Clinical Characteristics Predict the Yield of Head Computed Tomography Scans among Intoxicated Trauma Patients: Implications for the Initial Work-up

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Abstract

Background and Aims: Alcohol intoxication may confound the clinical assessment of the trauma patient. Head computed tomography (h-CT) is the standard imaging technique to rule out intracranial injury in most intoxicated trauma patients. The objective of this study was to determine whether certain clinical findings (computed clinical score [CCS]) could predict the h-CT yield, admission, and neurosurgical consultation (NSC) among intoxicated trauma patients. Materials and Methods: This is a 4-year retrospective cohort study (2013–2017) of trauma patients who presented to our level 1 trauma center emergency department with alcohol intoxication. For each patient, a computed clinical score (CCS) was generated based on the following findings: age ≥ 50 years, Glasgow Coma Scale < 13, evidence of trauma above the clavicles, amnesia, loss of consciousness, headache, vomiting, and seizures. The primary endpoints were NSC, admission, and acute h-CT finding. Univariate and multivariate regressions were used to compare predictors of the primary endpoints. Results: We identified 437 intoxicated trauma patients (median age: 35 years [interquartile range: 25–50]; 71.9% men; median blood alcohol content: 207.8 mg/dL). One hundred and twenty-four (30.4%) patients had acute findings on h-CT, 351 (80.3%) were admitted, and 112 (25.6%) received NSC. On multivariate analysis, CCS was the only predictor of acute h-CT (odds ratio [OR] = 1.6; 95% confidence interval [CI]: 1.3–2.0; P < 0.0001) and the best predictor of admission (OR = 1.6; 95% CI: 1.3–1.9; P < 0.0001) and NSC (OR = 1.8; 95% CI: 1.5–2.3; P < 0.0001). Conclusions: One-third of intoxicated trauma patients have acute findings on h-CT. While the CCS was the best predictor of acute h-CT findings, hospital admission, and NSC, h-CT scanning should continue to be a standard of care.

Keywords: Alcohol, clinical score, head computed tomography, head injury, intoxicated, trauma

Introduction

Head computed tomography (h-CT) scanning has become a standard of care in the initial evaluation of any trauma patient presenting to the emergency department (ED), particularly in those patients whose higher mental function examination is compromised by possible alcohol intoxication. As such, alcohol intoxication is associated with markedly elevated odds of head injury,[1-5] and the risk of a masked underlying injury, including an acute intracranial hemorrhage, cannot be understated in this population. Complicating matters, there is a prevailing notion that alcohol intoxication confounds the clinical history and examination since the signs and symptoms found in patients with underlying head injury are similar to those found in patients with acute alcohol intoxication. For example, an intoxicated patient presenting with amnesia, loss of consciousness, headache, vomiting, seizures, and other common symptoms could potentially have an intracranial injury, uncomplicated sequela of alcohol intoxication, or both.[6-9]

While h-CT decision guidelines that utilize clinical presentation provide valuable information for patients presenting to the ED without an obvious mechanism of injury (fall or motor vehicle accident) and are alert and orientated, they may have limited applicability to the intoxicated trauma patient.[10-12] Past
estimates of h-CT yield among intoxicated trauma patients range to over 40%; however, there is a paucity of clinical tools that predict h-CT yield among this population. There also remains the question of triaging (i.e., determining who should be scanned first) when patient flow through CT scanners becomes congested. Situations with multiple concurrent h-CT requests in the ED are common and often impede optimal patient care and ED flow. Therefore, a system is needed to judiciously stratify the risk of underlying head injury, especially among intoxicated trauma patients. Moreover, at the time of the primary and secondary assessments, it may not be clear who is likely to require admission or neurosurgical consultation (NSC) before CT scanning is performed.

