Seizure Correlates with Prolonged Hospital Stay, Increased Costs, and Increased Mortality in Nontraumatic Subdural Hematoma

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BACKGROUND: **Nontraumatic subdural hematoma (NTSDH) is a common neurosurgical disease process, with mortality reported as high as 13%. Seizure has a known association with NTSDH, although patient outcomes have not previously been well studied in this population. The purpose of this study was to examine the relationship between in-hospital seizure and inpatient outcomes in NTSDH.**

METHODS: **Using the University HealthSystem Consortium (UHC) database, we performed a retrospective cohort study of adults with a principal diagnosis of NTSDH (*International Classification of Diseases, Ninth Revision* code 43.21) between 2011 and 2015. Patients with in-hospital seizure (*International Classification of Diseases, Ninth Revision* codes 34500–34591, 78033, 78039) were compared with those without. Patients with a history of seizure before arrival were excluded. Patient demographics, hospital length of stay (LOS), intensive care unit stay, in-hospital mortality, and direct costs were recorded.**

RESULTS: **A total 16,928 patients with NTSDH were identified. Mean age was 69.2 years, and 64.7% were male. In-hospital seizure was documented in 744 (4.40%) patients. Hospital LOS was 17.64 days in patients with seizure and 6.26 days in those without ($P < 0.0001$). Mean intensive care unit stay increased from 3.36 days without seizure to 9.36 days with seizure. In-hospital mortality was 9.19% in patients without seizure and 16.13% in those with seizure ($P < 0.0001$). Direct costs were $12,781 in patients without seizure and $38,110 in those with seizure ($P < 0.0001$).**

CONCLUSIONS: **Seizure in patients with NTSDH correlates with significantly increased total LOS and increased mortality. Direct costs are similarly increased. Further studies accounting for effects of illness severity are necessary to validate these results.**

INTRODUCTION

Nontraumatic subdural hematoma (NTSDH) is a common neurosurgical disease process with a mortality reported as high as 13%.[1] Previous studies have shown that although prevalence has increased, patient outcomes have improved relatively, with a modest overall decrease in mortality.[2] However, a study by Busl et al.[3] showed that increased age, coagulopathy, and mechanical ventilation were associated with increased mortality, among other predictors. Although acute traumatic subdural hematomas are associated with younger patients, NTSDHs tend to occur in older patients with either no significant history of trauma or with a history of mild head trauma.

Seizure has a well-known association with NTSDH, and patients with NTSDH are frequently treated prophylactically with anticonvulsants. However, the role of anticonvulsants in this population is controversial, without clear evidence for its risk or benefit.[4] Even with seizure prophylaxis, seizures can occur, and the impact of seizures on hospitalized patients with NTSDH has not been well studied. Here, we examine the relationship between in-hospital seizure and patient outcomes in NTSDH.

METHODS

The University HealthSystem Consortium (UHC) database was used to perform a retrospective cohort study of all adults with a

Key words
- Epilepsy
- Nontraumatic
- Seizure
- Subdural hematoma

Abbreviations and Acronyms
ICD-9: *International Classification of Diseases, Ninth Revision*
ICU: Intensive care unit
LOS: Length of stay
NTSDH: Nontraumatic subdural hematoma
UHC: University HealthSystem Consortium

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principal diagnosis of NTSDH (*International Classification of Diseases, Ninth Revision* [ICD-9] diagnosis code 43.21) between 2011 and 2015. The study conformed to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) criteria.[5] Patients under the age of 18 years were excluded, as were those with a history of seizure before hospital admittance.

The UHC is a collaborative database of 117 academic medical centers in the United States that provides clinical, financial, and administrative data. UHC includes hospitals from 36 states and encompasses all major regions of the United States, including the Northeast, Southeast, Midwest, Southwest, and West Coast. Costs were calculated by UHC using line item charges grouped by revenue code and then multiplied by the ratio of cost to charge (calculated from the Medicare Cost Report). Costs are then adjusted for wage index and labor factors to obtain the observed direct cost (http://www.uhc.edu).

Patients with a diagnosis of in-hospital seizure (ICD-9 diagnosis codes 34500–34591, 78033, 78039) were compared with patients without seizure. Patient age, sex, mean hospital length of stay (LOS), mean intensive care unit (ICU) stay, in-hospital mortality, and direct costs were recorded directly from UHC. Patients were divided into those with seizure and those without seizure. In addition, a subgroup analysis of patients who underwent intervention for the NTSDH was performed. ICD-9 procedure code 01.31 (incision of cerebral meninges) was used to identify this cohort. Patients who underwent intervention were divided and compared between those with and without seizure. A similar analysis was performed for all patients who did not undergo intervention.

