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Traumatic subdural hematoma: Is there a weekend effect?

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ABSTRACT

Objective: Traumatic subdural hematoma (TSDH) is a surgical emergency. The effect of weekend admission on surgery and in-hospital outcomes in TSDH is not known.
Methods: We queried the Nationwide Inpatient Sample from 2002 to 2011 and used ICD-9-CM codes to identify all non-elective admissions with a primary diagnosis of TSDH. We did a subgroup analysis of patients who underwent surgical evacuation. Predictor variables included several patient and hospital characteristics. Outcome variables included length of stay, total hospitalization cost, in-hospital complications, adverse discharge disposition, and in-hospital mortality. We used multivariable analysis to determine if weekend admission was independently associated with increased likelihood of poor outcomes.
Results: Out of a total of 404,212 TSDH admissions, 24.8% received surgical intervention. Patients admitted on weekends were less likely to undergo surgical intervention (odds ratio [OR]: 0.85). In the surgical cohort, weekend admissions consisted of more patients with prolonged loss of consciousness (24+ h) without return to baseline (7.0% vs. 4.8%). In all TSDH patients and in sub-group of surgical cohort, weekend admission was associated with an increased likelihood of in-hospital complication (OR: 1.06 and 1.12), prolonged length of stay (OR: 1.08 and 1.17), increased total hospital costs (OR: 1.04 and 1.11), adverse discharge (OR: 1.08 and 1.18), and in-hospital mortality (OR: 1.04 and 1.11). All p-values were less than 0.01.
Conclusion: Our study demonstrates that patients admitted on weekends had similar mortality despite higher severity with no clinically significant weekend effect for tSDH.
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1. Introduction

Patients admitted to the hospital on a weekend are more susceptible to poor outcomes, including mortality. This phenomenon known as the "weekend effect" has been described in patients with severe illnesses that require immediate critical care attention, including myocardial infarction, acute ischemic stroke, and ruptured aortic aneurysm [1–3]. This disparity in outcomes is possibly a result of deficiencies and delays in care on weekends [1,2,4–9]. So far, the effect of weekend admission on the in-hospital outcomes of patients admitted with traumatic subdural hematoma (TSDH) is not known.

TSDH results from severe traumatic brain injury and is a time sensitive, life-threatening surgical emergency [10–12]. TSDH accounts for 10–20% of all traumatic brain injury patients and a previous nationwide analysis of TSDH hospitalizations reported a mortality rate of 14.9%.[11] If left untreated, a TSDH can lead to fatal complications resulting from increased intracranial pressure and brain herniation [13,14] Surgical and nonsurgical approaches to TSDH management aim to reduce symptoms and improve outcomes by relieving intracranial pressure [10,13]. Sawauchi et al. found that rapid surgical intervention significantly reduced both the intracranial pressure level and brain water content in rats with TSDH [15]. Wilberger et al. noted that TSDH patients who underwent surgery within four hours of injury may have a lower mortality rate and greater functional survival rate [12]. Thus, surgical interventions for treatment of TSDH are most effective in improving outcomes if performed promptly.

The aim of our study was to investigate whether weekend admission affects the surgical treatment and short-term outcomes of TSDH, using national discharge data obtained from the largest inpatient database in the United States. We also did a subgroup analysis of TSDH patients who underwent surgical evacuation to study the differences between patient and hospital characteristics,

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and outcomes between patients admitted over the weekend versus weekdays.

2. Methods and materials

2.1. Data source

The Nationwide Inpatient Sample (NIS) is known to be a valid and reliable data source for epidemiological estimates involving inpatient care. The NIS is a product of the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ). As a mechanism to evaluate and benchmark the NIS each year, the database is linked to the American Hospital Association Annual Survey and the National Hospital Ambulatory Medical Care Survey databases [16]. The NIS provides yearly admission and discharge data from a 20% stratified sample of all hospitals, excluding rehabilitation and long-term care hospitals [16]. When the discharge weights (DISCWT) are applied to the unweighted NIS data, the result is a weighted estimate of the total number of discharges representing the US population [16]. To eliminate admissions data in the NIS database that are likely to be miscoded, records were omitted from the analysis if information regarding age, sex, discharge disposition, or primary diagnosis was missing. Diagnostic and procedural information in the NIS are identified using the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) diagnosis and procedure codes. Unique subject identifiers are used, concealing the identity of the patient and preventing identification of multiple admissions for the same patient. Since the NIS is a publicly available de-identified dataset, it is considered exempt from Institutional Review Board approval. Further detail regarding the NIS database can be found at https://www.hcup-us.ahrq.gov/nisoverview.jsp.