The clinical examination has been shown to stratify the risk of patients with possible underlying head injury. Among intoxicated trauma patients, it has not been well established whether the clinical examination can be a reliable tool to screen and triage trauma patients. Therefore, the goal of this study is to evaluate the usefulness of certain clinical characteristics, as determined by our calculated clinical score (CCS), as a predictor of admission to the hospital, NSC, and h-CT yield despite the potentially confounding influence of alcohol on the clinical examination.

**Materials and Methods**

**Study design and setting**

This retrospective cohort study was performed using scanned patient charts of an American College of Surgeons/Committee on Trauma-verified level 1 trauma center located in a suburban area in the Northeastern United States with 631 beds, approximately 44,000 annual ED visits, and >1250 annual trauma admissions. This study was approved by the Institutional Review Board.

**Selection of participants**

Patients aged 14 years or older presenting to the ED between May 1, 2013, and April 30, 2017, were identified using the International Classification of Disease 9 (ICD9) and ICD10 codes involving acute alcohol intoxication. We used the ICD9 and ICD10 because of the mandate from the Centers for Medicare and Medicaid Services to switch from the ICD9 system to the ICD10 system by October 1, 2015. Given that our inclusion timeframe was between 2013 and 2017, both systems were used in order to continue to include patients from both the 2013–2015 and 2015–2017 timeframes. Study investigators confirmed acute alcohol exposure by identifying either a positive measured blood alcohol content (BAC) (>10 mg/dL) or explicit diagnosis of acute intoxication by the clinician at the time of the visit. We included only those patients who were level 1 or 2 trauma activation at the time of ED arrival, i.e., that they were triaged en route to the hospital as requiring either a full or partial activation of the trauma team on arrival. Patients were excluded if they were in police custody at the time of discharge, pregnant, transferred from another medical facility, or had an incomplete chart.

**Measurements**

Patients were identified by a blinded data analyst trained in medical record management. Data were abstracted concurrently by two trained and monitored abstractors using an explicit protocol and the same precisely defined variables and standardized abstraction instrument. Approximately 50 charts were reviewed by both abstractors to ensure consistent measurement. The majority of study variables were obtained from the electronic medical record, except those listed below that were obtained from our trauma registry. Patients with a limited number of missing measurements were included in the study, but the missing measurements were eliminated from subgroup analysis. Data were manually and independently checked for errors by searching for outliers, and issues were resolved using the patient chart.

**Outcomes**

The primary outcomes of this study were the presence or absence of an acute finding on h-CT performed in the ED, admission to the hospital, and NSC. An acute finding on h-CT scan was defined as any skull fracture or intracranial hemorrhage. For each patient, we computed a calculated clinical score (CCS) based on the presence of the following findings: Glasgow Coma Scale (GCS) <13, evidence of trauma above the clavicles, amnesia, loss of consciousness, headache, vomiting, seizures, and age ≥50 years. Each of the above characteristics was assigned one point. Summed scores could theoretically range from 0, having no evidence, to 8, having evidence of all clinical findings listed. These clinical characteristics were selected based on established h-CT guidelines. The cutoff age of ≥50 was determined by calculating the age (in 5-year intervals) at which the chance of having an acute finding on h-CT trended to be greater than 30%.

The secondary measurements included age, sex, race/ethnicity, intoxication status (including BAC if known), mechanism of injury, inhospital mortality, neurosurgical intervention, number of operations before discharge, Injury Severity Score (ISS), head Abbreviated Injury Scale (h-AIS) score, hospital length of stay (LOS), intensive care unit (ICU) LOS, and ventilator days. We also calculated the rates of other (i.e., incidental) findings on h-CT. Neurosurgical intervention was defined as a cranial procedure to monitor for or alleviate alterations to intracranial pressure, including external-ventricular drain, intracranial pressure monitoring, or decompressive craniectomy/craniotomy, or for cranial bone reduction. ISS, h-AIS, ICU LOS, and ventilator days were obtained from our hospital trauma registry.

