hours of hospitalization, includes antiplatelet or anticoagulant therapy.
‖Patients who are screened for dysphagia before any oral intake.
¶Patients who are at risk of DVT (nonambulatory) who receive DVT prophylaxis within 48 hours of hospitalization, includes warfarin, heparin, other anticoagulants, or pneumatic pressure devices.
**Antithrombotic therapy prescribed at discharge.
††Anticoagulation therapy prescribed at discharge for patients with atrial fibrillation documented during hospitalization, including therapeutic doses of warfarin, heparin, or other anticoagulants.
‡‡Lipid-lowering agent prescribed at discharge if low-density lipoprotein >100 or if patient on lipid-lowering agent at admission.
§§Smoking cessation intervention (medication and/or counseling) provided at discharge.
‖‖Symptomatic intracranial hemorrhage within 36 hours of intravenous recombinant tPA administration.
IV tPA indicates intravenous tissue plasminogen activator; DVT, deep vein thrombosis; ICH, intracerebral hemorrhage; D/C, discharge.

Interaction effects between off-hour presentation and hospital size or academic status were not significant. However, among IS admissions, a statistically significant interaction was observed between the duration of participation in the GWTG-Stroke program and the effect of off-hour presentation on in-hospital mortality (P=0.002). The ORs for in-hospital mortality in the off-hour group declined with increased duration of participation; the OR for off-hour presentation (versus on-hour presentation) was 1.18 (95% CI, 1.09 to 1.27) for the first quarter of participation and declined to the null by the end of the second year (OR, 1.02; 95% CI, 0.95 to 1.09). The interaction remained statistically significant after controlling for calendar time, which was not associated with either in-hospital mortality or off-hour presentation. There was no statistically significant interaction between off-hours presentation and duration of program participation among HS admissions (P=0.93).

Discussion

In this study of over 220 000 acute stroke admissions, in-hospital mortality was higher for those that presented outside of regular working hours. Although the absolute effect of off-hours presentation on in-hospital mortality among IS admissions was small (ie, 0.6%), on a relative basis, the odds of mortality was almost 10% higher, even after adjusting for differences in patient and hospital characteristics. Among HS admissions, the off-hours effect was even stronger with both a higher absolute difference (ie, 3.1%) and relative difference (ie, adjusted OR, 1.18). The number needed to harm estimates indicate that for every 166 IS admissions and 32 HS admissions that present during off-hours, one extra death would be expected to occur. Although these absolute effects appear modest, the overall impact of presenting during off-hours is more considerable when one takes into account that more than half of all patients with stroke present during these hours. A metric for expressing the clinical impact of the off-hours effect is the population-attributable risk fraction, which expresses the proportion of in-hospital mortality that is attributable to presenting during off-hours. For IS admissions, the population-attributable risk fraction was estimated to be 4.2%, whereas for HS, it was 6.9%; thus, approximately one in 20 in-hospital stroke deaths could be avoided if the higher mortality associated with off-hour presentation was eliminated.

The most directly comparable studies that have examined the effect of presentation during nonregular work hours on acute stroke outcomes include 2 studies from Canada[1,6] and one from California.[3] The first Canadian study examined data from almost 4 million acute emergency department admissions in Ontario between 1988 and 1997.[1] The study found no evidence of a "weekend effect" on in-hospital mortality for

Table 3. Association Between Demographics and Clinical Characteristics and Off-Hours versus On-Hours Presentation for HS Admissions

