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Article Title: Traumatic Intracranial Injury in Intoxicated Patients with Minor Head Trauma

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Educational Objectives
After completing this exercise the participant will be better able to describe treatment for traumatic head injuries in intoxicated patients.

Activity Disclosures
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Faculty Disclosures:

CME editor – Hal Thomas, MD: No relevant financial relationships to disclose.

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ORIGINAL RESEARCH CONTRIBUTION

CME

Traumatic Intracranial Injury in Intoxicated Patients With Minor Head Trauma

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Abstract

Objectives: Studies focusing on minor head injury in intoxicated patients report disparate prevalences of intracranial injury. It is unclear if the typical factors associated with intracranial injury in published clinical decision rules for computerized tomography (CT) acquisition are helpful in differentiating patients with and without intracranial injuries, as intoxication may obscure particular features of intracranial injury such as headache and mimic other signs of head injury such as altered mental status. This study aimed to estimate the prevalence of intracranial injury following minor head injury (Glasgow Coma Scale [GCS] score ≥14) in intoxicated patients and to assess the performance of established clinical decision rules in this population.

Methods: This was a prospective cohort study of consecutive intoxicated adults presenting to the emergency department (ED) following minor head injury. Historical and physical examination features included those from the Canadian CT Head Rule, National Emergency X-Radiography Utilization Study (NEXUS), and New Orleans Criteria. All patients underwent head CT.

Results: A total of 283 patients were enrolled, with a median age of 40 years (interquartile range [IQR] = 28 to 48 years) and median alcohol concentration of 195 mmol/L (IQR = 154 to 256 mmol/L). A total of 238 of 283 (84%) were male, and 225 (80%) had GCS scores of 15. Clinically important injuries (injuries requiring admission to the hospital or neurosurgical follow-up) were identified in 23 patients (8%; 95% confidence interval [CI] = 5% to 12%); one required neurosurgical intervention (0.4%, 95% CI = 0% to 2%). Loss of consciousness and headache were associated with clinically important intracranial injury on CT. The Canadian CT Head Rule had a sensitivity of 70% (95% CI = 47% to 87%) and NEXUS criteria had a sensitivity of 83% (95% CI = 61% to 95%) for clinically important injury in intoxicated patients.

Conclusions: In this study, the prevalence of clinically important injury in intoxicated patients with minor head injury was significant. While the presence of the common features associated with intracranial injury in nonintoxicated patients should raise clinical suspicion for intracranial injury in intoxicated patients, the Canadian CT Head Rule and NEXUS criteria do not have adequate sensitivity to be applied in intoxicated patients with minor head injury.

ACADEMIC EMERGENCY MEDICINE 2013; 20:754–760 © 2013 by the Society for Academic Emergency Medicine

A recent systematic review reported a median prevalence of 7.2% for intracranial injury in adults with minor head injury.[1] Review of the National Hospital Ambulatory Medical Care Survey (NHAMCS) revealed that 44% of emergency department (ED) patients with minor head injury undergo head

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Received December 14, 2012; revision received March 19, 2013; revision accepted March 30, 2013.

Supported, in part, by a Physician Scientist Award (K12HS019464-01) from the Agency for Healthcare Research and Quality (AHRQ) to Dr. Easter and an Independent Scientist Award (K02 HS017526) from the AHRQ to Dr. Haukoos. Dr. Wilbur, an associate editor of this journal, had no role in the peer review process and publication decision for this paper. The other authors have no conflicts of interest to declare.

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ISSN 1069-6563
PII ISSN 1069-6563583

doi: 10.1111/acem.12184

computerized tomography (CT), the criterion standard for diagnosing intracranial injury.[2] The risk of intracranial injury among intoxicated patients with minor head injury remains unclear.

