Does Isolated Traumatic Subarachnoid Hemorrhage Merit a Lower Intensity Level of Observation Than Other Traumatic Brain Injury?

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Abstract

Evidence is emerging that isolated traumatic subarachnoid hemorrhage (ITSAH) may be a milder form of traumatic brain injury (TBI). If true, ITSAH may not benefit from intensive care unit (ICU) admission, which would, in turn, decrease resource utilization. We conducted a retrospective review of all TBI admissions to our institution between February 2010 and November 2012 to compare the presentation and clinical course of subjects with ITSAH to all other TBI. We then performed descriptive statistics on the subset of ITSAH subjects presenting with a Glasgow Coma Score (GCS) of 13–15. Of 698 subjects, 102 had ITSAH and 596 had any other intracranial hemorrhage pattern. Compared to all other TBI, ITSAH had significantly lower injury severity scores ($p < 0.0001$), lower head abbreviated injury scores ($p < 0.0001$), higher emergency department GCS ($p < 0.0001$), shorter ICU stays ($p = 0.007$), higher discharge GCS ($p = 0.005$), lower mortality ($p = 0.003$), and significantly fewer head computed tomography scans ($p < 0.0001$). Of those ITSAH subjects presenting with a GCS of 13–15 ($n = 77$), none underwent placement of an intracranial monitor or craniotomy. One subject (1.3%) demonstrated a change in exam (worsened headache and dizziness) concomitant with a progression of his intracranial injury. His symptoms resolved with readmission to the ICU and continued observation. Our results suggest that ITSAH are less-severe brain injuries than other TBI. ITSAH patients with GCS scores of 13–15 demonstrate low rates of clinical progression, and when progression occurs, it resolves without further intervention. This subset of TBI patients does not appear to benefit from ICU admission.

Key words: isolated; progression; sequelae; subarachnoid; traumatic

Introduction

ALTHOUGH THE PRESENCE of traumatic intracranial hemorrhage has traditionally been considered an absolute indication for intensive care unit (ICU) admission, experience has shown that traumatic brain injury (TBI) is not a homogenous disease process.^{1,2} Consequently, evidence has accumulated suggesting that there are certain TBI subpopulations that are less severe and may not, in fact, benefit from ICU admission.^{3–5} If true, these patients incur the charges of a critical care environment while consuming a limited resource without realizing the benefits of this closer level of monitoring. The injury most discussed in this regard is isolated traumatic subarachnoid hemorrhage (ITSAH). Our clinical experience has been that patients with ITSAH tend to be less severely injured and rarely have progression of their

intracranial injury pattern. Additionally, on the rare occasions that progression occurs, it tends to be subtle, rather than catastrophic, and does not lead to a change in the clinical plan other than continued observation and repetition of the computed tomography (CT) scan of the brain.

We undertook this retrospective study to compare the presentation and clinical course of subjects with ITSAH to all other TBI and characterize the subset of ITSAH subjects presenting with a Glasgow Coma Score (GCS) of 13–15. We hypothesized that the overall ITSAH population would have less-severe injury burdens, lower rates of surgical intervention after admission, and better clinical courses and neurological function at the time of discharge than those of all other patients with TBI. We also sought to demonstrate that the specific subset of ITSAH patients with a GCS of 13–15 would have low incidences of benefiting from the ICU environment.

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Methods

This institutional review board (IRB)-approved study was a retrospective review of a dedicated TBI database tracking the radiographic findings and clinical courses of all patients presenting to our urban level 1 trauma center with any degree of traumatic intracranial hemorrhage between February 2010 and November 2012. All CT scans are reread by neurosurgical or radiological study personnel to ascertain precise injury descriptions and (in the instance of a repeat CT scan after hospital admission) make a binary determination of "worse/not worse" before entry into the data bank. The time period of the study saw our institution gradually adopt a policy of selective repetition of CT scans of the head based on changes in neurological exam. Subjects who were less than 18 years of age, pregnant, or prisoners were excluded from enrollment in the data bank per IRB stipulation. Subjects with altered mental status, but an absence of intracranial hemorrhage, were also excluded. All subjects had a mandatory neurosurgical evaluation as per our local standard of care.