**Statistical analysis**

The analysis was performed using Prism 7.0a (GraphPad Software, Inc., La Jolla, CA) and SPSS (International Business Machines Corp., Armonk, NY, USA). t-test and ANOVA (with Tukey’s post hoc analysis) were used for continuous variables, and a Fisher’s exact test was used for binary variables. We defined significance at P < 0.05.
median and interquartile range (IQR) is shown for continuous variables and number (%) is shown for categorical values. Where appropriate, the 95% confidence interval (CI) is shown. Incidental findings were considered nonacute for this analysis. Among those who received a h-CT scan, there were 3264 potential clinical characteristics, of which 465 (14.2%) were treated as missing data. To establish the predictors of NSC, admission and acute h-CT, multivariate logistic regressions using the forward conditional method were performed. The variables included in univariate analysis were age, sex, anticoagulant/antiplatelet (AC/AP) use, BAC, CCS, and GCS <13. Only variables significant in univariate logistic regression were used in the multivariate analysis. No collinearity was detected in any multivariate analysis as defined as a variance inflation factor of <1 or >10.

**Results**

**Characteristics of study participants**

Among the 2963 patients identified using ICD codes, 437 intoxicated patients met our inclusion criteria and were classified as a level 1 (98/437, 22.4%) or 2 (339/437, 77.6%) trauma activation [Figure 1]. Of those included, 290 (66.4%) were identified using ICD9 codes, whereas 147 (33.6%) were identified using ICD10 codes. The majority of patients were white (55.1%), men (71.9%), with a median age of 35 years (IQR: 25–50). The median BAC was 207.8 mg/dL (IQR: 155.1–271.5). Only 30 (6.9%) patients were found to have a BAC less than the legal driving limit of 0.08 mg/dl, and only 3 (0.6%) patients were found to be clinically intoxicated without a measured BAC. BAC was not different between level 1 or 2 trauma activations ($P = 0.4831$). The most common mechanisms of injury were due to blunt injury including motor vehicle collision (55.8%), falls (23.1%), and assault (11.2%) [Table 1]. The median ISS was 10 ($n = 291$; IQR: 2–17), whereas the median h-AIS was 3 (IQR: 2–3). Among the entire cohort, 351 (80.3%) were admitted, 112 (25.6%) patients received a neurosurgical consult, 12 (2.7%) received a neurosurgical intervention, and 101 (23.1%) received an operation for any indication [Table 2].

**Main results**

Among this study cohort, we found that 408 (93.4%) patients had a h-CT, of whom 242 (59.3%) had apparently normal findings on h-CT. However, 124 (30.4%) had acute findings and 42 (10.3%) patients had only incidental findings. The most common type of acute finding was skull fracture (84/124, 67.7%), followed by subarachnoid hemorrhage (60/124, 48.4%), intra-parenchymal hemorrhage (38/124, 30.6%), and subdural hemorrhage (29/124, 23.4%); however, there was considerable overlap between injury types within a given patient with 51 (41.1%) individuals having multiple types of acute findings. Of those with an acute h-CT, 56 (45.2%) arrived via advanced life support ambulance, 39 (31.5%) were activated Level 1 trauma patients, 118 (95.2%) were admitted, 48 (38.7%) received an operation, and 6 (4.8%) patients had acute findings and 42 (10.3%) patients had only incidental findings. The most common type of acute finding was skull fracture (84/124, 67.7%), followed by subarachnoid hemorrhage (60/124, 48.4%), intra-parenchymal hemorrhage (38/124, 30.6%), and subdural hemorrhage (29/124, 23.4%); however, there was considerable overlap between injury types within a given patient with 51 (41.1%) individuals having multiple types of acute findings. Of those with an acute h-CT, 56 (45.2%) arrived via advanced life support ambulance, 39 (31.5%) were activated Level 1 trauma patients, 118 (95.2%) were admitted, 48 (38.7%) received an operation, and 6 (4.8%) patients had acute findings and 42 (10.3%) patients had only incidental findings. The most common type of acute finding was skull fracture (84/124, 67.7%), followed by subarachnoid hemorrhage (60/124, 48.4%), intra-parenchymal hemorrhage (38/124, 30.6%), and subdural hemorrhage (29/124, 23.4%); however, there was considerable overlap between injury types within a given patient with 51 (41.1%) individuals having multiple types of acute findings.