Prior studies report disparate prevalences of intracranial injury among intoxicated patients. Several investigators have identified intoxication as an independent predictor of intracranial injury on CT.[3–5] In contrast, more recent studies identified similar prevalences of intracranial injury in intoxicated patients compared to nonintoxicated patients selected for CT.[6,7] None of these studies focused exclusively on intoxicated patients, with only 6% to 35% of their study cohorts consisting of intoxicated patients. The true prevalence of intracranial injury among intoxicated patients remains unclear.

Physicians are often guided by clinical decision rules to help determine the need for CT acquisition following minor head injury.[3,6,8] However, the effect of alcohol intoxication on the performance of these rules is unclear. Studies of the New Orleans Criteria, Canadian CT Head Rule, and National Emergency X-Radiography Utilization Study (NEXUS) have included intoxicated patients as part of their derivation cohorts, suggesting the rules can be applied to patients with intoxication (Appendix 1).[3,6,8] However, the performance of these rules in the intoxicated population was not assessed.

Guidelines differ in their recommendations regarding the role of intoxication in the decision to acquire a head CT following minor head injury. The American College of Emergency Physicians clinical policy and Neurotraumatology Committee of the World Federation of Neurosurgical Societies include alcohol intoxication as an indication for CT acquisition after minor head injury with loss of consciousness or amnesia.[9,10] The National Institute for Health and Clinical Excellence (NICE) and the Eastern Association for the Surgery of Trauma (EAST) do not include intoxication as an indication for CT acquisition.[11,12]

Given that 35% to 50% of patients with minor head injury are intoxicated, it is crucial to determine the prevalence of traumatic intracranial injury in this population and to assess the ability of existing clinical decision rules to identify intoxicated patients with intracranial injuries.[13,14] We hypothesized that the prevalence of clinically important intracranial injury in intoxicated patients would be similar to the prevalence reported in prior studies of nonintoxicated patients. We also hypothesized that existing clinical decision rules would successfully identify intoxicated patients with intracranial injury, as many of the historical and physical examination features included in the rules are present in intoxication as well as in patients with intracranial injuries.

METHODS

Study Design

This was a prospective cohort study. The institutional review board approved this study with a waiver of informed consent.

Study Setting and Population

The study was performed over 1 year at Denver Health Medical Center in Denver, Colorado. Denver Health Medical Center is a 477-bed urban, Level 1 trauma center for the city and county of Denver, as well as a trauma referral center for the Rocky Mountain region. It has approximately 55,000 annual ED visits with 2,500 annual major trauma visits.

We enrolled consecutive adults (≥18 years of age) presenting to the ED with intoxication and minor head injury, as defined by a Glasgow Coma Scale (GCS) score ≥14 and trauma to the head. As many patients were unable to provide accurate histories due to intoxication, objective evidence of injury to the head, defined by any evidence of injury above the eyebrows anteriorly or atlantoaxial line posteriorly, was required for inclusion to ensure patients had truly experienced head injury. In addition, all patients had alcohol concentrations measured via blood or breathalyzer and were excluded if their alcohol concentrations were <80 mmol/L, corresponding to the legal driving limit for intoxication. Patients were also excluded from the study if they: 1) had evidence of acute penetrating head injury; 2) were pregnant; 3) were transferred from outside facilities and already had received head CTs; 4) had GCS scores ≤13 on initial presentation; or 5) were in the custody of police, as this population is considered a protected population by our review board.

Study Protocol

The initial treating physicians identified patients with head injury and any suspicion for intoxication. As part of the study protocol, these patients had their blood drawn or breathalyzer administered to confirm intoxication. Urine pregnancy tests were obtained on all female patients with child-bearing potential; pregnant patients were excluded from the study. A noncontrast head CT was then obtained on each enrolled subject. This acquisition of head CTs was standard of care in the ED for all intoxicated patients with objective evidence of trauma to the head. Subsequent treatment and disposition decisions for each patient were at the discretion of the emergency physician (EP), with consultation from the trauma surgeon or neurosurgeon when appropriate.

