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A Nationwide Analysis of Outcomes of Weekend Admissions for Intracerebral Hemorrhage Shows Disparities Based on Hospital Teaching Status

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Abstract

Background and Purpose: With the "weekend effect" being well described, the Brain Attack Coalition released a set of "best practice" guidelines in 2005, with the goal to uniformly provide standard of care to patients with stroke. We attempted to define a "weekend effect" in outcomes among patients with intracranial hemorrhage (ICH) over the last decade, utilizing the Nationwide Inpatient Sample (NIS) data. We also attempted to analyze the trend of such an effect. **Materials and Methods:** We determined the association of ICH weekend admissions with hospital outcomes including mortality, adverse discharge, length of stay, and cost compared to weekday admissions using multivariable logistic regression. We extracted our study cohort from the NIS, the largest all-payer data set in the United States. **Results:** Of 485 329 ICH admissions from 2002 to 2011, 27.5% were weekend admissions. Overall, weekend admissions were associated with 11% higher odds of in-hospital mortality. When analyzed in 3-year groups, excess mortality of weekend admissions showed temporal decline. There was higher mortality with weekend admissions in nonteaching hospitals persisted (odds ratios 1.16, 1.13, and 1.09, respectively, for 3-year subgroups). Patients admitted during weekends were also 9% more likely to have an adverse discharge (odds ratio 1.09; 95% confidence interval: 1.07-1.11; *P* < .001) with no variation by hospital status. There was no effect of a weekend admission on either length of stay or cost of care. **Conclusion:** Nontraumatic ICH admissions on weekends have higher in-hospital mortality and adverse discharge. This demonstrates need for in-depth review for elucidating this discrepancy and stricter adherence to standard-of-care guidelines to ensure uniform care.

Keywords

stroke and cerebrovascular disease, intracerebral hemorrhage, epidemiology, neurohospitalist, general neurology

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Introduction

The Center for Disease Control and Prevention lists Stroke as the fifth leading cause of mortality in the United States, with 130 000 deaths annually.[1] Nontraumatic intracranial hemorrhage (ICH) constitutes approximately 15% of all cases, establishing it as an independent contributor to premature mortality.[2,3] A study on hospitalizations between 1988 and 2011 demonstrated that nontraumatic ICH represented 17.3% of years of potential life lost (YPLL) due to in-hospital deaths from all neurologic conditions and that the annual YPLL for ICH is increasing.[4]

The mortality rate of ICH is the highest of all cerebrovascular events, with a 30-day mortality rate close to 50%.[5] The number of ICH cases is expected to increase over the next 50 years with a change in demographics.[6] Although a number of patient-related risk factors have been implicated in an association with ICH incidence and mortality, hospital-related factors have not been fully explored.[7] The management of ICH requires urgent procedures that are not homogenous throughout all hospitals and through time. The teams first assessing incoming patients with stroke might vary from hospitalists to vascular neurologists to even neurointerventionists. Thus, there may be some hospital- and system-related risk factors that are contributory to overall mortality and complications. It is vital to quantify these to guide targeted intervention and resource utilization.

A "weekend effect" in patients with cerebrovascular disease is reported with heterogeneous results.[8-16] A study utilized the Nationwide Inpatient Sample (NIS) from 2004 and showed 12% increased risk of death with weekend admissions.[13] A second study using data from Get With the Guidelines—Stroke program also demonstrated 19% increased mortality in weekend admissions among patients with hemorrhagic stroke.[15] Data from a single specialized stroke center identified no such significant "weekend effect" among patients with ICH admitted to the neurological intensive care unit.[16]

The need for uniform management of ICH was recognized in the last decade with the "weekend effect" being well described and accepted as a legitimate phenomenon in 2004. In 2005, the Brain Attack Coalition released a set of "best practice" guidelines to address standard of care in management of stroke.[17]

We attempted to define a "weekend effect" in outcomes among patients with ICH over the last decade, utilizing the NIS data. We also attempted to analyze the trend of such an effect in 3-year intervals to explore changes from 2002 to 2011.

