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ED disposition of the Glasgow Coma Scale 13 to 15 traumatic brain injury patient: analysis of the Transforming Research and Clinical Knowledge in TBI study☆,☆☆

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Abstract

Objective—Mild traumatic brain injury (mTBI) patients are frequently admitted to high levels of care despite limited evidence suggesting benefit. Such decisions may contribute to the significant cost of caring for mTBI patients. Understanding the factors that drive disposition decision making and how disposition is associated with outcomes is necessary for developing an evidence-base supporting disposition decisions. We evaluated factors associated with emergency department triage of mTBI patients to 1 of 3 levels of care: home, inpatient floor, or intensive care unit (ICU).

Methods—This multicenter, prospective, cohort study included patients with isolated head trauma, a cranial computed tomography as part of routine care, and a Glasgow Coma Scale (GCS) score of 13 to 15. Data analysis was performed using multinomial logistic regression.

Results—Of the 304 patients included, 167 (55%) were discharged home, 76 (25%) were admitted to the inpatient floor, and 61 (20%) were admitted to the ICU. In the multivariable model, admission to the ICU, compared with floor admission, varied by study site, odds ratio (OR) 0.18 (95% confidence interval [CI], 0.06–0.57); antiplatelet/anticoagulation therapy, OR 7.46 (95% CI, 1.79–31.13); skull fracture, OR 7.60 (95% CI, 2.44–23.73); and lower GCS, OR 2.36 (95% CI, 1.05–5.30). No difference in outcome was observed between the 3 levels of care.

Conclusion—Clinical characteristics and local practice patterns contribute to mTBI disposition decisions. Level of care was not associated with outcomes. Intracranial hemorrhage, GCS 13 to 14, skull fracture, and current antiplatelet/anticoagulant therapy influenced disposition decisions.

1. Introduction

An estimated 1.7 million people have a traumatic brain injury (TBI) every year in the United States, of which 275000 are hospitalized [1,2]. Mild traumatic brain injury (mTBI), defined as Glasgow Coma Scale (GCS) 13 to 15, represents 75% or more of all TBI and is one of the most common neurologic diseases treated in US emergency departments (EDs) [2]. It is accepted that TBI patients with a GCS of 15 and a negative head computed tomographic (CT) scan can be safely discharged home after ED evaluation, but there remain limited data to guide clinicians in the triage of mTBI patients with GCS 13 to 14 and/or traumatic intracranial hemorrhage (ICH) [3]. Currently, many mTBI patients are dispositioned into the hospital for observation, including to the intensive care unit (ICU), yet it remains unclear if this results in a net benefit for the patient and the health care system [4–7]. Understanding factors that drive clinical decision making in the disposition of these patients and the outcomes subsequent to ED disposition would provide a framework for improving the consistency of appropriate acute care. Given that mTBI costs society $17 billion every year, optimization of the disposition of these patients may represent an opportunity for important patient safety and cost containment interventions [8].

The objective of this study was to understand the clinical variables most predictive of ED triage of mTBI patients to 1 of 3 levels of care: home, inpatient floor, or ICU. We also examined the effect of ED triage decision on 6-month outcome.

2. Materials and methods

2.1. Study design

Transforming Research and Clinical Knowledge in TBI (TRACK-TBI) study (clinicaltrials.gov, NCT01565551) is a prospective cohort study of all TBI patients presenting to 1 of 2 level I trauma centers with in-house neurosurgical coverage [9–11]. Institutional review board approval was obtained for this study from the participating institutions.

2.2. Study setting and population

Traumatic brain injury patients with an ED GCS score of 13 to 15 from the TRACK-TBI study were considered for inclusion. Patients were recruited from 2 busy level I trauma centers. Eligible patients presented to a participating hospital within 24 hours of an injury that resulted from an external force to the head and had a noncontrast cranial CT performed in the ED. The current study included only those with mTBI, defined as a GCS 13 to 15. In an effort to limit the potential confounding effects that concomitant injuries have on ED disposition and overall outcome, we excluded subjects with an abbreviated injury scale score greater than 2 for chest, abdomen, extremities, and external categories [12].