Comorbidities were also evaluated, comparing patients with and without seizure. The UHC database used the Agency for Healthcare Research and Quality 29-Comorbidity Index.[6] Each of the 29 comorbidities was based on a set of ICD-9 codes.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 23.0 software (IBM Corp., Armonk, New York, USA). Two-tailed t tests were used to evaluate statistically significant differences in mean numerical values for hospital LOS and direct costs between seizure and nonseizure populations. Proportions of in-hospital mortality and comorbidities were analyzed for statistically significant differences in seizure and nonseizure populations using 2×2 contingency tables and χ^2 testing. A statistical significance level of $P < 0.05$ was set for this analysis.

RESULTS

Participants and Descriptive Data

A total 16,928 patients met the inclusion criteria. Mean age was 69.2 years, and 64.7% of patients were male. Overall, 744 (4.4%) patients had a recorded seizure during their hospital stay. The comparison of patients with and without seizure is summarized in Table 1. Of patients with seizure, 523 (70.3%) underwent drainage of the NTSDH, whereas 6,834 (42.2%) patients without seizure underwent drainage ($P < 0.0001$). There were 579 patients with nonspecific ICD-9 codes for seizure; 108 patients were diagnosed with generalized status epilepticus, 13 had generalized seizures, 28 had partial seizures, and 16 had epilepsia partialis continua.

Table 1. Seizure Group Comparison for Patients with Nontraumatic Subdural Hematoma

	Seizure	No Seizure	*P* Value
Cases	744	16,184	
Length of stay (days) (mean ± SD)	17.6 ± 23.5	6.3 ± 7.1	<0.0001
Mean days in intensive care unit	9.4	3.4	<0.0001
Deaths	120	1487	<0.0001
Mortality percentage	16.1	9.2	
Direct costs ($) (mean ± SD)	38,110 ± 42,975	12,781 ± 22,850	<0.0001

SD, standard deviation.

Overall, patients with seizure tended to have more comorbidities. Patients with seizure averaged 3.42 complications per patient, whereas patients without seizure averaged 2.41 ($P < 0.0001$). Of the 29 comorbidities defined, patients with seizure had an increased odds of having chronic pulmonary disease, coagulopathy, congestive heart failure, deficiency anemias, diabetes with chronic complications, fluid and electrolyte disorders, hypertension, hypothyroidism, obesity, other neurologic disorders, paralysis, peptic ulcer disease excluding bleeding, pulmonary circulation disease, renal failure, valvular disease, and weight loss. These results are summarized in Table 2.

Outcome Results

Mean hospital LOS was 6.26 ± 7.13 days for patients without a seizure and 17.64 ± 23.51 days for patients with a seizure ($P < 0.0001$). Mean ICU stay was 3.36 days for patients without seizure and 9.36 days for those with seizure. There were 1487 (9.19%) deaths in patients without seizure and 120 (16.13%) deaths in patients with seizure ($P < 0.0001$). Mean direct costs were $12,781 ± $22,850 in patients without seizure, and $38,110 ± $42,975 in those with seizure ($P < 0.0001$). Of all patients who underwent surgery, patients with documented seizure had a longer mean hospital LOS (18.56 ± 22.92 days vs. 7.80 ± 7.73 days; $P < 0.0001$), as well as longer ICU stay (mean 10.01 days vs. 3.95 days). In addition, in this group, patients with seizure had higher in-hospital mortality (13.58% vs. 4.95%; $P < 0.0001$) and higher direct costs ($41,492 ± $44,622 vs. $17,486 ± $29,554; $P < 0.0001$). These findings are summarized in Table 3.

In all patients managed nonoperatively, there were longer mean hospital LOS (15.46 ± 24.77 days vs. 5.13 ± 6.42 days; $P < 0.0001$) and longer ICU stay (7.68 days vs. 2.76 days) in those patients who had seizure. In this group, there were also higher in-hospital mortality (22.17% vs. 12.29%; $P < 0.0001$) and higher direct costs ($30,001 ± $37,618 vs. $9311 ± $15,319; $P < 0.0001$) in patients with seizure compared with those without. These findings are summarized in Table 4.