| Table 1: Patient demographics |
|--------------------------------|
| **Characteristic** | **Value** |
| Age (years), median (IQR) | 35 (25–50) |
| Male sex (%) | 314 (71.9) |
| BAC (mg/dL), median (IQR) | 207.8 (155.1–271.5) |
| Trauma level 1 ($n=98$) | 204.5 (167.8–272.3) |
| Trauma level 2 ($n=339$) | 208.6 (151.7–271.1) |
| Race/ethnicity (%) | |
| White | 241 (55.1) |
| Hispanic | 137 (30.6) |
| Black | 30 (5.9) |
| Hispanic white | 30 (5.9) |
| Asian | 10 (2.3) |
| Hispanic black | 3 (0.69) |
| Others/missing | 59 (13.5) |
| Mechanism of injury (%) | |
| Motor vehicle collision | 244 (55.8) |
| Falls | 101 (23.1) |
| Assault | 49 (11.2) |
| Pedestrian struck | 23 (5.3) |
| Others | 20 (4.6) |

Median (IQR) is shown for continuous variables and n (%) is shown for categorical values. IQR: Interquartile range, BAC: Blood alcohol content

| Table 2: Injury severity and hospital course |
|-------------------------------------------|
| **Characteristics** | **Value** |
| Mortality (%) | 7 (1.6) |
| Neurosurgical consult (%) | 112 (25.6) |
| Neurosurgical intervention (%) | 12 (2.7) |
| Operations | |
| Received an operation (%) | 101 (23.1) |
| Number per patient, median (IQR) | 1 (1–2) |
| GCS score, median (IQR) | 15 (14–15) |
| ISS ($n=291$), median (IQR) | 10 (2–17) |
| h-AIS ($n=159$), median (IQR) | 3 (2–3) |
| Hospital LOS (days), median (IQR) | 0 (0–4) |
| Admitted to ICU (%) | 161 (36.8) |
| ICU LOS (days), median (IQR) | 2 (1–4) |
| Ventilator days ($n=72$), median (IQR) | 2 (1–10) |

Median (25%-75% IQR) is shown for continuous variables and n (%) is shown for categorical values. GCS: Glasgow Coma Scale, h-AIS: Head Abbreviated Injury Score, ISS: Injury Severity Score, ICU: Intensive care unit, IQR: Interquartile range, LOS: Length of stay
died. The type of acute head injury was not associated with any differences in BAC (\( P = 0.429 \)), age (\( P = 0.282 \)), or sex (\( \chi^2 = 5.047, P = 0.283 \)) [Figure 2a-b].

Of the eight CCS criteria included in our study, the most common was evidence of trauma above the clavicles, followed by loss of consciousness and amnesia. Evidence of trauma above the clavicles was the most sensitive (93.6%), whereas GCS <13 was the most specific (93.7%) for an acute finding on h-CT [Table 3]. When all eight criteria were considered together, we found that the presence of one or more clinical characteristic (CCS ≥1) was associated with increased odds of an acute finding on h-CT (odds ratio [OR] = 5.9; 95% CI: 2.0–18.4; \( P = 0.0008 \)), admission to the hospital (OR = 2.9; 95% CI: 1.6–5.3; \( P = 0.0012 \)), and NSC (OR = 7.5; 95% CI: 2.4–23.1; \( P < 0.0001 \)).

