



Research Paper

A retrospective analysis of factors influencing readmission rates of acute traumatic subdural hematoma in the elderly: A cohort study

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ABSTRACT

Objective: Acute traumatic subdural hematomas (TSDH) readmission rate is high (27.8%) with an increase in morbidity and cost for the elderly. This study identifies risk factors affecting readmission rates for these patients and presents strategies to reduce it.

Methods: A retrospective analysis was conducted including patients with TSDH admitted to our Community Hospital and followed subsequently for two years regarding readmission within 6 months of initial discharge. The following factors were compared for patients readmitted versus not readmitted: patient age, sex, number of comorbidities, anticoagulation status, surgical intervention, ICU length of stay, injury severity score, and discharge disposition.

Results: A total of 167 patients were included in the study. Overall, 75 patients (44.9%) were readmitted within 6 months. Readmitted patients had an overall higher mean age (74.1 vs. 65.4, $p = 0.001$). Readmission with recurrent subdural hematoma was diagnosed in 32.2% of readmitted patients vs. 67.8% ($p < 0.0005$) with readmission for other medical complications. 80.0% of readmitted patients had more than four comorbid conditions ($p < 0.0001$).

Conclusion: This study identifies risk factors that affect readmission rates for patients with TSDH and establishes strategies that may help to decrease readmission.

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1. Introduction

Traumatic Subdural Hematoma (TSDH) is one of the most devastating traumatic brain injuries, with mortality rates of approximately 40%–60% even with surgical intervention [1,2]. There has been a per-capita increase in the hospitalization for subdural hematomas in the United States by nearly 40% from 1998 to 2007 [3]. In fact, Frontera et al. reports that nationwide charges related to SDH more than doubled “from \$2.2 billion in 1998 to \$4.9 billion in 2007” [3]. Given the financial burden that this places on the health care system, several studies have analyzed inpatient management strategies that may improve outcomes, reduce readmissions and thereby decrease overall health care costs for TSDH [4]. Readmission for traumatic brain injury (TBI) according to HHS in 2018 public access report [5] occurred at a rate of 27.8% in the

first year following discharge, with little changes in subsequent years; averaging 22–23.4%. The significance that first year post-traumatic brain injury readmission suggests the need for preventative models of health maintenance [6]. The factors associated with readmission after TBI should be considered in the discharge planning [7]. On the other hand, readmission rate for patients with subdural hematoma during the 1st year run around 20–25% [8–11] coupled with this finding, the co-morbid conditions associated with traumatic brain injury had a significant impact on patient outcomes, and subsequent readmission in the prior studies [6], initiated the current study on our aging trauma patients with TSDH. Addressing the above issues and establishing a strategy to monitor these factors with the aim of possible reduction in the readmission rate of these elderly patients.

2. Methods

A retrospective analysis was conducted on patients with traumatic brain injuries (ICD-9-CM codes 800.20–801.86,

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852.00–853.05) admitted between 2014 and 2016 at Genesys Regional Medical Center through the trauma service. From this group, we selected patients admitted with traumatic SDH, and those patients were followed over the following 6 months as regards to readmission status. We compared patients who were readmitted versus patients who were not readmitted for our final analysis. The risk of readmission within 6 months of discharge for SDH was analyzed adjusting for age, prior anticoagulation use, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), gender, time to readmission and co-morbid conditions which included diabetes mellitus, cardiovascular disease, renal disease, chronic obstructive pulmonary disease, and osteoporotic/orthopedic fractures using Cox Proportional Hazards Regression analysis. We elected four or more comorbid conditions in calculating readmission rate as their impact became more significant at that level.

Age was divided into those ≤ 60 or > 60 years old. The number of comorbidities was divided into ≤ 4 or greater than four comorbidities. Mean ICU days was calculated for comparison. ISS was stratified into scores of ≤ 15 and > 15 . Discharge disposition was divided into home versus another health care facility. The latter included rehabilitation, assisted living, subacute rehabilitation, and skilled nursing facilities. Patient anticoagulation status was stratified into whether or not patients were given anticoagulation therapy (i.e. warfarin, apixaban, heparin, enoxaparin, dabigatran, and rivaroxaban) upon discharge from the first admission. The number of days until readmission was calculated at 180 days from initial discharge. A two-sample T-test was used for statistical analysis between the study groups. IRB approval was obtained for this study and in line with the STROCCS criteria [12].

3. Results

Between 2014 and 2016, our institution had a total of 221 adult patients who were treated for a diagnosis of traumatic SDH. Readmission data was missing and not included for 54 patients including those who died before the end of 6 months from initial discharge. Overall, 75 patients (44.9%) were readmitted and 92 (55.1%) were not readmitted (Table 1). Readmissions were secondary to recurrent SDH, syncope, falls, cerebrovascular accident, seizures, and altered mental status as well as for other medical reasons not related to the initial trauma. Most readmissions were found to occur within the first six months after the initial discharge from the hospital.