Variable	Level	Total N	(%)	Off-Hour N	(%)	On-Hour N	(%)	*P* Value*
Total		34 845		19 767	(56.7)	15 078	(43.3)	
Demographics								
Age	Median	34 845	(70.0)	19 767	(69.0)	15 078	(71.0)	<0.0001
	Mean		(67.5)		(66.9)		(68.5)	
Gender†	Male	16 652	(47.8)	9444	(47.8)	7208	(47.8)	0.9618
Race†	White	24 278	(69.7)	13 556	(68.6)	10 722	(71.1)	<0.0001
	Black	5108	(14.7)	3026	(15.3)	2082	(13.8)	
	Hispanic	1910	(5.5)	1130	(5.7)	780	(5.2)	
	Other	3523	(10.2)	2039	(10.3)	1484	(9.9)	
Arrival mode	EMS from scene	19 887	(57.1)	11 247	(56.9)	8640	(57.3)	<0.0001
	EMS hospital transfer	6804	(19.5)	4368	(22.1)	2436	(16.1)	
	Other	7049	(20.2)	3542	(17.9)	3507	(23.3)	
	Not documented	1105	(3.2)	610	(3.1)	495	(3.3)	
Medical history								
Atrial fibrillation†	Yes	4670	(13.4)	2540	(12.9)	2130	(14.1)	0.0004
Previous stroke/transient ischemic attack†	Yes	7572	(21.7)	4224	(21.4)	3348	(22.2)	0.0524
Coronary artery disease/prior myocardial infarction†	Yes	6661	(19.1)	3710	(18.8)	2951	(19.6)	0.0513
Carotid stenosis†	Yes	555	(1.6)	313	(1.6)	242	(1.6)	0.8612
Diabetes mellitus†	Yes	7231	(20.8)	4109	(20.8)	3122	(20.7)	0.9025
PVD†	Yes	1031	(3.0)	563	(2.9)	468	(3.1)	0.1564
Hypertension†	Yes	23 412	(67.2)	13 208	(66.8)	10 204	(67.7)	0.0618
Dyslipidemia†	Yes	7697	(22.1)	4278	(21.6)	3419	(22.7)	0.0178
Current smoker†	Yes	5407	(15.5)	3128	(15.8)	2279	(15.1)	0.0784
Hospital characteristics								
No. of beds†	Median	31 257	(450.0)	17 730	(454.0)	13 527	(440.0)	<0.0001
	Mean		(486.6)		(493.4)		(477.8)	
Hospital type	Missing	3577	(10.3)	2028	(10.3)	1549	(10.3)	<0.0001
	Academic	16 648	(47.8)	9640	(48.8)	7008	(46.5)	
	Nonacademic	14 620	(42.0)	8099	(41.0)	6521	(43.3)	
No. of stroke discharges	Missing	5452	(15.7)	3082	(15.6)	2370	(15.7)	<0.0001
	0–100	2361	(6.8)	1264	(6.4)	1097	(7.3)	
	101–300	11 896	(34.1)	6672	(33.8)	5224	(34.7)	
	301+	15 136	(43.4)	8749	(44.3)	6387	(42.4)	
Region	Northeast	8513	(24.4)	4739	(24.0)	3774	(25.0)	0.1219
	Midwest	6273	(18.0)	3604	(18.2)	2669	(17.7)	
	South	12 789	(36.7)	7296	(36.9)	5493	(36.4)	
	West	7243	(20.8)	4115	(20.8)	3128	(20.8)	

*P values are based on Pearson χ^2 tests for categorical row variables or χ^2 rank based group means score statistics for continuous/ordinal variables.
†Missing observations were <2% of the total.
EMS indicates emergency medical services; PVD, peripheral vascular disease.

intracerebral hemorrhage (OR, 1.01) or IS (OR, 1.00), although it did identify a statistically significant elevated risk among cases of unspecified intracranial hemorrhage (OR, 1.23) and a trend toward an increased risk among subarachnoid hemorrhage (OR, 1.10). The second Canadian study used national-level data from over 26 000 IS cases discharged from 606 hospitals during a 1-year period (2003 to 2004).[6] Weekend presentation was associated with a 8% higher adjusted odds of in-hospital mortality, an estimate similar to that seen in our study. The California study used data from over 24 000 IS cases admitted during a 1-year period (1998) to all acute care hospitals in the state. In contrast to our

Table 4. Association Between QOC Indicators and Complications and Off-Hour versus On-Hour Presentation for HS Admissions

Variable	Level	Total N	(%)	Off-Hour N	(%)	On-Hour N	(%)	*P* Value*
Total		34 845	(100)	19 767	(50.1)	15 078	(49.9)	
Quality indicators								
Screening for dysphagia†	Yes	14 154	(40.6)	7939	(40.2)	6215	(41.2)	0.0002
DVT prophylaxis	Yes	21 837	(62.7)	12 522	(63.4)	9315	(61.8)	<0.0001
D/C smoking cessation	Yes	2422	(67.5)	1367	(67.3)	1055	(67.7)	0.8335
Complications								
Treatment for pneumonia	Yes	3323	(9.5)	1981	(10.0)	1342	(8.9)	0.0008

**P* values are based on Pearson χ^2 tests for categorical row variables or χ^2 rank based group means score statistics for continuous/ordinal variables.
†Missing observations were <2% of the total. See Table 2 for definitions of quality indicators.
DVT indicates deep vein thrombosis; D/C, discharge.

findings, they found no effect of weekend admission among cerebral infarction cases admitted through the emergency room (OR, 0.99).

The reasons why an effect of weekend presentation on in-hospital mortality is observed in some stroke studies but not others is unclear. All of these studies have used large representative samples and have adjusted for similar factors such as demographic factors and the presence of comorbidities. One explanation for the presence of a "weekend effect" is that acute stroke admissions are systematically different from those that present during the week. It is known that there is circadian variation in the timing of stroke onset with more stroke cases occurring in the morning hours between 6 AM and noon[13] and on Mondays.[14,15] It has also been hypothesized that weekend admissions may differ in terms of stroke subtype or severity[16] as has been observed in acute myocardial infarction.[17] However, solid evidence for differences in stroke subtype or severity by day of admission is lacking. Only one study that evaluated weekend effects on stroke outcomes was able to adjust for stroke severity, and an effect of weekend admission was still observed.[7]