Prior to obtaining CT scans, EPs identified the presence of predictor variables and prospectively recorded them on a standardized, closed response data collection instrument. Physicians recorded the presenting signs and symptoms, including loss of consciousness, nausea, vomiting, amnesia, headache, seizure, and mechanism of injury (assault, fall, pedestrian struck, motor vehicle collision, or other). Finally, any signs of trauma to the head were documented, including laceration, hematoma, abrasion, ecchymosis, and signs of skull fracture (open, depressed, or basilar). Dedicated research assistants were present in the ED to ensure protocol adherence and enrollment of eligible subjects.

Measures

The primary outcome was a clinically important intracranial injury, and the secondary outcome was an injury requiring neurosurgical intervention. Clinically important injuries were defined using the criteria specified by Stiell et al.[8] through their formal survey of neurosurgeons, neuroradiologists, and EPs. They included injuries that would typically require hospital admission or neurosurgical follow-up, such as epidural hematoma, subdural hematoma >4 mm thick, subarachnoid hemorrhage larger than 1 mm thick, depressed skull fracture, cerebral contusion >5 mm in diameter, intraventricular hemorrhage, pneumocephalus, or traumatic infarction. Patients admitted to the hospital for management of extracranial injuries were not considered to have sustained clinically important intracranial injuries. Medical records and prior imaging studies were reviewed to ensure that only acute injuries were classified as clinically important intracranial injuries. Meanwhile, injury resulting in need for neurosurgical intervention was defined by a need for craniotomy, intracranial pressure monitoring, or ventricular drainage within 1 week after the injury.

Two attending radiologists (MM, DS) independently determined the presence of intracranial injury on CT. They were each blinded to the patients' presentations, clinical characteristics, and the other radiologist's interpretations. All disagreements about the nature of the intracranial injuries on CT were resolved through consensus between the two radiologists. The outcome of need for neurosurgical intervention was determined through review of the patient's medical record by the senior author (KB), who was blinded to ED data and outcomes at the time of the review.

Data Analysis

All data were manually entered into Microsoft Excel (Microsoft Corp., Redmond, WA) and transferred into native SAS format using translational software (dfPower DBMS Copy, Dataflux Corporation, Cary, NC). All statistical analyses were performed using Stata 12.0 (StataCorp, College Station, TX). Descriptive statistics for all variables and the prevalence of acute intracranial injury were determined and reported with 95% confidence intervals (CIs). Continuous data are presented as medians with interquartile ranges (IQRs) and categorical data as percentages with 95% CIs. Kappa was used to estimate agreement. No a priori adjustments were made for statistical comparisons.

Sample Size. Sample size was calculated to estimate precision for the prevalence of acute intracranial injury. We estimated a prevalence of 8% and powered the study to have a 95% confidence limit for this estimate of <3.5% (<7% for the entire 95% CI). As such, we estimated requiring a minimum of 275 subjects in this study.

RESULTS

During the study period, 319 consecutive patients presented with evidence of minor head injury and intoxication, with 283 of 319 (89%) meeting inclusion criteria. The median age was 40 years (IQR = 28 to 48 years), and 238 of 283 (84%) were male. Of the 283 patients, 26 (9%, 95% CI = 6% to 13%) had acute intracranial injuries, with 23 (8%; 95% CI = 5% to 12%) of these considered clinically important. The clinically important intracranial injuries were as follows: 10 of 23 (44%) subarachnoid hemorrhage, six (26%) intraparenchymal hemorrhage, four (17%) subdural hemorrhage, one (4%) epidural hemorrhage, one (4%) cerebral contusions, and one (4%) intraventricular hemorrhage. There was excellent interrater reliability between the two radiologists for the presence of intracranial injuries with agreement on all but three cases, yielding a kappa of 0.93 (95% CI = 0.86 to 1.00). Neurosurgical intervention was required in one patient (0.4%; 95% CI = 0% to 2%), a 57 year old male, who was struck over the head with a pool cue and had subarachnoid and temporal intraparenchymal hemorrhages. Initially in the ED he had a GCS score of 15, but his mental status deteriorated after admission to the hospital. A repeat head CT showed a substantial increase in the size of his intraparenchymal hemorrhage. He was taken emergently to the operating room for craniotomy and hematoma evacuation. After a prolonged hospital course, he was transferred to a skilled nursing facility with severe neurologic disability (Glasgow Outcome Scale score of 3).