Materials and Methods

Data Source

We extracted our study cohort from the NIS, Healthcare Cost and Utilization Project (HCUP), and Agency for Healthcare Research and Quality.[18] This is the largest all-payer data set in the United States containing 20% stratified sample of all hospitals.

Study Population and Design

We queried the database between 2002 and 2011 using the *International Classification of Diseases, 9th Revision, Clinical Modification* (*ICD-9-CM*) diagnosis code 431.xx for ICH as a primary diagnosis after excluding patients with age <18 years. This code has a sensitivity of 85%, specificity of 96%, and positive predictive value of 89%.[19]

We excluded all nonemergency department admissions and elective admissions, since the NIS data for transferred patients do not include the admission day to the initial facility and elective admissions tend to occur during weekdays. We also excluded observations with missing data on in-hospital mortality and discharge disposition. Finally, this cohort was divided into 2 groups based on their admission day: weekday (Monday to Friday until midnight) and weekend (Saturday and Sunday). The day and time of admission was counted when they were registered as an "inpatient" from the emergency department. However, we do realize that such registered "inpatients" might physically be present in the emergency department at the time of initiation of treatment.

Definition of Variables

We extracted baseline characteristics of the study population. Patient-level characteristics included age, gender, race, and quartile classification of median household income according to ZIP code, primary payer, and palliative care status, and hospital-level characteristics included hospital location (urban/rural), hospital bed size (small, medium, and large), region (Northeast, Midwest or North Central, South, and West), teaching status, and annual hospital volume of ICH admissions. We assessed for palliative care utilization using *ICD-9-CM* diagnosis code V66.7.[20] We calculated annual hospital volume using unique identification numbers and divided them into quartiles for analysis. We used the All Patient Refined Diagnosis Related Groups (APRDRGs) mortality scale to describe the severity of illness and likelihood of death. This scale is validated and uses various elements to scale patients' mortality risk.[21,22] This has been shown to be a reasonable surrogate of disease severity and mortality risk in Cerebrovascular Accident hospitalizations including ICH.[24] Discharge disposition was grouped as follows: (1) home or short-term facility (routine, short-term hospital, against medical advice, home with health care, another rehabilitation facility, another institution for outpatient services, discharged alive, and destination unknown) versus (2) adverse discharge (skilled nursing facility, intermediate care, hospice home, hospice medical facility, long-term care hospital, and certified nursing facility). This dichotomization of discharge disposition is used previously in studies utilizing the NIS data.[25] Analysis involving discharge/disposition was performed in patients who were discharged alive.

This study used the NIS, a deidentified hospitalization-level database. Therefore, this study did not require review of the institutional review board in accordance with the Code of Federal Regulations, 45 CFR 46.

Statistical Analysis

We carried out comparisons between weekend and weekday ICH admissions for 4 outcomes: (1) in-hospital mortality, (2) discharge disposition, (3) length of stay (LOS), and (4) total hospitalization cost. We grouped discharge disposition into home or short-term facility (reference) versus adverse discharge as defined above. We considered LOS of less than 1 day as 1 day and calculated total cost using the HCUP Cost-to-Charge Ratio Files.[26]

We compared baseline characteristics of both populations utilizing chi-square test, Student *t* test, Wilcoxon rank-sum test, and survey regression depending on variable distributions. The NIS data set is inherently hierarchical having both intergroup (ie, hospital level) and intragroup (ie, patient level) attributes. We created 2-level hierarchical models (with patient-level factors nested within hospital-level factors) with the unique hospital identification number incorporated as random effects. We then constructed final models after adjusting for potential confounders. We adjusted for age, gender, race, median household income according to ZIP code, primary payer, APRDRG risk of mortality scale, palliative care status, and hospital-level characteristics such as hospital type, hospital bed size, hospital region, and annual hospital volume (except hospital type). We also tested interactions and ensured no multicollinearity. For each model, C-statistic was calculated to account for model discrimination. We used significant *P* value of .013 (.05/4) after considering Bonferroni correction for multiple hypothesis comparison.

For each outcome, we fitted 4 models, 1 for overall and 3 for year groups. Years were categorized as 2002 to 2004, 2005 to 2007, and 2008 to 2011 for optimal power and sample size. We performed subgroup analysis for nonteaching and teaching hospitals. We utilized SAS 9.3 (SAS Institute Inc, Cary, North Carolina).