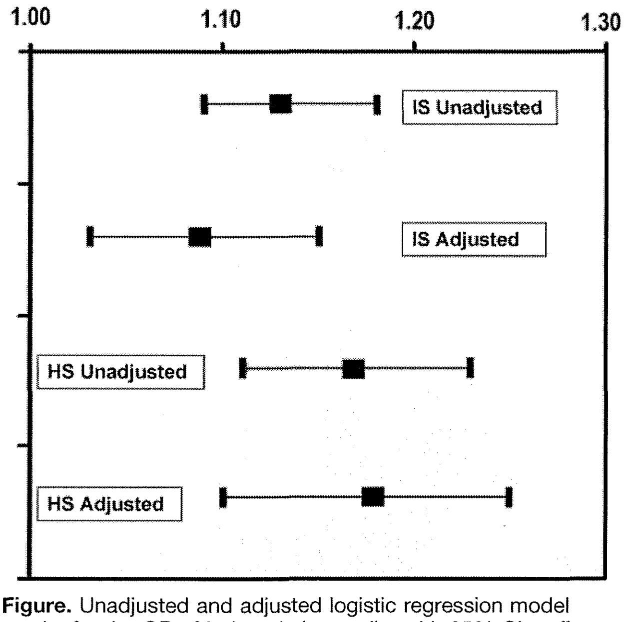

Figure. Unadjusted and adjusted logistic regression model results for the OR of in-hospital mortality with 95% CIs: off-hours presentation versus on-hours presentation for IS and HS. Error bars indicate 95% CIs for each OR. Multivariable models were generated by general estimating equations and were adjusted for age, gender, race, body mass index, arrival mode, medical history (atrial fibrillation, heart value, previous stroke/transient ischemic attack, coronary heart disease or prior myocardial infarction, carotid stenosis, diabetes, hypertension, peripheral vascular disease, current smoking, and dyslipidemia), length of stay, and hospital characteristics (bed size, academic hospital, region). (The full model results for both IS and HS cases can be found online).

Although the potential for the "weekend effect" to be accounted for by confounding or other biases inherent to observational data cannot be completely discounted, many observers believe these effects to be real[6,18] and that they reflect differences in the QOC provided to patients outside of regular work hours. The belief that differences in the QOC affect in-hospital mortality is bolstered by the observation that mortality is higher in for-profit hospitals compared with not-for-profit hospitals[19] and in for-profit hemodialysis centers compared with not-for-profit centers.[20] These findings have been shown to be related to the reduced availability of highly skilled personnel per risk-adjusted bed, a factor that is strongly associated with hospital mortality.[21,22] Given the reduction in staffing that occurs during off-hours, there is clearly the potential for substandard care. Reduced access to specialists on weekends results in a concomitant reduction in access to urgent procedures.[2] The fact that the negative effect of weekend admission on in-hospital mortality of patients with acute myocardial infarction was attenuated after accounting for the lower use of cardiac procedures[4,5] is seen as strong evidence that the weekend effect is primarily driven by QOC.[18] A recent study from the United Kingdom has shown that the quality of acute stroke care is influenced by when stroke cases are admitted.[23] In this study of over 8000 stroke cases treated at 246 hospitals, patients admitted on the weekend had longer delays in obtaining a brain scan or being admitted into a stroke unit.

The GWTG-Stroke program monitors the quality of in-hospital stroke care through the generation of core stroke performance measures that address acute, subacute, and discharge care.[8] We did not find any clinically important differences in compliance with these performance measures between subjects who presented during off- or on-hours. Such findings could be interpreted as showing that the mortality differences found between off- and on-hour presentations are not due to underlying differences in the QOC. However, it could be argued that the performance measures used by the

GWTG program do not reflect the acute care processes that likely influence in-hospital mortality such as the control of fluid and electrolyte imbalances, blood pressure, glycemia, and pyrexia. Moreover, determining the exact influence of QOC on in-hospital mortality is difficult, because it requires knowledge of the timing of the in-hospital death and the expected time of delivery of each care process. Details on the decision to withdraw care due to a terminal condition or the presence of do-not-resuscitate or comfort care orders would also need to be carefully documented. Unfortunately, such details are not available in the GWTG-Stroke program.

Given that the mortality differences for cases that present out of hours are thought to be driven primarily by differences in the quality and intensity of care, the "weekend effect" has been identified as a target for policy changes and quality improvement efforts.[18] Increased reimbursement of hospitals to provide greater staffing of critical services on the weekends has been discussed in both Canada and the United States[2,24,25] Whether interventions to increase the availability of stroke nursing and/or specialty stroke services on weekends is both efficacious and cost-effective requires further study. We found that the mortality effect of off-hours presentation on IS admissions declined with longer program participation, suggesting that the weekend effect could be ameliorated by hospitals participating in stroke quality improvement initiatives over the long-term. It is possible that longer participation is associated with more consistent application of quality stroke care regardless of time of presentation.