Several factors were associated with clinically important intracranial injury in intoxicated patients (Table 1). Witnessed loss of consciousness and headache were more common in subjects with clinically important intracranial injuries compared to those without clinically important injuries (absolute difference loss of consciousness = 22%, 95% CI = 2% to 42%; and headache absolute difference = 30%, 95% CI = 10% to 49%). There was no substantial difference between groups in mechanisms of injury, alcohol concentrations, or initial GCS scores. Amnesia, nausea, vomiting, and seizure were also not substantially different between the two groups. While signs of basilar skull fracture were not associated with clinically important intracranial injury, they were associated with any intracranial injury on CT, when injuries such as skull fractures were included.

Multiple patients with intracranial injuries lacked indications for CT provided by the Canadian CT Head Rule and NEXUS criteria (Table 2). Of the 23 intoxicated patients with clinically important intracranial injuries, four (17%, 95% CI = 5% to 39%) did not have any of the NEXUS criteria, and seven (30%, 95% CI = 13% to 53%) did not have any of the Canadian CT Head Rule criteria, resulting in sensitivities of 83% (95% CI = 61% to 95%) and 70% (95% CI = 47% to 87%) for these rules, respectively (Table 2). Of the four patients missed by the NEXUS criteria, two had subarachnoid hemorrhage with one given antiepileptic medications on discharge, one had subdural hemorrhage with midline shift on his initial CT, and one had cerebral contusion. Of the seven patients missed by the Canadian CT Head Rule, four had subarachnoid hemorrhage with one given antiepileptic medications on discharge, two had subdural hemorrhage with one having midline shift on his initial CT, and one had epidural hemorrhage. None of the patients without any of the indications for CT provided by these rules required neurosurgical intervention. As intoxication and signs of trauma above the clavicle were inclusion criteria for our study, all patients met the New Orleans Criteria, for which these are components.

DISCUSSION

Prevalence of Intracranial Injury

To our knowledge, this is the largest study to date designed to prospectively determine the prevalence of

Table 1
Relationship Between Clinical Findings and CT Results in Intoxicated Patients With Minor Head Injury

	Clinically Important Injury			No Clinically Important Injury			Entire Cohort			Absolute Difference
	n = 23	(%)	(95% CI)	*n* = 260	(%)	(95% CI)	*n* = 283	(%)	(95% CI)	(95% CI)
Median age (yr) (IQR)	42		(30 to 48)	40		(28 to 48)	40		(28 to 48)	3 (–4 to 9)
Male	20	(87)	(66 to 97)	218	(84)	(79 to 88)	238	(84)	(79 to 88)	3 (–11 to 18)
Median alcohol conc (mmol/L) (IQR)	193		(164 to 225)	196		(151 to 256)	196		(154 to 256)	–3 (–32 to 28)
Initial GCS score										
15	18	(78)	(56 to 3)	205	(79)	(74 to 84)	223	(79)	(74 to 83)	–1 (–18 to 17)
14	5	(22)	(8 to 44)	55	(21)	(16 to 27)	60	(21)	(17 to 26)	1 (–17 to 18)
Mechanism										
Assault	12	(52)	(31 to 73)	123	(47)	(41 to 54)	135	(48)	(42 to 54)	5 (–16 to 26)
Fall	10	(43)	(23 to 66)	85	(33)	(27 to 39)	95	(34)	(28 to 39)	10 (–10 to 32)
MVC	1	(4)	(0 to 22)	22	(9)	(5 to 13)	23	(8)	(5 to 12)	4 (–13 to 5)
LOC	12	(52)	(31 to 73)	83	(32)	(26 to 38)	95	(34)	(28 to 39)	20 (–1 to 41)
Witnessed	8	(35)	(16 to 57)	33	(13)	(9 to 17)	41	(15)	(11 to 19)	22 (2 to 42)
Amnesia	8	(35)	(16 to 57)	59	(22)	(18 to 28)	67	(24)	(19 to 29)	12 (–8 to 32)
Nausea	3	(13)	(3 to 34)	12	(5)	(2 to 8)	15	(5)	(3 to 9)	8 (–6 to 22)
Vomiting	1	(4)	(0 to 22)	8	(3)	(1 to 6)	9	(3)	(2 to 6)	1 (–7 to 10)
Headache	16	(70)	(47 to 87)	104	(40)	(34 to 46)	120	(42)	(37 to 48)	30 (10 to 9)
Seizure	0	(0)	(0 to 15)	9	(4)	(2 to 7)	9	(4)	(2 to 6)	–3 (–6 to –1)
Signs basilar skull fracture	1	(4)	(0 to 22)	3	(1)	(0 to 3)	4	(1)	(0 to 4)	3 (–5 to 12)
Suspected open or depressed skull fracture	1	(4)	(0 to 22)	0	(0)	(0 to 1)	1	(0)	(0 to 2)	4 (–4 to 13)