Subjects were divided into two groups: ITSAH and all other TBI. Continuous data were compared using Student's *t*-test, and categorical data was compared using Fischer's exact test. Alpha was set at 0.05. Descriptive statistics were also calculated for the subset of ITSAH subjects presenting with GCS of 13–15.

Results

The study cohort consisted of 102 subjects with ITSAH and 596 with any other type of traumatic hemorrhage pattern. Descriptive statistics for the two groups can be found in Table 1. ITSAH patients demonstrated significantly lower Head Abbreviated Injury Scores (AIS), Injury Severity Scores (ISS), higher GCS both in the emergency department and on discharge, fewer head CTs, shorter stays, and lower mortality rates. Fifteen percent of the ITSAH cohort was taking an antiplatelet medication or warfarin at the time of injury, whereas the same was true of 16% of the non-ITSAH cohort ($p=0.77$). Four deaths occurred in the ITSAH group. All of these patients had significant extracranial injuries, along with depressed

levels of consciousness (death #1: ISS, 57; GCS=3; death #2: ISS, 42; GCS=3; death #3: ISS, 45; GCS=9; death #4: ISS, 22; GCS=3).

In considering the ITSAH patients with a presenting GCS of 13–15 ($n=77$), 27 subjects were scheduled to undergo a routine repeat CT scan of the head at an interval of between 6 and 24 h after injury based on the preference of the attending neurosurgical and trauma attending physicians. A radiographic progression rate of 11% was found in these patients undergoing scheduled scan repetition, with none of these correlating with a change in the clinical exam. The only change in management for those subjects demonstrating a radiographic progression of hemorrhage on scheduled CT scan was repetition of daily scans until radiographic stabilization was documented.

Of the remaining 50 ITSAH subjects presenting with a GCS of 13–15, observation was undertaken with plans to repeat a CT scan of the head only in the event of a change in exam. Again, this course was chosen based on the preferences of the attending physicians. Of these 50 subjects chosen for expectant management at the time of admission in the emergency department, 4 (8%) had a subsequent change in their neurological exam that prompted a stat repetition of their CT scan of the head. These changes in exam and emergent scan performance occurred at a mean of 63 h after injury. Of these 4 subjects, 1 (2%) was found to have a radiographic progression of his hemorrhage at 57 h after injury. He was readmitted to the ICU, where his exam normalized after continued observation. Twenty-nine percent of GCS 13–15 ITSAH subjects arrived at our institution as a result of transfer, and 36% had no or only minor extracranial injuries (defined as all non-head AIS scores being ≤ 1).

Discussion

Our analysis suggests that the overall cohort of subjects with ITSAH have significantly less-severe head injuries, lower overall burdens of injury, and better outcomes than all other types of TBI. When an analysis is performed on the subset of ITSAH subjects with GCS of 13–15, they are observed to demonstrate low rates of clinically significant progression, and when progression occurs, it resolves without further intervention, suggesting that this subset of ITSAH patients do not benefit from ICU admission. At the time of the conduct of this study, our trauma and neurosurgical group's practice was to admit all patients with any amount of intracranial hemorrhage of any type to the ICU for observation. Based on the results of this investigation, we have modified our local standard of care to selectively consider ITSAH patients with a GCS of 13–15 to be candidates for admission to a floor bed based on the clinical preferences of the provider.

TBI is a disease process that consumes high amounts of institutional and systemic resources. As an urban safety net hospital and level 1 trauma center, administering the appropriate allocation of these resources is a vital part of our practice. We have an institutional policy of acceptance of nearly all transfer requests, and this requires balancing the needs of those outside patients who need our specialized services with those of the patients who are already within our walls all in the context of our 32-bed surgical ICU. This conundrum is not unique to our institution, especially given the gaps in neurosurgical coverage that exist for large swaths of the country, which result in a high volume of transfers of TBI patients from remote areas to regionalized trauma centers. A policy of ICU admission for any amount of intracranial hemorrhage, regardless of neurological exam, is widely practiced, in part because of the perception that this condition holds the potential for catastrophic and sudden decompensation with permanent sequelae. Given that this is certainly true for the majority of TBI, it is understandable