Results

Our queries from 2002 to 2011 yielded 485 329 nontraumatic ICH, nonelective emergency department admissions, of which 133 369 (27.5%) were weekend admissions. Table 1 lists the patient demographics and hospital characteristics of the admissions. Weekend admissions were likely to be older in age, female in gender, and have lower APRDRG score. With respect to hospital-level characteristics, weekend admissions were less likely to get admitted to high-volume hospitals but more likely to get admitted to teaching hospitals. Table 1 shows the total number of hospitalizations with percentage mortality stratified by weekend/weekday admissions.

Table 1 also shows statistics for the primary outcomes for weekend compared with weekday admissions. In univariable analysis, significantly higher deaths (30.2% vs 28.4%; $P < .001$) were observed with weekend admissions. In multivariable analysis, weekend admissions were associated with 11% higher chance of in-hospital mortality overall from 2002 to 2011 (odds ratio [OR]: 1.11; 95% confidence interval: 1.09-1.13; $P < .0001$), which means that for every 100 deaths associated with ICH on the weekdays, there are 111 deaths associated with ICH on the weekends. On analyzing 3-year subgroups (2002-2004, 2005-2007, and 2008-2011), weekend effect of in-hospital mortality decreased after 2007 but was still significant (OR: 1.13, 1.16, and 1.05, respectively; Table 2). However, subgroup analysis showed persistent weekend effect over the last decade for nonteaching/rural hospitals (OR: 1.16, 1.13, and 1.09, respectively; Table 2). In teaching hospitals, although there was increased mortality in 2002 to 2004 and 2005 to 2007 (OR: 1.10 and 1.18, respectively), there was no increased mortality in 2008 to 2011 (OR: 1.02; 95% confidence interval: 0.98-1.06; $P = .05$; Table 2 and Figure S1).

Patients on weekends were more likely to sustain adverse discharge (59.1% vs 57.4%; $P < .001$). In multivariable analysis, we found that overall from 2002 to 2011, weekend admission was associated with 9% higher chance of adverse discharge (OR: 1.09; 95% confidence interval: 1.07-1.11; $P < .0001$). On analyzing 3-year subgroups (2002-2004, 2005-2007, and 2008-2011), we found that there was a clear trend of increasing weekend effect on adverse discharge (OR: 1.01, 1.09, and 1.15, respectively; Table 3 and Figure S2). On subgroup analysis, this was true in both nonteaching (OR: 0.99, 1.08, and 1.18 for 2002-2004, 2005-2007, and 2008-2011, respectively) and teaching hospitals (OR: 1.02, 1.10, and 1.13 for 2002-2004, 2005-2007, and 2008-2011, respectively; Table 3 and Figure S2). Weekend admissions did not have a significant effect on LOS and hospital costs either in overall or in 3-year analysis, with no differences in subgroup analysis.

Discussion

The concept of a "weekend effect" has been examined before. In ICH, Crowley et al demonstrated increased risk of 30-day mortality for weekend when compared to weekday admissions.[13] However, it was restricted to a single year without temporal trends and did not stratify by hospital status. McDowell et al showed that admission timing was not associated with mortality risk at a specialized stroke center.[16] This is consistent with our findings of no increased effect of weekend admissions on mortality after 2007 in teaching hospitals, which are likely to have specialized stroke services.

With time being the most important commodity to ensure good outcomes in stroke, hospitalists are often in a unique role in multidisciplinary teams, along with vascular neurologists and neurointensivists, to reduce risk, promote a system of rapid and accurate response, and thus improve outcomes in patients with stroke.[27] Although there is less emphasis on neurology in internal medicine training,[28] hospitalists often end up as primary providers of inpatient stroke care, especially in nonteaching hospitals.