2.3. Neuroimaging interpretation

Head CT images from the ED were interpreted by a neuroradiologist. Extraaxial hemorrhage (ie, subdural and epidural hematoma), subarachnoid hemorrhage, and parenchymal hemorrhage (ie, contusions) were all considered traumatic ICH.

2.4. Outcome measures

Six-month follow-up included a battery of neuropsychologic tests and predetermined structured outcome measures. Given the heterogeneity of the impairment after mTBI, we considered several complementary assessments. The Rivermead Postconcussion 13-item Questionnaire (RPQ-13) was used to assess somatoaffective outcomes [13,14]. The Trail Making Test part B was used to assess neurocognitive performance and executive functioning [15]. Functional dependence was measured by the Glasgow Outcome Scale Extended (GOSE) instrument [16,17]. Lastly, the Satisfaction with Life Scale (SWLS) was used to assess a patients' overall subjective experience after mTBI [18,19].

2.5. Data analysis

To optimize the power of the study to detect differences, multinomial logistic regression was used to investigate factors associated with disposition. We report odds ratios for the following contrasts: the odds of being admitted to the floor compared with the odds of being discharged home, the odds of being admitted to the ICU vs being sent home, and the odds of a floor admission compared with the odds of an ICU admission. Patients admitted to step-down units were considered ICU admissions in the data analysis. The international normalized ratio (INR) was dichotomized at 1.2 based on epidemiologic associations suggesting increased risk of poor outcome when INR is above this level [20–23].

All variables were selected for consideration before conducting statistical evaluation, with a focus on data that are typically available to the ED physician and that may reasonably influence a provider's disposition plan. Variables that had a statistically significant (set a priori at $P < .05$) crude association with disposition from the ED were considered in further multivariable data analysis. We used a manual, backward stepwise approach to variable inclusion. Independent variables that remained statistically significant were included. Collinearity was evaluated using variance inflation factor more than 10 as a cut-off; no collinearity was noted in the evaluation of the final model.

In addition, we analyzed the relationship between ED disposition and 6-month outcome. Three-way analysis of variance models were constructed to explore a crude association between disposition from the ED and the RPQ-13, the time necessary to complete the Trail Making Test part B, and the composite of the SWLS. A χ^2 test was used to assess the relationship between ED disposition and GOSE.

All analyses were performed using SAS version 9.3 (SAS Institute Inc, Cary, NC).

3. Results

3.1. Characteristics of the study population

A total of 580 patients were enrolled in TRACK-TBI, of which 304 patients were eligible for inclusion in the current study. Males represented 71% (215) of the population, and the mean (SD) age was 40.8 years (17.3). Characteristics of the study population are presented in Table 1. Most patients in this analysis (246; 81%) were enrolled at 1 of the 2 sites. Eighty-four (28%) patients presented after a fall, which represented the dominant mechanism of injury in this cohort; bicycle crashes, 59 (19%); assaults, 58 (19%); and motor vehicle crashes, 41 (13%) represented the remaining mechanisms of injury. Approximately 3 quarters of all subjects (72%) had a GCS of 15 at presentation, and 195 (64%) reported a history consistent with loss of consciousness. Intracranial hemorrhage was observed on head CT in 90 patients (29%). Five (1.6%) of the 304 mTBI patients examined in this study had a neurosurgical intervention (Table 2). All 5 patients were admitted to the ICU from the ED, and none were taking antiplatelet or anticoagulation medications.

3.2. Primary results

The univariable multinomial logistic regression analyses are shown in Fig. 1. Glasgow Coma Scale 13 to 14, elevated blood alcohol content, evidence of ICH on head CT, skull fracture, and facial fractures were each associated with increasing odds of disposition to both floor and ICU relative to discharge home. Intensive care unit admission compared with admission to the floor was predicted by increasing education, antiplatelet/anticoagulation therapy, ICH, and skull fractures. One site preferred floor admissions, whereas the other site had a predilection for ICU admissions. Education level, age older than 65 years, and antiplatelet/anticoagulation therapy were associated with increased odds of admission to the ICU compared with discharge home but were not associated with increased odds of admission to a floor setting. The following variables were carried forward to the final model: GCS 13 to 14, presence of ICH on head CT, evidence of skull fracture, study site, and patient use of anticoagulation/antiplatelet therapy.