Absolute difference reflects the difference between subjects with clinically important injuries and those without clinically important injuries.
conc = concentration; IQR = interquartile range; GCS = Glasgow Coma Scale; LOC = loss of consciousness; MVC = motor vehicle collision.

traumatic clinically important intracranial injury in a cohort of exclusively intoxicated patients presenting after minor head injury. We identified an 8% prevalence of clinically important intracranial injury, compared to the 5% noted by Bracken et al.[15] in a secondary review of NEXUS-II focusing on intoxicated patients. Due to differences in study design, the true difference is likely even larger than this estimate. In our study, all patients presenting with intoxication and head injury underwent CT, while in the Bracken study patients only underwent CT at the discretion of the treating physicians, thus likely incorporating selection bias. Also, Bracken et al. did not measure intoxication objectively, likely leading to an underestimation of the prevalence of injury, as a substantial number of patients with unknown intoxication status in their study had intracranial injuries. In contrast, we objectively measured intoxication status in all patients. The prevalence in our study was higher than the prevalence of 2% for any intracranial injury reported in a recent review of intoxicated trauma patients undergoing head CT.[16] This study was limited by its retrospective design and potential selection bias.

In developing the New Orleans Criteria, the study design of Haydel et al.[3] was similar to ours in that CT was performed on consecutive patients, resulting in a prevalence of 12% for traumatic intracranial injury in intoxicated patients. While the overall sample size in their study was larger than ours, they only included 180 intoxicated patients. In addition, these intoxicated patients all had reported loss of consciousness or amnesia, as defined by their criteria for inclusion. Given that these variables are difficult to assess in intoxicated patients, we believe that our results provide a more generalizable estimate of the prevalence of traumatic intracranial injury in intoxicated patients presenting to the ED after minor head injury.

The overall prevalence of clinically important intracranial injury that we identified in intoxicated individuals was similar to previously reported prevalences of clinically important intracranial injuries in all patients, regardless of intoxication status. Haydel et al.[3] found 7% of patients with minor head injury had clinically important intracranial injuries, while Stiell et al.[8] found 8% of patients had clinically important intracranial injuries. Both of these studies only included patients with loss of consciousness, amnesia, or disorientation and therefore are likely to represent a higher risk population than included in our study. Further study is needed to directly compare the prevalence of head injury in intoxicated and nonintoxicated individuals. Based on our findings, in the setting of head injury, physicians should resist attributing signs or symptoms suggestive of intracranial injury (e.g., altered mental status or vomiting) to intoxication alone. Prior studies examining the effect of intoxication on GCS score support this contention, demonstrating that alcohol intoxication alone does not result in significant reductions in GCS score.[14]