Table 1. Baseline Characteristics of the Study Population.[a]

	Weekday	Weekend	Overall	*P*
Weighted total ICH admissions	351 959 (72.5)	133 370 (27.5)	485 329	
Patient-level characteristics				
Age, years				<.001
18-34	1.97	2.06	1.99	
35-49	9.35	9.64	9.43	
50-64	23.46	22.93	23.32	
65-79	33.4	32.74	33.22	
≥80	31.82	32.62	32.04	
Gender				<.001
Male	49.5	48.7	49.28	
Female	50.47	51.27	50.69	
Race				<.001
White	53.07	52.31	52.86	
Black	13.79	13.76	13.78	
Hispanic	7.74	7.76	7.75	
Others	6.2	6.77	6.36	
Missing	19.2	19.4	19.25	
APRDRG mortality scale				<.001
0 or 1	26.98	27.42	27.1	
2	20.75	21	20.82	
3	51.33	50.62	51.14	
Palliative care status	5.69	5.88	5.74	.015
Median household income category for patient's ZIP code[b]				.669
0-25th percentile	25.33	25.27	25.32	
26-50th percentile	23.88	24.02	23.92	
51-75th percentile	23.34	23.4	23.36	
76-100th percentile	24.99	24.89	24.96	
Primary payer				.491
Medicare/Medicaid	71.21	71.36	71.25	
Private including HMO	19.85	19.7	19.81	
Self-pay/no charge/other	8.78	8.79	8.78	
Hospital-level characteristics				
ICH hospital volume (annual)				<.001
Once a week (≤52)	44.15	45.14	44.42	
More than once a week (>52)	55.85	54.86	55.58	
Hospital bed size				.270
Small	7.04	7.05	7.04	
Medium	21.73	21.54	21.68	
Large	70.57	70.83	70.64	
Hospital type				<.001
Nonteaching	47.29	46.25	47.01	
Teaching	52.05	53.16	52.36	
Hospital region				.016
Northeast	20.16	19.87	20.08	
Midwest or North Central	17.63	17.82	17.68	
South	37.88	38.37	38.01	
West	20.03	20.23	20.08	
Outcomes				
In-hospital mortality (number of patients)	28.43	30.20	28.91	<.001
Adverse discharge (number of patients)	57.41	59.08	57.86	<.001
LOS (number of days)	9.3 ± 0.12	9.3 ± 0.13	9.3 ± 0.11	.553
Total hospitalization cost (US$)	20 709 ± 366.70	20 834 ± 400.35	20 743 ± 362.00	.589

Abbreviations: APRDRG, All Patient Refined Diagnosis Related Group; ICH, intracranial hemorrhage; LOS, length of stay; HMO, Health Maintenance Organization.

[a] We compared groups utilizing chi-square test, Student *t* test, Wilcoxon rank-sum test, and survey regression.

[b] Quartile classification of the estimated median household income of residents in the patient's ZIP code. These values are derived from ZIP code demographic data obtained from Claritas. The quartiles are identified by values of 1 to 4, indicating the poorest to wealthiest populations. Because these estimates are updated annually, the value ranges vary by year.

Table 2. Multivariable Model for Adjusted Odds of In-Hospital Mortality With Weekend Admissions.

In-Hospital Mortality	Percentage of Mortality in Total Admissions	Percentage of Mortality in Weekday Admissions	Percentage of Mortality in Weekend Admissions	Adjusted Odds Ratio (95% Confidence Interval)[a]	*P*
All hospitals					
Overall	28.91	28.43	30.2	1.11 (1.09-1.13)	<.0001
2002-2004	32.6	32.2	33.62	1.13 (1.10-1.17)	<.0001
2005-2007	28.62	27.81	30.73	1.16 (1.12-1.19)	<.0001
2008-2011	26.39	26.08	27.21	1.05 (1.02-1.08)	.001
Teaching hospitals[b]					
Overall	28.13	27.78	29.03	1.09 (1.06-1.11)	<.0001
2002-2004	31.86	31.52	32.73	1.10 (1.06-1.15)	<.0001
2005-2007	27.92	27.25	29.63	1.18 (1.13-1.23)	<.0001
2008-2011	25.87	25.75	26.18	1.02 (0.98-1.06)	.301
Nonteaching hospitals[b]					
Overall	29.79	29.13	31.57	1.11 (1.08-1.14)	<.0001
2002-2004	33.29	32.84	34.49	1.16 (1.11-1.22)	<.0001
2005-2007	29.37	28.42	31.94	1.13 (1.08-1.19)	<.0001
2008-2011	26.98	26.41	28.54	1.10 (1.05-1.15)	<.0001

[a]Adjusted for age, gender, race, median household income according to ZIP code, primary payer, All Patient Refined Diagnosis Related Group (APRDRG) risk of mortality scale, palliative care status, and hospital-level characteristics such as hospital type, hospital bed size, hospital region, and annual hospital volume.
[b]Adjusted for all of the above except hospital type.