The multivariable model is reported in Fig. 2. A presenting GCS of 13 to 14 resulted in a 2-fold increase in odds of admission to the floor and more than 4-fold increase in admission to the ICU. Evidence of ICH on head CT increased the odds of floor and ICU admissions; however, there was no significant difference in ICH among those admitted to the floor vs the ICU. Skull fractures also increased the odds of an ICU admission when compared with both home and floor. Antiplatelet/anticoagulant therapy was associated with increased odds of ICU admission (odds ratio, 3.6; 95% confidence interval, 1.05–12.32) but was not associated with admission to the floor. After adjusting for clinical characteristics, disposition decisions differed between sites. No statistically significant interaction terms were noted.

3.3. Secondary analysis

A secondary analysis of selected outcomes assessed at 6 months postinjury did not detect a statistically significant association with disposition (Table 3).

4. Discussion

In this prospective cohort study of isolated mTBI patients presenting to 2 level 1 trauma centers, we found that patients with GCS 13 to 14, evidence of ICH on CT, skull fracture, or antiplatelet/anticoagulation use were associated with increased odds of admission compared with patients without these findings. Despite the observation that those patients admitted had worse disease compared with those sent home, we found no relationship between ED disposition decisions and outcome 6 months after injury.

That GCS score of 13 to 14, ICH, skull fracture, and antiplatelet/anticoagulation use were associated with disposition to a higher level of care is consistent with the knowledge that these variables have been associated with higher likelihood of deterioration or increased risk of intracranial pathology [24–28]. It is noteworthy that, in multivariable analysis, no relationship was observed between disposition and age, intoxication, or facial fractures, as these variables have been considered potentially important for risk stratification of mTBI patients [24,29]. Presence of ICH did not increase the odds of admission to the ICU when compared with floor admission.

The data presented here represent experience from only 2 hospital systems, yet variability in disposition patterns are observed. Site A was more likely to admit patients when compared with discharge home but was less likely to place patients in the ICU. This type of clinical variability has been noted previously and may be due to limited evidence to guide ED disposition decisions [6]. It is therefore expected that local practice patterns may be a significant determinant of disposition decisions and thereby costs of care.

It is commonly recommended that a patient with a negative head CT and a GCS of 15 may be safely discharged from the ED [3–5,7]. In contrast, if the head CT shows any traumatic ICH, many centers opt to admit the patient to an ICU setting [24,29,30]. However, with the rising cost of medical care and the push to use limited resources effectively, the practicality of frequently admitting patients with traumatic ICH to the ICU merits investigation.

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Our data reveal no association between disposition from the ED and 4 different outcome measures at 6 months postinjury, including patient reported SWLS. These findings suggest that the frequent use of higher level ICU care for mTBI patients with traumatic ICH may be unnecessary. The disposition decision from the ED is complex and of critical importance when balancing patient safety with the reality of limited resources. Society spends approximately $17 billion annually caring for the mTBI patient, and much of that cost is related to direct patient care during the acute period [8]. Therefore, if cost may be safely reduced in the management of mTBI, disposition may reflect one of the most important branch points in cost of caring for the mTBI patient.

We note, however, that 5 of the 62 patients in the ICU group did require a neurosurgical intervention. Meanwhile, a lack of any neurosurgical intervention in patients admitted to a floor setting suggests that hospital resources are being used without acute physician-directed intervention to affect patient outcomes. Admissions, however, may occur for symptom control, poor social situation, nursing-driven interventions, and several other reasons that have not been accounted for here or previously [6,24,31]. A potential alternative approach for this cohort of floor admissions may be through the application of ED-based observation units [32].