This study has several limitations. First, the GWTG program is voluntary and the hospitals that participate are more likely to be larger teaching hospitals with a strong interest in stroke and quality improvement. Thus, the generalizability of these findings remains to be determined. Second, it was not possible to account for stroke severity because National Institutes of Health Stroke Scale data are poorly documented in this registry. Third, we cannot confirm that the subjects entered into the GWTG program represent a consecutive or unbiased patient sample. Hospitals are instructed to include all consecutive admissions or to take a systematic sample after selecting a random starting point. However, because these processes are not audited, the potential exists for selection bias.[8] Finally, only in-hospital mortality was assessed and so deaths that occurred soon after discharge were not accounted for. However, to assess whether this could have introduced a bias, we repeated the analysis using a combined end point of in-hospital death or discharge to hospice, and the results were essentially unchanged (data not shown).

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Disclosures

None.

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図1　脳卒中と診断された患者の疾病別年齢構成

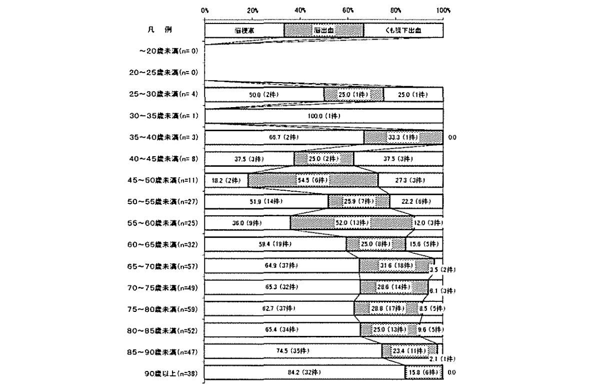


図2　発症から病着までの時間

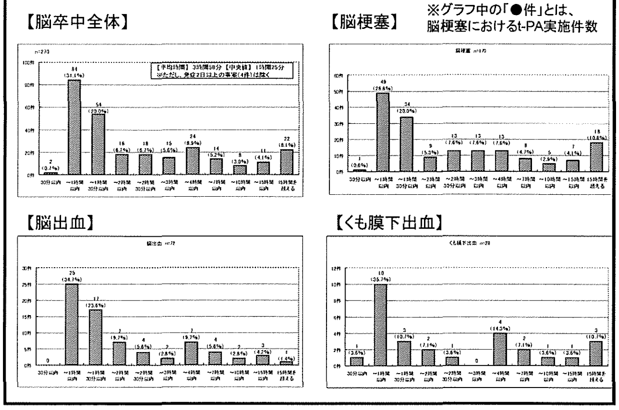


図3　脳梗塞における搬送時間の比較

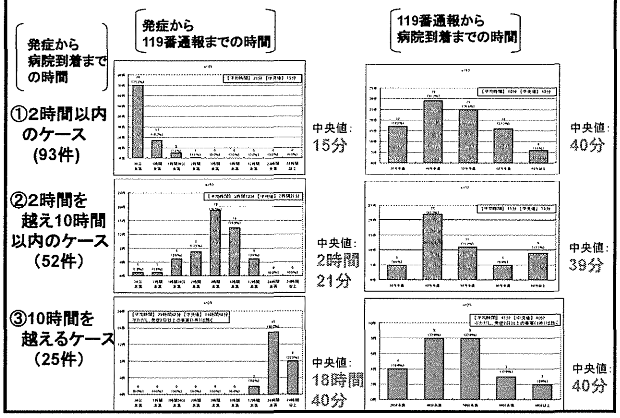


図4　脳卒中を疑うべきであった64件の内訳

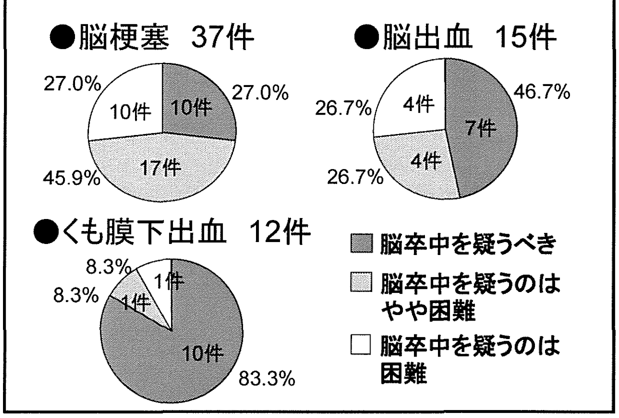


表1　救急隊による脳卒中判断

	医療機関が脳卒中と診断	医療機関が脳卒中以外と診断	計	
救急隊が脳卒中疑いと判断	300件	203件	503件	陽性的中率 59.6%
救急隊が脳卒中非該当と判断	64件	9,542件	9,606件	陰性的中率 99.3%
計	364件	9,745件		
	感度 82.4%	特異度 97.9%		

厚生労働科学研究費補助金（循環器疾患・糖尿病等生活習慣病対策総合研究事業）

「包括的脳卒中センターの整備に向けた脳卒中の救急医療に関する研究」

北海道における脳卒中急性期医療実態調査の分析と対策

発症から専門医療機関到着までの所要時間に影響を与える要因の検討

中村記念病院　脳神経外科　脳卒中センター
中 川 原 譲 二

平成25年6月29日　平成24年度第1回班会議　東京

Ⅰ　調査目的

北海道医療計画に定めた脳卒中と急性心筋梗塞の発症予防から応急手当・病院前救護、急性期医療の医療機能について、各機関の取り組みの実態を把握し、医療機能の検証や推進方策について検討を行い医療連携体制の充実を図ることを目的とする。