The patients who were readmitted had an overall higher mean age than those who were not readmitted (74.1 vs. 64.5, $p < 0.001$). The number of patients readmitted with recurrent subdural hematoma (32.2%) was found to be significantly lower than the number of patients with a readmission due to other medical conditions (67.8%, $p < 0.005$). However, this was true only for female patients (26.3% vs 57.5%, $p = 0.003$), while males had a significantly higher readmission rate with subdural hematomas (73.7% vs 42.5%

Table 1
Traumatic subdural hematoma admissions between 2014 and 2016.

Readmission	Yes n (%)	No n (%)	p-value
Frequency	75 (44.9)	92 (55.1)	0.89
Age			
≤60yr	14 (18.7)	36 (39.1)	0.02
>60yr	61 (81.3)	56 (60.9)	0.004
Age: Mean (SD)	74.1 (16.1)	64.5 (19.7)	<0.001
Gender: Female	37 (49.3)	46 (50.0)	0.92
Discharge Disposition			
Home	29 (38.7)	56 (60.9)	0.05
Other HealthCare Facility	46 (61.3)	27 (29.3)	0.01
Died in Hospital	0	8 (8.7)	–
Other	0	1 (1.1)	–

$p = 0.003$). Males were also readmitted earlier (average 59 days) when compared to females (average of 80 days). We further analyzed the differences in age groups between the two populations. It showed that a higher proportion of patients who were readmitted were in the age group of > 60 compared to those who were not readmitted (81.3% vs. 60.9%, $p = 0.0047$). The proportion of genders in both groups was nearly equal and thus was not a predictor of readmission (Table 1).

Most patients in the group that was not readmitted were initially discharged home (60.9% vs. 38.7%, $p = 0.05$). However, the majority of patients in the group that was readmitted were discharged to another health care facility (61.3% vs. 29.3%, $p = 0.01$) (Table 1).

Comparisons were made between the mean ICU length of stay on first admission in each patient group. The mean length of stay in the ICU was 4.12 days for patients in the readmitted group and 3.36 days for patients who were not readmitted ($p = 0.19$).

Injury severity scores were examined between both groups in Table 2. While a greater percentage of patients in the group that was readmitted had an ISS > 15 , this did not serve as a predictor of readmission (51.4% vs. 46.7%, $p = 0.67$). Anticoagulation status on discharge was not a significant risk factor for readmission (13.0% vs. 11.7%, $p = 0.93$).

Table 2 also displays patients in each group receiving surgical intervention. Of the patients who were readmitted, 9.6% of patients received surgical intervention at their initial readmission. This compares to the 11.5% of patients who received surgical intervention and were not readmitted. Thus, surgical intervention at initial admission was not found to be a significant factor in readmission ($p = 0.9$).

SDH significantly increased the risk of readmission (HR = 16.21; $p = 0.001$). Other independent significant factors associated with readmission in this model included prior anticoagulation use (HR = 5.2, $p = 0.23$), anticoagulation at discharge (HR = 4.2, $p = 0.04$), and male gender (HR = 8.2, $p = 0.004$).

4. Discussion

Traumatic brain injury in general is a major cause of morbidity and mortality in the United States and in the world [12,13]. According to the Centers for Disease Control and Prevention [9], the

Table 2
Outcome differences between readmission groups for patients with traumatic subdural hematoma.

Readmission	Yes n (%)	No n (%)	p-value
Comorbidities			
≤4	12 (16.0)	53 (57.6)	0.01
>4	60 (80.0)	35 (38.0)	<0.01
None	1 (1.3)	2 (2.2)	0.95
Missing	2 (2.7)	2 (2.2)	0.97
ICU LOS	(N = 74)	(N = 84) ^a	
Mean (SD) range days	4.12 (3.6) 1 - 21	3.36 (3.1) 1 - 17	0.19
ISS			
≤15	35 (48.6)	49 (53.3)	0.67
>15	37 (51.4)	43 (46.7)	0.67
Anticoagulation			
Yes ^b	9 (13.0)	10 (11.7)	0.93
No ^c	60 (87.0)	73 (85.6)	0.82
Surgical Intervention			
Yes	7 (9.6)	10 (11.5)	0.90
No	66 (90.4)	77 (88.5)	0.71
Diagnosis for readmission			
Subdural	25 (32.2%)		
Other	49 (67.8%)		<0.0005

^a A total of 63 patients overall were not initially admitted to the ICU.

^b Yes includes warfarin, apixaban, heparin, enoxaparin, dabigatran, and rivaroxaban.

^c No includes aspirin, clopidogrel, cilostazol, or none.

rates of TBI-related hospitalizations have substantially increased in recent years for age groups 45–64 years old and 65 years and older [14–16]. Readmission is undesirable and multifactorial. In 2018, HHS Study of TBI readmission rate for those age 37–44 years was 27.8% for the first years and did not significantly change thereafter for the following years (22–23.4%) [5]. Factors associated with readmission after TBI should be considered in designing plan and the need for preventative methods that target this spectrum of comorbidity [5]. Ground level falls from standing height are the most common cause in the elderly population, accounting for 50–70% of all traumatic brain injuries, and are usually secondary to motor and muscle weakness coupled with visual and equilibrium function impairment [17]. Comorbid conditions such as diabetes mellitus, cardiovascular disease, osteoporosis, renal disease as well as multiple medications such as opioids, vasodilators, beta blockers, and anti-coagulants, to mention a few, will only add to the complexity of management of those patients. Readmission of the elderly patients following TBI and more specifically, subdural hematomas average around 25–27% and are a major burden on the health care system [4]. Our study shows that 44.9% of patients initially admitted for traumatic SDH are in fact readmitted within 6 months after initial discharge for either neurologic related problems or other medical conditions which is higher than the national average of 35% [17], and this only adds to an already large financial burden resulting from the extensive management of the initial injury, therefore classifying patients according to their risk factors in readmission is a positive step in planning preventable measures.