We found that those who did not receive a h-CT (\( n = 24 \)) had a lower CCS (median = 1 [IQR: 0–1]) compared to those who were scanned (median = 2 [IQR: 1–3], \( P < 0.0001 \)). Among those who did receive a h-CT, there was a significant difference in CCS between those who had an acute finding and those who had no findings (\( P < 0.0001 \)). Those with an incidental finding tended to have a higher CCS compared to those with no findings on h-CT; however, this comparison failed to attain significance on post hoc analysis.

**Figure 2:** The association between blood alcohol content, age, and clinical score with head computed tomography findings. Head injury type is not associated with blood alcohol content (a) or age (b); however, CCS was higher for subarachnoid hemorrhage and subdural hemorrhage compared to skull fractures (c). The CCS is associated with head computed tomography yield. Different letters indicate a post hoc significance (d) *\( P < 0.05 \)

**Table 3: Individual clinical characteristics predict acute head computed tomography finding**

| Clinical characteristic | Percentage of sensitivity | Percentage of Specificity | Percentage of PPV | Percentage of NPV | OR | \( P \) |
|-------------------------|--------------------------|---------------------------|------------------|------------------|----|------|
| Evidence of trauma above clavicles | 93.6 (87.8–96.7) | 34.9 (29.6–40.6) | 38.5 (33.2–44.2) | 92.5 (85.9–96.2) | 7.8 (3.7–16.2) | <0.0001 |
| GCS <13 | 31.5 (23.9–40.1) | 93.7 (90.2–96.0) | 68.4 (55.5–79.0) | 75.8 (71.0–80.0) | 6.8 (3.8–12.1) | <0.0001 |
| Loss of consciousness | 81.1 (72.8–87.3) | 49.0 (42.9–55.1) | 41.1 (34.8–47.7) | 85.5 (78.9–90.3) | 4.1 (2.4–7.1) | <0.0001 |
| Amnesia | 75.0 (65.5–82.6) | 53.2 (46.8–59.5) | 39.6 (32.7–46.8) | 83.9 (77.2–88.9) | 3.4 (2.0–5.7) | <0.0001 |
| Vomiting | 15.7 (9.0–26.0) | 93.0 (88.7–95.7) | 42.3 (25.5–61.1) | 77.0 (71.5–81.8) | 2.5 (1.1–5.5) | 0.0530 |
| Age ≥50 years | 33.1 (25.4–41.7) | 74.7 (69.3–79.4) | 36.3 (28.0–45.5) | 71.9 (66.5–76.7) | 1.5 (0.9–2.3) | 0.1187 |
| Headache | 21.5 (13.3–33.0) | 78.1 (72.2–83.1) | 23.0 (14.2–34.9) | 76.7 (70.7–81.8) | 0.98 (0.50–1.88) | >0.9999 |
| Seizure | - | 98.2 (95.5–99.3) | - | 70.3 (65–75.1) | - | 0.3248 |
| CCS ≥1 | 97.6 (93.1–99.3) | 12.7 (9.3–17.1) | 32.8 (28.2–37.7) | 92.3 (79.7–97.4) | 5.9 (2.0–18.4) | 0.0008 |

Analysis was completed using only patients with a recorded value for that particular characteristic. The maximum number of patients that could be included was 408. GCS: Glasgow Coma Scale, CI: Confidence interval, PPV: Positive predictive value, NPV: Negative predictive value, OR: Odds ratio, CCS: Calculated clinical score.
analysis ($P = 0.33$) [Figure 2d]. Moreover, we found that the CCS is associated with differences in the type of acute head injury ($P = 0.0007$) despite considerable overlap within a given patient. *Post hoc* analysis revealed that those with subarachnoid and subdural hemorrhages were found to have significantly higher clinical scores compared to those with a skull fracture ($P = 0.0106$ and $P = 0.01$, respectively) [Figure 2c]. Those with a skull fracture and an underlying hemorrhage had a higher CCS compared to those with an isolated skull fracture ($3.7 \pm 0.2$ vs. $2.5 \pm 0.2$; $P < 0.0001$).