Table 3. Multivariable Model of Adjusted Odds of Nonroutine Discharge With Weekend Admission in Teaching Hospitals.[a]

Nonroutine Discharge	Percent of Total Admissions	Percent of Weekday Admissions	Percent of Weekend Admissions	Adjusted Odds Ratio (95% Confidence Interval)[a]	*P*
All hospitals					
Overall	57.86	57.41	59.08	1.09 (1.07-1.11)	<.0001
2002-2004	56.68	56.56	56.98	1.01 (0.98-1.04)	.577
2005-2007	57.9	57.44	59.16	1.09 (1.06-1.13)	<.0001
2008-2011	58.64	57.96	60.49	1.15 (1.12-1.18)	<.0001
Teaching hospitals[b]					
Overall	58.19	57.77	59.3	1.09 (1.07-1.12)	<.0001
2002-2004	57.64	57.52	57.93	1.02 (0.98-1.07)	.323
2005-2007	57.42	57.01	58.5	1.10 (1.06-1.16)	<.0001
2008-2011	59.02	58.4	60.64	1.13 (1.09-1.17)	<.0001
Nonteaching hospitals[b]					
Overall	57.55	57.04	58.98	1.08 (1.05-1.11)	<.001
2002-2004	55.75	55.64	56.03	0.99 (0.95-1.04)	.004
2005-2007	58.48	57.96	59.48	1.08 (1.02-1.13)	<.0001
2008-2011	58.3	57.45	60.71	1.18 (1.13-1.23)	<.0001

[a]Adjusted for age, gender, race, median household income according to ZIP code, primary payer, All Patient Refined Diagnosis Related Group (APRDRG) risk of mortality scale, palliative care status, and hospital-level characteristics such as hospital type, hospital bed size, hospital region and annual hospital volume.
[b]Adjusted for all of the above except hospital type.

Although such care by hospitalists and multidisciplinary teams is present during the week, weekend shifts are likely associated with fewer medical staff, reduced access to specialists, and a concomitant reduction in access to urgent procedures.[23,29] This was shown when the mortality due to weekend admissions for myocardial infarctions was mediated by lower rate of invasive procedures.[29,30] Although this accounts for worse outcomes where invasive procedures have benefit, this is unlikely with ICH since surgical intervention in ICH has heterogeneous benefit. It could be postulated that ICH admissions on weekends have worse severity than those on weekdays. In our analysis, weekday admissions had a higher APRDRG score that is reflective of increased severity.

This temporal decrease is likely multifactorial with reasons difficult to capture, even using high-level data. However, increased recognition of the associated mortality risk and improved dialogue about reimbursement to provide greater staffing of critical services on weekends, secondary to identification of this "weekend effect," as a target for quality improvement are likely responsible for this decrease.[31,32] With regard to the discrepancy between teaching and nonteaching hospitals, the former is associated with higher number of physicians, nurses, and around-the-clock resident coverage. Further, specialty care access, along with improved quality initiatives and resource allocation, has improved the difference in mortality. The 2007 guidelines for ICH management also emphasized the importance of multimodal monitoring to assess metabolic and hemodynamic variables, increased intensive care management, and multidisciplinary care. All of these might be available on the weekend in teaching, when compared to nonteaching hospitals.[33] Although speculative, there might be a possibility of increased penetration of these guidelines in teaching hospitals.