Ⅱ　調査方法

1　調査対象医療機関

北海道医療計画において公表された脳卒中又は急性心筋梗塞の急性期医療を担う医療機関を対象にとする。

ただし、北海道医療計画において、公表該当医療機関がない二次圏域においては、地域センター病院を対象とする。

2　調査期間

平成21年度・22年度の夏期・冬期に実施。

対象疾患	期	平成21年度	平成22年度
脳卒中	夏期 14日間	平成21年7月5日（日）～平成21年7月18日（土）	平成22年7月4日（日）～平成22年7月17日（土）
	冬期 14日間	平成22年1月17日（日）～平成22年1月30日（土）	平成23年1月16日（日）～平成23年1月29日（土）
急性心筋梗塞	夏期 28日間	平成21年7月5日（日）～平成21年8月1日（土）	平成22年7月4日（日）～平成22年7月31日（土）
	冬期 28日間	平成22年1月17日（日）～平成22年2月13日（土）	平成23年1月16日（日）～平成23年2月12日（土）

3　調査対象

調査対象は、脳卒中又は急性心筋梗塞の発症後1週間以内で、調査期間中に調査対象機関を受診した全ての患者とする。

ただし、他の医療機関において発症し、調査該当医療機関を受診した場合は対象とするが、調査該当医療機関における院内発症例については、対象外とする。

Ⅲ　回収状況

○　脳卒中

	合計	H21夏	H21冬	H21小計	H22夏	H22冬	H22小計
総数(人)	2,594	656	701	1,357	611	626	1,237
男性(人)	1,465	362	384	746	363	356	719
(%)	56.5%	55.2%	54.8%	55.0%	59.4%	56.9%	58.1%
女性(人)	1,129	294	317	611	248	270	518
(%)	43.5%	44.8%	45.2%	45.0%	40.6%	43.1%	41.9%

○　急性心筋梗塞

	合計	H21夏	H21冬	H21小計	H22夏	H22冬	H22小計
総数(人)	728	173	210	383	155	190	345
男性(人)	529	132	150	282	118	129	247
(%)	72.7%	76.3%	71.4%	73.6%	76.1%	67.9%	71.6%
女性(人)	199	41	60	101	37	61	98
(%)	27.3%	23.7%	28.6%	26.4%	23.9%	32.1%	28.4%

救急要請の有無

救急要請は発症から専門医療機関到着までの所要時間に影響を与えていた。

なお、救急要請までの時間の遅延に関与する事項については、次のとおりであった。

①発症年齢

②意識障害の有無

③発症時間

④冬期間の発症

⑤目撃者の有無

①発症年齢	・高齢者ほど、脳卒中に占める脳梗塞の割合は高い。その他の脳卒中と比較し、脳梗塞は軽症者の割合が高い。軽症者は救急要請までに時間を要しており、その背景として、安静にし、様子を見ている可能性があることから、発症から救急要請までの時間を短縮するためには、特に高齢者に対し、軽症であっても救急要請を行うなど、適切な受診行動をとるよう啓発することが重要である。
②意識障害の有無	・発症時に意識障害が軽度（JCS1）の場合、救急要請までの時間が遅延しており、脳卒中の症状であると認識されにくいと推察される。脳卒中の症状等を一般に周知する際は、軽症の場合があること、また、その場合であっても、救急要請を行うなどの受診行動をとるよう啓発することが重要である。
③発症時間	・午前5時～午後1時の脳卒中発症は、救急車以外の受診手段が多く選択されており、また、午前1時～午前5時の発症では、受診手段として救急車が多く選択されていた。救急要請は発症から専門医療機関到着までの所要時間に影響を与えることから、発症後、速やかに専門医療機関で受診するよう、日中の発症であっても、適切な受診行動をとるよう啓発することが重要である。
④冬期間の発症	・冬期間は発症から救急要請までの時間が夏期と比較し遅延していることから、住民への教育において考慮すべき要素と考えられる。
⑤目撃者の有無	・目撃者が無いと、発症から救急要請までの時間が遅延する。また、発症から診断確定までの時間についても、遅延することから、発症者を目撃した際に、脳卒中を疑って、速やかに救急要請を行えるよう、脳卒中の症状や適切な受診行動について、啓発することが重要である。

他の医療機関の経由

他の医療機関の経由が有ると、発症から専門医療機関到着までの時間が遅延しており、発症地に よる地域差の影響を上回っていた。

なお、経由が増える要因となる事項については、次のとおりであった。

①専門医・専門医療機関の不足	・道内21の2次医療圏のうち、15圏域で、他の医療機関を多く経由していた。経由の多かった上位7圏域のうち、6圏域では、脳神経外科手術を行う医療機関が無かった。