**Predictors of an acute head computed tomography finding, admission, and neurosurgical consultation**

To establish the best predictors of an acute h-CT, admission, or NSC, univariate and multivariate logistic regressions were performed considering age, sex, BAC, AC/AP use, CCS, and GCS <13 alone. The CCS was found to be the only independent predictor of an acute h-CT finding (OR = 1.6; 95% CI: 1.3–2.0) on multivariate analysis [Table 4]. The best predictor of hospital admission was the CCS (OR = 1.6; 95% CI: 1.3–1.9; $P < 0.0001$), followed by BAC (OR = 1.003; 95% CI: 1.0–1.006; $P = 0.026$). The CCS was also found to be the best predictor of NSC (OR = 1.8; 95% CI: 1.5–2.3; $P < 0.0001$), followed by GCS <13 (OR = 3.3; 95% CI 1.04–11.1; $P = 0.043$). In multivariate analysis, age, sex, and AC/AP use alone were not found to be independent predictors of either an acute h-CT finding, admission to the hospital, or NSC.

**Discussion**

In the current study, we demonstrated that 30.4% of intoxicated trauma patients have an underlying acute head injury. Of those who had an acute finding on h-CT, 38.7% were operated on, and 4.8% died. As expected, the calculated clinical score (CCS) was elevated in patients who had an underlying head injury. A CCS ≥1 was associated with increased odds of an acute finding on h-CT, admission to the hospital, and NSC. Multivariate regression analysis showed that the CCS was a better predictor of acute h-CT finding, admission, and NSC than GCS <13, age, or BAC alone. These results may have implications for hospital resource activation and triage of trauma patients presenting under the influence of alcohol.

In our analysis, we included all intoxicated patients who presented to the ED rather than a subset with a certain BAC or GCS, as this approach maximizes the clinical utility of our findings. As such, only a small minority of patients (6.9%) were included who could be classified as acute alcohol ingestion rather than intoxication but were included given that their BAC was likely higher both at the time of injury and during the primary and secondary surveys. We also opted to include all skull fractures in this analysis given that the presence of a fracture indicates that a high impact injury occurred and that the patient should be more closely followed for signs of worsening neurologic status. This could explain the CCS’s increased predictive value compared to GCS <13 for acute h-CT finding, a finding that would likely be altered

| Table 4: Univariate and multivariate logistic regression for acute head computed tomography finding and admission |
|---------------------------------------------------------------|
| **Univariate** | **Multivariate** |
|----------------|----------------|
| **Acute h-CT finding** | | |
| Age | 1.01 (1.00-1.03) | 0.033 |
| Sex | NS | |
| AC/AP use | 4.5 (1.8-11.1) | 0.002 |
| BAC | NS | |
| CCS | 1.8 (1.5-2.1) | <0.0001 |
| GCS <13 | 6.7 (3.7-12.5) | <0.0001 |
| **Admission** | | |
| Age | 1.02 (1.004-1.04) | 0.013 |
| Sex | NS | |
| AC/AP use | NS | |
| BAC | 1.004 (1.001-1.007) | 0.005 |
| CCS | 1.6 (1.4-2.0) | <0.0001 |
| GCS <13 | 7.7 (1.9-33.3) | 0.004 |
| **NSC** | | |
| Age | 1.02 (1.004-1.03) | 0.009 |
| Sex | NS | |
| AC/AP use | 4.2 (1.6-10.3) | 0.002 |
| BAC | NS | |
| CCS | 2.05 (1.7-2.5) | <0.0001 |
| GCS <13 | 8.3 (4.8-16.7) | <0.0001 |