The decrease in mortality risk associated with weekend admissions is mirrored by increasing trend of adverse discharge to long-term facilities. The reasons for this are likely multiple and interlinked. One of the potential reasons might be the lack of multidisciplinary rehabilitation services on the weekend that improve patient outcomes. These have been incorporated into the latest guidelines for ICH management.[34] Another possible reason is mortality decrease manifesting downstream as increased admissions to long-term facilities. However, in the absence of specific explanations, a prospective analysis exploring both qualitative and systematic aspects of this is warranted.

We did not find a significant effect of weekend admissions on LOS and cost. This is in line with previous studies demonstrating similar results.[29] However, overall LOS and cost are possibly higher with weekend admissions due to increased adverse discharge.

Although this study has significant implications, there are several limitations. Retrospective studies are always subject to selection bias. However, it is impossible to randomize patients on the basis of day of admission. Weekend admission is only a surrogate measure of hospital staffing differences. However, we tried to overcome this with subgroup analysis by hospital type. We have attempted to use discharge/disposition as a quality measure specified by the National Joint Commission recommendations.[35] We do agree that individual and family preferences, along with insurance status, may play an important role in finally making such a decision. Patient disposition at discharge is commonly used as a quality measure by hospitals and has been used in the literature as such. We were not able to measure and adjust for potentially important confounders such as ICH severity, imaging findings, volume of hemorrhage, and site of hemorrhage. However, we did adjust for APRDRG risk and palliative care utilization that, although limited, are surrogates of ICH severity.[24] Additionally, although we accounted for palliative care status in our models, residual confounding influencing both LOS and cost is possible since both are known to be significantly higher in patients on palliative care.

We could not account for patients who were admitted from long-term facilities and then returned to those facilities after treatment, although this number is likely to be small. In addition, although we attempted to account for a majority of interhospital transfers by excluding all nonemergency department admissions, there might be a minority that may have been transferred through the emergency department. Despite these potential limitations, the NIS database provides an unparalleled population-based perspective on disease associations with systematic and temporal factors and provides a rationale for further in-depth studies.

Conclusion

With the standard-of-care guidelines recommending uniform care regardless of the day of admission, an in-depth multicenter review of reasons for this nonuniformity of care is warranted. Second, adherence of institutions caring for patients with ICH to these guidelines should be assessed. Our study, although limited by lack of granular patient-level data to answer these questions, provides a framework for future, prospective, qualitative studies to answer these important questions and ensures uniformity of care in this vulnerable population.

Author Contributions

Achint A. Patel and Abhimanyu Mahajan gave equal contribution. Achint A. Patel, Abhimanyu Mahajan, Jitesh Kar, Alexandre Benjo, Ambarish Pathak, and Girish N. Nadkarni contributed to study concept and design. Narender Annapureddy, Shiv Kumar Agarwal, Vishal B. Jani, Manpreet S. Sabharwal, Rabi Yacoub, and Alexandre Benjo contributed to acquisition of data. Priya K. Simoes, Madhav C. Menon, Ioannis Konstantinidis, Rabi Yacoub, and Abhimanyu Mahajan contributed to analysis and interpretation of data. Achint A. Patel, Abhimanyu Mahajan, Jitesh Kar, Priya K. Simoes, and Girish N. Nadkarni contributed to analysis and interpretation of data. Narender Annapureddy, Shiv Kumar Agarwal, Vishal B. Jani, Manpreet S. Sabharwal, Priya K. Simoes, Ambarish Pathak, Ioannis Konstantinidis, Madhav C. Menon, Georges El Hayek, Rabi Yacoub, and Alexandre Benjo contributed to critical revision of the manuscript for important intellectual content. Achint A. Patel, Abhimanyu Mahajan, Alexandre Benjo, and Girish N. Nadkarni contributed to statistical analysis. Narender Annapureddy, Shiv Kumar Agarwal, Vishal B. Jani, Manpreet S. Sabharwal, Georges El Hayek, Rabi Yacoub, Ioannis Konstantinidis, and Alexandre Benjo contributed to statistical analysis. Madhav C. Menon, Alexandre Benjo, and Girish N. Nadkarni contributed to study supervision.

Declaration of Conflicting Interests

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Supplemental Material

The online [appendices/data supplements/etc] are available at http://nhos.sagepub.com/supplemental.

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