その他の要因

(1)目撃者の有無	・独居は、発症時に目撃されないことが多く、独居の高齢者が脳卒中を発症した際に救急要請が速やかに行えるよう対応策を講じることが重要である。（緊急通報システム、安否確認サービスの活用、自治会や家族友人等とのコミュニケーションの充実など）また、脳卒中の発症であることを認識し、速やかに救急要請を行えるよう、脳卒中の症状や適切な受診行動について啓発することが重要である。
(2)発症場所	・公共の場や道路での発症と比較し、自宅で発症した場合は、発症から救急要請・発症から診断確定までの時間が遅延していた。自宅で発症した場合、とりあえず安静にするという措置が取られてしまい、救急要請が躊躇されている可能性があり、公共の場や道路では、症状に係らず救急要請されていると考えられる。住民への教育では、自宅での発症で軽度の症状であっても、高齢者やハイリスク者については、経過観察せず直ちに救急要請するよう啓発することが重要である。
(3)性別	・発症から診断確定まで、男性は女性より30分程度時間を要することから、住民への教育において、考慮すべき要素と考えられる。
(4)診断名	・脳梗塞症例は一過性脳虚血発作症例と比較し、発症から診断までの時間が遅延していた。脳出血・くも膜下出血は強い症状が出るのに比べ、脳梗塞では軽症例も多く含まれることから、住民へ教育する際は、脳梗塞は軽症も多いことを説明する必要がある。ただし、軽症脳梗塞と鑑別困難な病態が多数あることから、説明内容には注意が必要である。

まとめ

- 北海道における脳卒中の発症から診断確定までの所要時間について分析したところ、①救急要請の有無、②経由医療機関の有無、③目撃者の有無などが所要時間に影響を与えていた。①の遅延要因として、高齢者、軽度の意識障害、日中の発症、②の要因として、専門医・専門医療機関の不足が挙げられる。
- 脳卒中急性期医療の迅速化を図るためには、脳卒中の典型的症状の啓発（ACT-FAST）と救急要請の必要性の理解、地域の医療連携体制の強化が重要である。