The CCS is the best predictor of both acute h-CT finding and hospital admission. Only variables found to be significant in univariate analysis were used in the multivariate regression. NS: Nonsignificant, h-CT: Head computed tomography, CCS: Calculated clinical score, GCS: Glasgow Coma Scale, BAC: Blood alcohol content, NSC: Neurosurgical consultation, AC/AP: Anticoagulant/antiplatelet, OR: Odds ratio, CI: Confidence interval.
Multivariate regression analysis showed that the only independent predictor of h-CT yield, NSC, and hospital admission was the CCS regardless of BAC or age. This has implications for hospital resource activation since our data show that the clinical examination pre-CT scan can predict ED disposition and the need for NSC. Recent studies by Joseph et al. have described a similar scoring system known as the Brain Injury Guidelines (BIG), however, with several key differences. First, the BIG are decision guidelines for how to manage patients who have an acute injury on h-CT. Second, all patients in our study with an acute h-CT finding would be classified as BIG 2 or 3 due to alcohol intoxication and thus would be hospitalized. In contrast, the utility of the CCS lies as a pre-CT risk stratification system that, in theory, could be used in conjunction with the BIG once the h-CT is performed. Of course, the decision to admit a patient or obtain a neurological consult is a clinical one and is influenced by the presence of both head and nonhead injuries. This makes the finding that the CCS can predict admission to the hospital all the more striking as the majority of CCS components are nervous system findings.

While future study is needed, one potential use for our study could be used in times with a high volume of intoxicated trauma patients. Recent reports show that comparable injuries have higher mortality rates in mass casualty scenarios compared to low-volume days. In these situations, resource allocation is key, and among intoxicated patients, it can be challenging to determine who should be prioritized. Similarly, Granata et al. showed that it is safe to defer h-CT scanning among low-risk intoxicated patients. Therefore, we believe that, despite the confounding influence of alcohol on clinical presentation, the features identified here may still be valuable in terms of risk stratification; however, clinicians should continue to use their best judgment in determining when a patient should receive a h-CT. The CCS presented here is an attempt to better stratify this group of patients, especially in situations requiring triage and resource allocation.

We would like to acknowledge certain limitations of the present study. First, the retrospective cohort design is subject to certain biases as described previously. Second, over the course of our study, the ICD codes changed, which could affect the identification of patients. However, we found that the proportion of patients with acute findings on h-CT was not influenced by year \((P = 0.3530)\). Third, we did not directly compare the frequency of clinical characteristics between the intoxicated and nonintoxicated trauma patient populations. Future study is needed with a matched cohort of intoxicated and nonintoxicated trauma patients to evaluate the utility of the CCS in trauma triage. Fourth, we did not include ISS in the multivariate regression analysis since if a patient was not found to have any injuries or admitted to the hospital, they were excluded from the hospital’s trauma database and their ISS was, therefore, unavailable for our analysis. Therefore, the inclusion of only those who had a documented ISS would confound our data, especially given that the ISS may not be clear before a CT is performed. In addition, we only examined the rate of initial acute head injury on CT and did not examine the incidence of delayed presentation of intracranial injury on subsequent repeat h-CT scans. Moreover, we did not examine the potentially confounding effect of nonhead-related injuries. Finally, our study mainly included patients who presented the following blunt injury trauma (motor vehicle collisions and falls). In contrast, trauma patients presenting after penetrating injury often have distinct clinical courses from those with blunt injury. Therefore, the use of the CCS should mainly be limited to blunt injury trauma.

**Conclusions**

In summary, while it is well established that the clinical examination can reveal underlying head trauma among nonintoxicated patients, these results show that certain clinical characteristics may predict underlying head injury, hospital admission, and the need for neurological consult in this population. However, given that 30.4% of alcohol-intoxicated trauma patients have acute findings on h-CT, intoxicated patients should be initially scanned, but we provide evidence that the clinical examination of an intoxicated patient, specifically the factors identified herein, may be of use for prioritizing patients that could have an underlying acute head injury. A prospective study is needed to more critically evaluate the utility of the CCS on predicting the incidence of head injury in the intoxicated trauma patient.

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**Conflicts of interest**

There are no conflicts of interest.

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