It is noteworthy that patients with apparently worse disease were more likely to be admitted to the ICU, but outcomes at 6 months did not differ by disposition. As all 3 groups had similar outcomes, this may reflect either an opportunity for cost saving by reducing admissions and/or level of care, or support the value of intensive, high-quality care for the more severely injured mTBI patient. Optimization of care and disposition strategy for the mTBI patient require rigorous consideration through a carefully designed multicenter study.

5. Limitations

This study is limited by disproportionate enrollment between the 2 study sites. Findings may not reflect practice outside these 2 institutions. Some information that may reasonably influence ED disposition decisions such as social situation or support, persistent symptoms (ie, intractable nausea and vomiting), and ability to arrange follow-up were not available for consideration. In addition, admission to an ED observation unit was not considered. Admission to an observation unit may be an important cost-saving approach to disposition of the mTBI patient, particularly when compared with admission to the floor [32].

6. Conclusion

The goal of this study was to determine factors associated with ED triage decisions and if this decision has a relationship with 6-month outcome. Our study revealed several clinical factors that physicians use to guide disposition decisions. Variability in practice patterns may be substantial suggesting a need for a comparative effectiveness study to evaluate the best strategy for disposition of the mTBI patient from the ED. In this cohort, outcome at 6 months did not differ by disposition. General predictors of outcome after mTBI merit further consideration and study. An 11-center TRACK-TBI study is currently enrolling.

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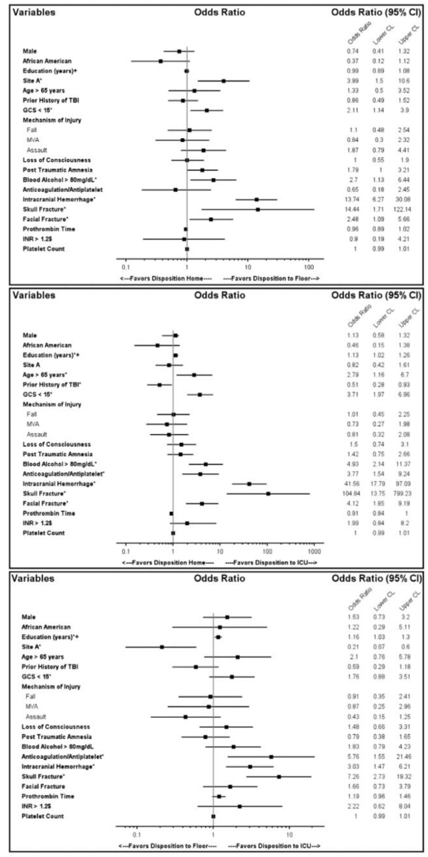

Fig. 1.

Univariable multinomial logistic regression results by ED disposition. *$P < .05$; $International normalized ratio; +Odds per year of education.

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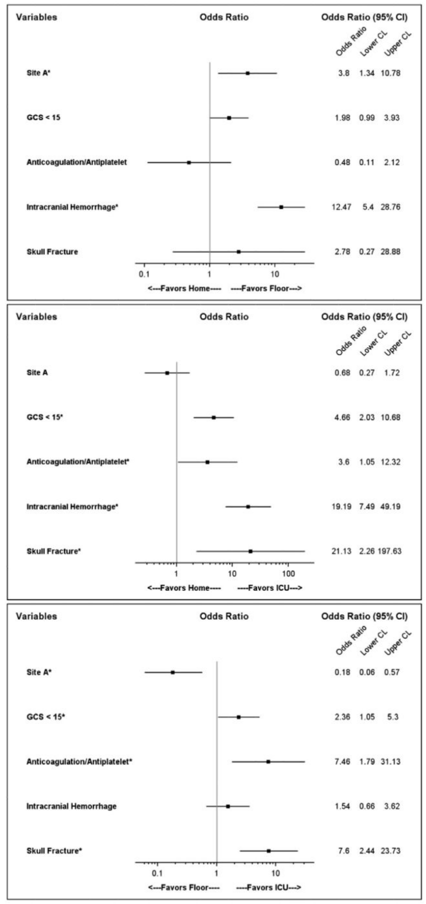

Fig. 2.

Multivariable multinomial logistic regression results by ED disposition. *$P < .05$.