岩手県の脳卒中救急医療の現状 と震災前後の変化

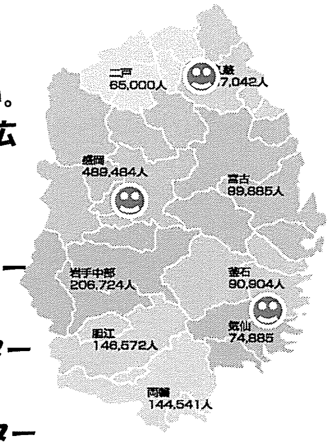
岩手医科大学　脳神経外科

小笠原邦昭

岩手県

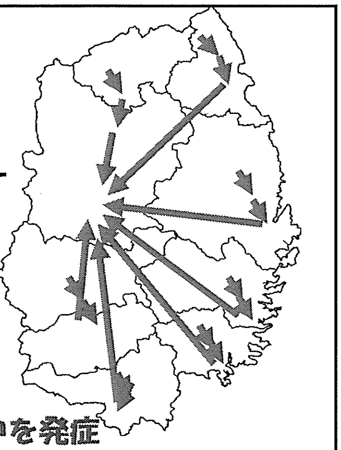
北海道についで広い。
四国4県に匹敵する広大な県土。
９つの２次医療圏

高度救命救急センター
県立久慈病院
高次救命救急センター
県立大船渡病院
高次救命救急センター

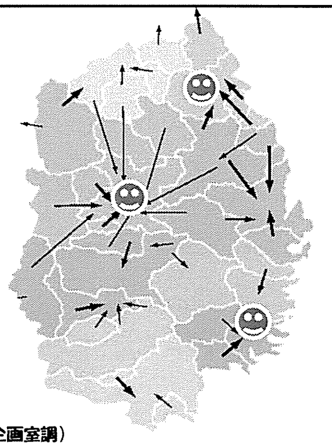


岩手県の脳卒中救急診療

岩手医科大学
高度救急センター
↑
地域の基幹病院
↑
地域の病院
↑
開業医
脳卒中を発症



患者受療動向

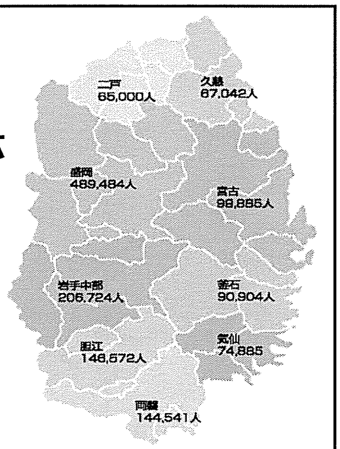


流出量
10%以上30%未満
30%以上50%未満
50%以上

（出典：県保健福祉部保健福祉企画室調）

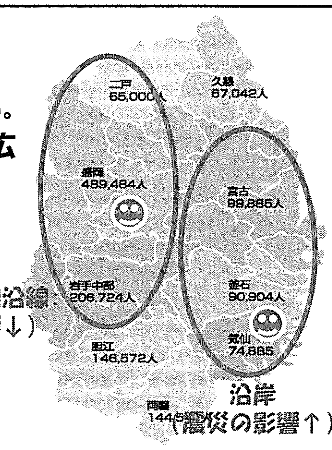
岩手県

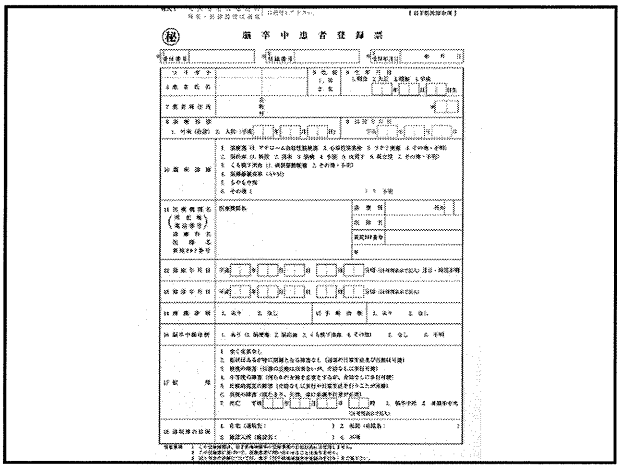
北海道についで広い。
四国4県に匹敵する広大な県土。
９つの２次医療圏



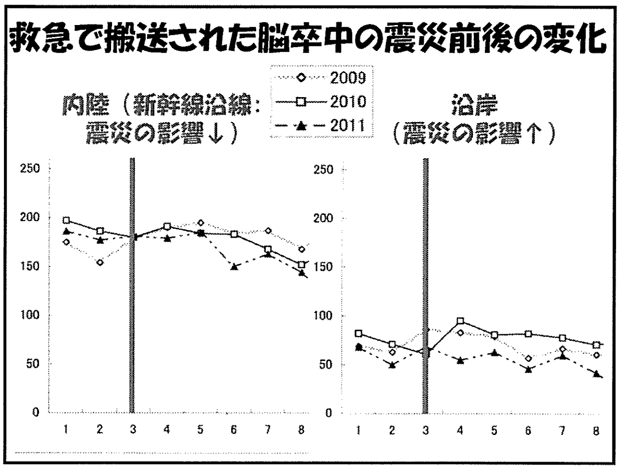
岩手県

北海道についで広い。
四国4県に匹敵する広大な県土。
９つの２次医療圏

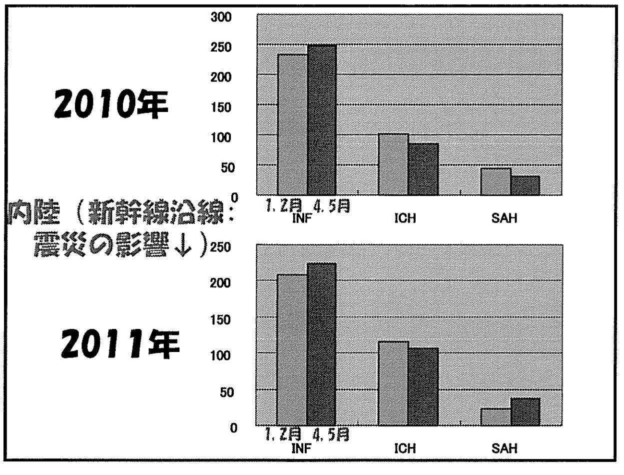




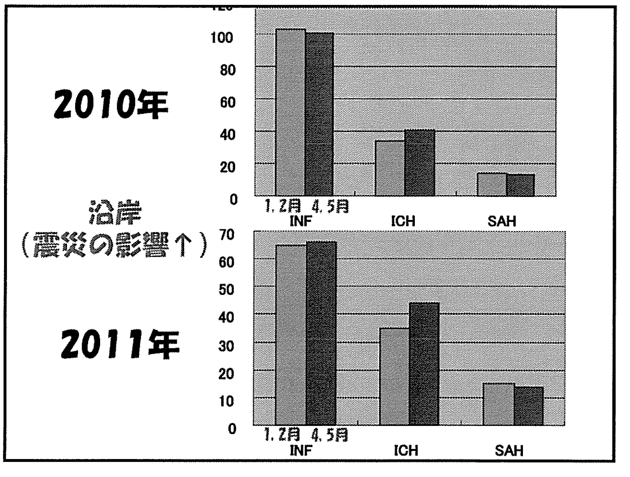
㊙ 脳卒中患者登録票