TABLE 1. DESCRIPTIVE STATISTICS
FOR THE ITSAH AND ALL OTHER TBI GROUPS

	All ITSAH	All other TBI	p value
<i>n</i>	102	596	
Age, years	42.5 ± 19.2	43.9 ± 21.1	0.53
Male/female, %	71/29	75/25	0.42
Blunt mechanism of injury, %	99	96	0.11
Injury Severity Score	18.2 ± 10.2	25.2 ± 11.5	<0.0001
Head Abbreviated Injury Score	3.2 ± 0.7	4.1 ± 0.8	<0.0001
Chest Abbreviated Injury Score	1.2 ± 1.5	1.6 ± 1.7	0.03
Abdomen Abbreviated Injury Score	0.6 ± 1.1	0.8 ± 1.2	0.11
Emergency department GCS	12.6 ± 3.9	10.5 ± 4.8	<0.0001
Number of head CT scans	1.8 ± 1.2	2.6 ± 2.0	<0.0001
ICU length of stay, days	3.1 ± 5.0	4.9 ± 6.4	0.007
Hospital length of stay, days	7.6 ± 10.6	10.4 ± 12.9	0.04
Discharge GCS	14.8 ± 0.9	14.3 ± 1.7	0.005
Mortality, %	4	14	0.003

ITSAH, isolated traumatic subarachnoid hemorrhage; TBI, traumatic brain injury; GCS, Glasgow Coma Scale; CT, computed tomography; ICU, intensive care unit.

why most institutions default to this practice of mandatory ICU admission for any amount of intracranial hemorrhage. Though this is clearly a best practice for the majority of TBI patients, frustratingly little work has been done on the identification of subsets of TBI patients who could potentially be observed in a non-ICU setting. Identification of these TBI injury patterns, and a definition of their natural courses, would allow for their observation on a general ward, rather than the ICU, for those already at our institution. Characterization of this cohort also has the potential to obviate the transfer of these patients to a center with neurosurgical coverage, which could impart financial savings as well as spare family and patient frustrations over being transferred in order to "just be watched." The reality of the changing face of health care is that all providers and centers are being pushed to deliver better care for fewer reimbursement dollars. Clearly, there is value in identifying cohorts of TBI patients who do not benefit from ICU admission.

Three recent studies have attempted to define the natural history and severity of ITSAH with a high GCS. Levy and colleagues compared patients with isolated concussions to those with ITSAH and found that the latter were 9 times more likely to be admitted to the ICU while demonstrating shorter ICU stays than the isolated concussion cohort. Further, hospital lengths of stay and mortality rates were similar between the groups, and no patients in either group underwent an invasive neurosurgical procedure.³ The Allegheny group recently examined the clinical courses of 478 subjects presenting to their institution with ITSAH.⁴ Ninety-eight percent of these subjects underwent repeat imaging, with only a 3% rate of radiographic progression of injury. Notably, none of these patients exhibited a neurological decline or underwent an invasive neurosurgical procedure. Finally, Borczuk and colleagues examined ITSAH in the context of a larger investigation on the clinical decompensation rates of all TBI.⁵ Their cohort of 75 ITSAH patients did very well, with only one clinical decompensation, albeit a mortality. This patient was a 98-year-old male who suffered a fall from standing while on antiplatelet therapy. Whereas his GCS was initially 14, he subsequently developed hypoxia and hypotension, which caused his family to initiate comfort care only. When pooled with our results, this collection of studies shows that, in a series of 747 ITSAH patients with GCS scores of 13–15, a rate of clinical or radiographic progression of hemorrhage pattern was observed in 0.9–1.9% of subjects, none of whom underwent an invasive neurosurgical procedure (Table 2). This pooled experience represents the largest reported in the literature on this particular subset of TBI patients.