Table 1

Clinical and demographic features of all isolated mTBI patients upon ED presentation stratified by ED disposition (n = 304)

Characteristic	Home (n = 167)	Floor (n = 75)	ICU (n = 62)
Male	120 (72%)	49 (65%)	46 (74%)
White	126 (75%)	65 (87%)	51 (82%)
Education, years (mean ± SD)	13.6 (3)	13.5 (3)	14.8 (3.2)
Site A	130 (78%)	70 (93%)	46 (74%)
Age (mean ± SD)	38.9 (16.2)	41.7 (17.6)	44.4 (19.5)
Prior history of TBI	107 (64%)	46 (61%)	29 (47%)
GCS <15	32 (19%)	25 (33%)	29 (47%)
Mechanism of injury			
Motor vehicle crash	25 (15%)	8 (11%)	8 (11%)
Fall	45 (27%)	19 (25%)	20 (32%)
Bicycle crash	35 (21%)	15 (20%)	9 (15%)
Assault	28 (17%)	20 (27%)	10 (16%)
Other	34 (20%)	13 (17%)	15 (24%)
Loss of consciousness	103 (62%)	48 (64%)	44 (71%)
Posttraumatic amnesia	89 (53%)	51 (68%)	35 (56%)
Blood alcohol >0.08	11 (7%)	12 (16%)	16 (26%)
Anticoagulation/antiplatelet	10 (6%)	3 (4%)	12 (19%)
ICH[a]	10 (6%)	35 (47%)	45 (73%)
Skull fracture	1 (0.6%)	6 (8%)	24 (39%)
Facial fracture	13 (8%)	13 (17%)	16 (26%)
Partial thromboplastin time (mean ± SD)	30.1 (11)	27.8 (4.3)	27.0 (4.4)
INR (mean ± SD)	1.16 (0.47)	1.07 (0.12)	1.15 (0.34)
Platelet count (mean ± SD)	253 (63.9)	265 (102.2)	251 (83.2)

[a]Any ICH identified on noncontrast head CT.

Table 2

Clinical details of patients requiring neurosurgical intervention (n = 5)

Patient	Age (y)	Mechanism of injury	Arrival GCS[a]	INR[b]	Injury	Procedure
A	25	MVC	15 (4/5/6)	1.00	Epidural hematoma, skull fracture	Craniotomy, hematoma evacuation, skull repair
B	18	Assault	14 (4/4/6)	1.40	Skull fracture	Craniotomy, skull repair
C	59	Assault	15 (4/5/6)	1.10	Subdural hematoma	Craniotomy, hematoma evacuation
D	25	MVC	13 (3/4/6)	1.30	Midbrain intraparenchymal hemorrhage	External ventricular drain, Licox® (Integra™; Plainsboro, NJ)
E	39	Assault	14 (4/4/6)	1.10	Intraparenchymal hemorrhage, subarachnoid hemorrhage	Hemicraniectomy, intraparenchymal hemorrhage evacuation

Abbreviation: *MVC*, motor vehicle crash.

[a] Glasgow Coma Scale total (eye score/verbal score/motor score).

[b] International normalized ratio.

Table 3

Outcomes at 6-month follow-up, stratified by ED disposition

Outcome measure	Discharge home	Admit to floor	Admit to ICU	P^a
RPQ-13[b] (mean ± SD)	15.1 (13.2)	16.4 (12.7)	11.3 (10.3)	.17
Trail Making Test part B[b] (mean ± SD)	84.8 (59.5)	104 (78.3)	84.7 (60.6)	.23
SWLS[c] (mean ± SD)	20.1 (7.6)	20.1 (8.5)	22.3 (7.9)	.38
GOSE[d]—good recovery, n (%)	90 (54%)	40 (53%)	39 (63%)	.43

[a] Analysis of variance or χ^2 test as appropriate.

[b] Rivermead Post Concussion Questionaire: Lower score represents a better performance.

[c] Satisfaction With Life Survey: Higher score represents a better performance.

[d] Glasgow Outcome Scale Extended.