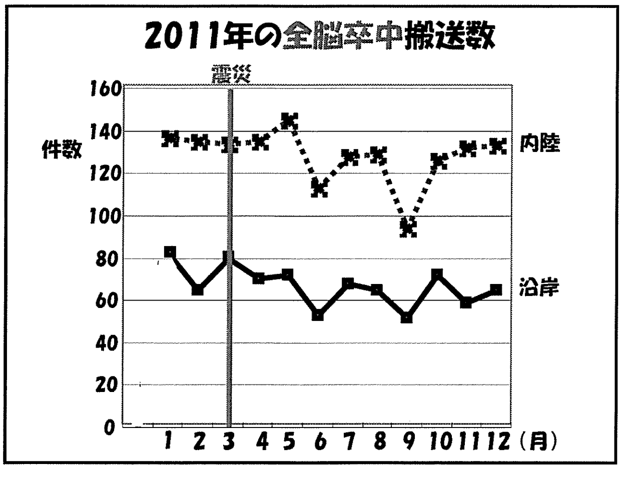
救急で搬送された脳卒中の震災前後の変化
内陸（新幹線沿線：
震災の影響↓）
2009
2010
2011
沿岸
（震災の影響↑）
250
200
150
100
50
0
1 2 3 4 5 6 7 8



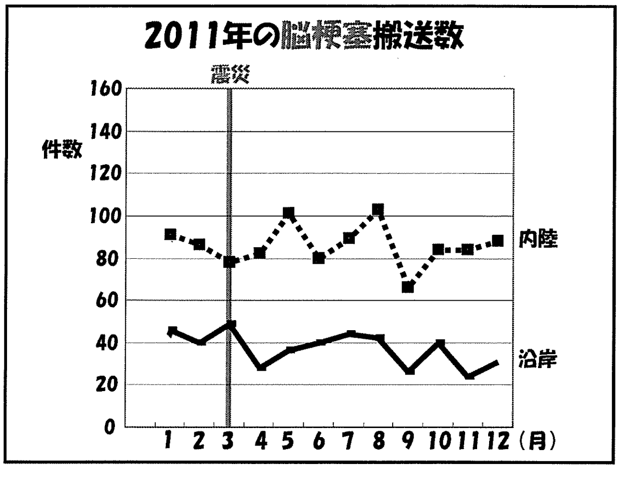
2010年
内陸（新幹線沿線：
震災の影響↓）
2011年
300
250
200
150
100
50
0
1, 2月 4, 5月
INF
ICH
SAH



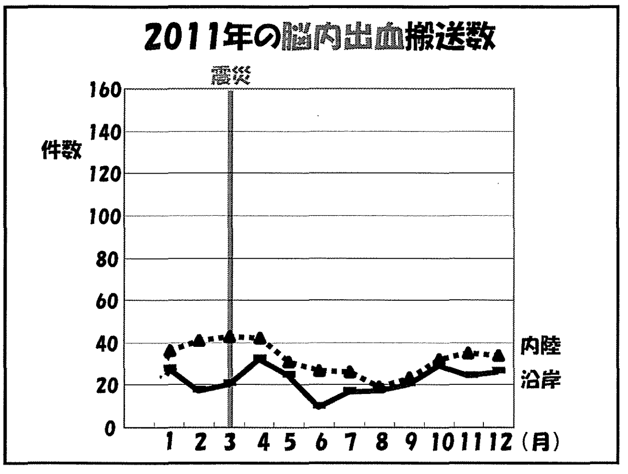
2010年
沿岸
（震災の影響↑）
2011年
100
80
60
40
20
0
70
1, 2月 4, 5月
INF
ICH
SAH

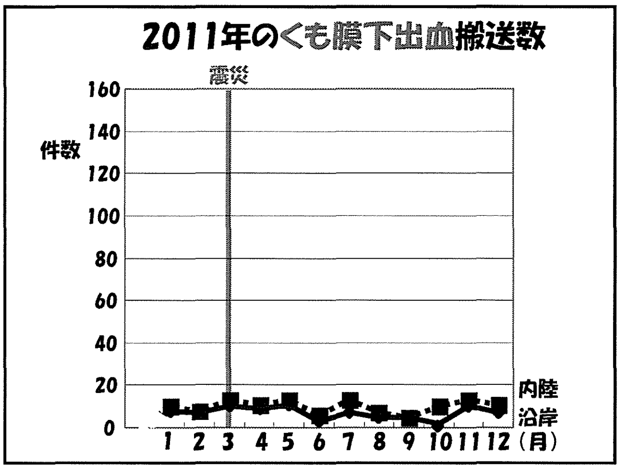


2011年の全脳卒中搬送数
震災
件数
160
140
120
100
80
60
40
20
0
内陸
沿岸
1 2 3 4 5 6 7 8 9 10 11 12 (月)



2011年の脳梗塞搬送数
震災
件数
160
140
120
100
80
60
40
20
0
内陸
沿岸
1 2 3 4 5 6 7 8 9 10 11 12 (月)


2011年の脳内出血搬送数
震災
160
140
件数
120
100
80
60
40
20
0
内陸
沿岸
1 2 3 4 5 6 7 8 9 10 11 12 (月)


2011年のくも膜下出血搬送数
震災
160
140
件数
120
100
80
60
40
20
0
内陸
沿岸
1 2 3 4 5 6 7 8 9 10 11 12 (月)