When neurological changes occur, they are frequently at a time point that is beyond that of a normal period of observation. The

single ITSAH patient with a GCS of 13–15 in our cohort in whom a clinical change occurred took place at 57 h after injury. This subject had already been discharged home and returned to the emergency department the following day for headache and emesis. A repeat CT scan showed an increase in the amount of his subarachnoid hemorrhage (SAH) and he was readmitted to the ICU. Another CT scan was scheduled for the following morning, which showed no change in his new hemorrhage pattern, whereas his clinical picture had improved. He was discharged once again with a GCS of 15 and resolution of his symptoms. Additionally, the single patient in the Allegheny group who demonstrated clinical sequelae of ITSAH progression did so at 6 weeks after injury when chronic subdural hemorrhages manifested and required drainage.

We found it surprising that only 38% of our sample of ITSAH patients with a high GCS had few or no extracranial injuries. In raw numbers, this translates into only 29 subjects (10 of whom were transfers) in the 33 months that the dedicated TBI database was tracked. Seen in the context of a busy urban trauma center that admitted 3000 trauma patients annually through this same time period, it was gratifying that our institution appears to be having relatively few isolated injuries being transferred in for the explicit purpose of managing what appears to be a benign clinical entity. It should be kept in mind, however, that the same cannot be said for many other centers that have large rural catchment areas and a dearth of neurosurgical coverage for which these numbers would likely be higher. Though our volume of resource savings with a policy of non-ICU observation for these patients may not be generalizable to all centers, the principles involved regarding the natural history of this injury certainly are. Additionally, we have approached this study as a starting point from which we can begin to study whether other TBI subsets with high GCS scores are also candidates for this same treatment strategy.

This investigation is not without its limitations. The management of these patients was not protocol driven, meaning that decisions about rescanning and clinical endpoints were left to whichever of the roughly two dozen physicians that provided TBI care during the time period of the study at our institution was covering. Further, we do not have long-term follow-up on the cohort and therefore cannot ascertain whether there are any delayed sequelae from an initial period of lower-intensity observation for these injuries. Additionally, it is not our group's practice to routinely perform a CT angiogram on all trauma patients with isolated SAH to rule out an antecedent aneurysmal rupture as an etiology for the traumatic event, unless some historical point raises our index of suspicion. Therefore, we cannot say definitively that there were not any nontraumatic SAHs in our cohort. Finally, we do not have any data regarding transcranial doppler (TCD) velocities in our ITSAH cohort. Whereas the propensity of aneurysmal SAH to induce vasospasm and negatively affect outcome is well known, data exist suggesting that the same can be said for traumatic SAH as well.^{6,7} Because the increase in velocities on TCDs in these studies has been shown to correlate with the volume of traumatic subarachnoid blood, and we base our care on the clinical exam rather than a quantitative score of the hemorrhage volume, we cannot say whether the ITSAH patients were experiencing spasm.

In conclusion, patients with ITSAH and a GCS of 13–15 do not appear to benefit from a higher level of intensity of observation after injury because clinical deteriorations attributable to their head injury are rare and without apparent short-term sequelae. These results add to a body of literature on this subject that now totals almost 750 patients, none of whom have undergone a neurosurgical procedure. This body of work should support national guidelines

TABLE 2. PREVIOUS INVESTIGATIONS OF ITSAH WITH GCS OF 13-15 AND DETERMINABLE OUTCOMES

<i>Authors</i>	<i>ITSAH (n)</i>	<i>Clinical or radiographic hemorrhage progression (%)</i>	<i>Craniotomy/ monitor placement</i>
Levy and colleagues ³	117	1 (0.9)	0
Quigley and colleagues ⁴	478	9 (1.9)	0
Borczuk and colleagues ⁵	75	1 (1.3)	0
Phelan and colleagues	77	1 (1.3)	0
Total	747	12 (1.6)	0

GCS, Glasgow Coma Score; ITSAH, isolated traumatic subarachnoid hemorrhage.

regarding the triage and transfer of these patients. Future work will aim to describe other TBI subgroups that may also be candidates for a similar treatment strategy.

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Author Disclosure Statement

No competing financial interests exist.

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