Our study found that the majority of readmissions occurred in the first six months after initial discharge from the hospital (80.87%). In fact, 42.3% of patients were readmitted within a month. The majority of patients who were readmitted were over the age of 60 (81.3%) and had greater than four comorbidities (80%). These unsurprising two factors of increased age and number of comorbidities were significant predictors of readmission.

Gender was not a risk factor in readmission as the proportions were nearly identical in both groups. However, there was a significant difference in the number of males readmitted for recurrent acute subdural hematomas (73.3%) when compared to female patients (26.3%, $p = 0.001$). This independent significant factor associated with readmission in our model has also been observed by others [3,4,12]. ICU length of stay and surgical intervention on first admission between the two groups were also similar (3.6 vs. 3.1 days, 9.6% vs. 11.5% respectively $p = 0.19$), and did not approach significance in predicting readmission. A total of only 21.1% patients between both groups ($n = 17$) received surgical intervention. This may possibly be explained by differences in management by different neurosurgeons, patient clinical status, increased mean ages, and increased comorbidities between both groups. Therefore, examining a larger number of surgical patients is needed to determine the significance and timing of surgery [18–20].

Within the group of patients who were readmitted, most had been discharged to another health care facility rather than home (Table 1). In those who were not readmitted, the majority of patients were discharged home. It is difficult to determine the true significance of discharge disposition in predicting readmission because confounding factors may be present. Patients who were discharged to another health care facility in the readmitted group may have already had more serious medical conditions upon initial discharge and thus were already more likely to be readmitted. Similarly, those patients who were initially discharged home inherently already had a better condition to allow them to be discharged home and therefore less likely to be readmitted.

Anticoagulation therapy on first discharge were nearly similar between the two groups and was an independent significant factor associated with readmission while Injury Severity Score (ISS) was

not (Table 2). Analysis of the comorbidities between each group shows that 80.0% of patients who were readmitted had >4 comorbidities compared to only 38% of patients in the group who were not readmitted ($p < 0.01$). The significance of specific comorbidities in each group was not analyzed in our study. However, in the literature, there are studies proving the effect of comorbidities on the outcomes of elderly patients with traumatic subdural hematomas [9,10]. Ganesh et al. suggest that patients with such comorbid conditions will benefit from programs and support to reduce poor functional outcomes [9].

Currently, we have established new programs in order to address some of the factors influencing readmission rates at our institution. One such program is S.E.E.M. (Strength, Eye, Environment, Medications), which seeks to reduce falls by modifying a patient's surrounding environment as well as building patient strength and balance [17]. We also started a new program in the Neurosurgery Department based on the Extension for Community Healthcare Outcomes (ECHO) model discussed by Arora et al., in 2011 [21]. This program specifically uses video conferencing as a technique to provide multimodality care for underserved communities. In the same way, our department has a neurosurgeon advising primary care physicians, nursing home facilities, and other patient caretakers in the prevention and management of acute vertebral fractures and subdural hematomas [22–24]. Through this, we plan to decrease the number of falls leading to these injuries as well as provide relief for professional isolation of the primary care physician and patient caretakers in rural communities.

We had several limitations to our study. Firstly, it was difficult to capture all of the ICD-9-CM codes that were relevant to our study. Therefore, we may have underestimated the number of traumatic SDH treated at our institution during this time period and thus decreased the power of the study. Secondly, of the patients with ICD-9-CM codes that we were able to capture, we still had incomplete information for many risk factors that needed to be analyzed. This also may have resulted in decreased power in certain subgroups. Finally, the significance of specific comorbidities was not included in our analysis.

5. Conclusion

This study identifies risk factors (i.e. age, comorbid conditions, and recurrent subdural hematoma) that predict readmission of elderly patients admitted initially with TSDH and establishes strategies that may help decrease readmission rate for patients with traumatic SDH.

Ethical Approval

Ethical Approval for this study (GRMC 160013) was given by the Genesys Health System – IRB Medical Education Review Board on June 19, 2017.

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Author contribution

Tran Ho – study design, data collection, writing.
Jacob Frisbie – data collection, writing.
Tarik Wasfie – study design, data collection, data analysis, writing.
Jennifer Boyer – data collection.
Tara Knisely – data collection.

Natalia Cwalina – data collection, writing.
 Kimberly Barber – study design, data analysis.
 Brian Shapiro – study design, data analysis.

Conflicts of interest statement

There are no conflicts of interest. We have nothing to declare.

Guarantor

Dr. Tarik Wasfie, MD, FACS.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijso.2019.09.007>.

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