2.2. Inclusion criteria

The NIS was queried from 2002 to 2011 and patients were selected using ICD-9-CM codes based on criteria previously described by Kalanithi et al. [11]. All patients 18 years or older with a primary diagnosis of TSDH were identified using ICD-9-CM codes (852.20–852.39), which all represent "subdural hematoma following injury" [17]. The 4th digit of the ICD-9-CM code tells us whether the patient had an open intracranial injury (852.3) or not (852.2). The 5th digit of the ICD-9-CM code specifies the level of patient consciousness following subdural hematoma. All of these specifications were used to adjust for severity of TSDH in the statistical analysis. All patients with "elective" admission types were excluded. All other diagnoses and procedures were defined by searching for the codes in all available fields. A "weekend admission" in the NIS database was defined as an admission at any time on a Saturday or Sunday. The NIS does not include information in regards to time of day so Friday night and Monday early morning admissions were not included in our weekend cohort.

2.3. Predictor variables

Patient characteristics of interest included patient age (18–59, 60–69, 70–79, 80+), sex (male, female), race (White, Black, Hispanic, other), payer status (Private, Medicare, Medicaid, Other), and pre-existing comorbidity. We used existing variables provided by the AHRQ to assess patient comorbidity based on methodology described by Elixhauser et al. [18]. Hospital characteristics included hospital location (rural or urban), bedsize (small, medium, large), and teaching status (teaching vs. nonteaching). Medical complications were defined using previously defined ICD-9-CM criteria and included neurological (997.00–997.09), postoperative hemorrhage/hematoma (998.1–998.13), thromboembolic (387, 415, 415.11–415.19, 453.0–453.9), pulmonary (518.81–518.85, 997.3), cardiac (997.1, 410), and urinary/renal (584, 997.5) [11].

2.4. Outcome variables

The primary in-hospital outcome of interest was in-hospital mortality. Secondary in-hospital outcomes included surgical intervention, surgical intervention within 24 h of admission, average time to surgical intervention, length of stay (LOS), total hospitalization cost, and adverse discharge disposition. We dichotomized LOS and total costs into the variables "prolonged LOS (at or above the 75th percentile, 8 days)" and "increased costs (at or above the 75th percentile, $22,596)". The NIS variable "discharge disposition" was recoded into a dichotomous variable "routine discharge to home" and "adverse discharge disposition" (defined as transfer to short-term hospital, home with home health care, transfer to rehabilitation/nursing home or long-term facility, or mortality). Since total hospital charges, the variable provided by the NIS originally, does not represent how much hospitals receive in payment, we used the HCUP cost-to-charge ratio files to convert these "charges" to "costs". We identified patients who underwent "TSDH surgical intervention" by ICD-9-CM procedure code 01.31 (incision of cerebral meninges for drainage) [11]. The variable "surgical evacuation within 24 h" was defined as a surgical evacuation that took place within 24 h of a patient's admission.

2.5. Subgroup analysis

We selected a subgroup of TSDH patients who underwent surgical evacuation. We compared their patient and hospital characteristics, and outcomes according to their day of admission (weekend versus weekday).

2.6. Statistical analysis

All statistical analyses utilized SPSS v.23 (SPSS, Inc., Chicago, IL, USA) and statistical significant was set *a priori* at <0.01. Patients admitted for TSDH were divided into weekend and weekday cohorts to compare patient and hospital characteristics, pre-existing comorbidities, TSDH type and severity, surgical intervention, in-hospital complications, and discharge outcomes. Univariate analysis was performed using the Pearson chi-squared test for categorical data and the independent samples *t*-tests for continuous data. Binary logistic regression analysis was used to determine the effect of weekend admission on surgical intervention, surgical intervention within 24 h, complication occurrence, and in-hospital mortality. Predictor variables (patient and hospital characteristics, pre-existing comorbidity, and clinical presentation) with $P < 0.2$ in the univariate analysis and at least 11 cases per cohort were included as covariates in the stepwise logistic regression analysis, and variables with $P < 0.1$ in the model were retained. The exception to the rule regarding initial inclusion was that all TSDH severity categories with at least 11 cases per cohort were initially included in the multivariable model. Similar analysis was conducted for the surgical subgroup.

3. Results

3.1. Patient and hospital characteristics (Table 1)

A total of 404,212 TSDH hospitalized patients were identified using the NIS 2002–2011 datasets. Of these patients, 72.6% were admitted on a weekday and 27.4% were admitted on a weekend. The weekend cohort was younger (67.7 ± 20.3 versus 70.9 ± 18.0 years,

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