Ours is also the largest study to report factors associated with traumatic intracranial injury in intoxicated patients. The only other prior study that attempted to identify such factors was performed over 15 years ago and included only 107 patients.[17] It did not identify any

Table 2
Sensitivity of Published Minor Head Injury Clinical Decision Rules for Identifying Clinically Important Intracranial Injuries in Intoxicated Patients

Rule and Characteristics	No.	Sensitivity,% (95% CI)
Total	23	
NEXUS Head CT Rule		
Skull fracture or hematoma	16	70 (47–87)
Loss of consciousness	12	52 (31–73)
Abnormal mental status	9	39 (20–62)
Abnormal behavior	9	39 (20–62)
Age ≥65 yr	2	9 (1–28)
Persistent vomiting	1	4 (0–22)
Neurologic deficit	0	0 (0–15)
Coagulopathy	0	0 (0–15)
Overall	*19*	*83 (61–95)*
Canadian CT Head Rule		
Amnesia	8	35 (16–57)
GCS <15 at 2 hours	5	22 (8–44)
Age ≥65 yr	2	9 (1–28)
Open or depressed skull fracture	1	4 (0–22)
Signs of basal skull fracture	1	4 (0–22)
Vomiting ≥2 occurrences	1	4 (0–22)
Dangerous mechanism	1	4 (0–22)
Overall	*16*	*70 (47–87)*
New Orleans Criteria		
Headache	16	70 (47–87)
Amnesia	8	35 (16–57)
Age ≥60 yr	4	17 (5–29)
Vomiting	1	4 (0–22)
Seizure	0	0 (0–15)
Intoxication	23	100* (85–100)
Signs of trauma above the clavicle	23	100* (85–100)
Overall	*23*	*100* (85–100*)*

Note: Characteristics are not mutually exclusive.
NEXUS = National Emergency X-Radiography Utilization Study.
*Intoxication and signs of trauma above the clavicle were components of the New Orleans Criteria and therefore by definition would include all patients in this study. Excluding these two variables, the New Orleans Criteria identified 20/23 (87%) patients with clinically important intracranial injuries.

factors associated with intracranial injury. With our larger sample size, we found loss of consciousness and headache to be significantly associated with traumatic intracranial injury in intoxicated patients, factors also shown to be associated with traumatic intracranial injury in nonintoxicated patients.[3,6,8]Although our study suggests that these factors should increase clinicians' suspicion for intracranial injury in intoxicated patients, these findings require validation before concluding their presence should mandate head CT acquisition.

Performance of Clinical Decision Rules

Compared to the strong performance noted in multiple prior validation studies in nonintoxicated patients, the Canadian CT Head rule and NEXUS criteria performed less well in our cohort of intoxicated patients for identifying clinically important intracranial injuries. As many physicians rely on these clinical decision rules for determining the need for CT acquisition in the setting of minor head injury, there may be a temptation to use these same rules for intoxicated patients, particularly in lieu of alternative guidelines for this population. Although each of the rules included intoxicated patients in their derivation analyses, they represented only 12% to 35% of their cohorts and did not include independent performance breakdowns of the rules for intoxicated patients.[3,6,8] We suspected that the overlap of the signs and symptoms of intoxication with intracranial injury would result in most intoxicated patients demonstrating one of the criteria of the rules, thereby ensuring the rules would maintain high sensitivity for intracranial injury. Surprisingly, we identified multiple patients with intracranial injuries who did not have any of the published criteria for suspecting injury in minor head injury. Although these occult injuries were each clinically important, none prompted neurosurgical intervention. The sensitivity for clinically important intracranial injury was statistically similar for the NEXUS criteria (83%) and the Canadian CT Head Rule (70%). The New Orleans Criteria predictably identified all patients with clinically important injuries, as intoxication is a criterion for this rule. Exclusion of the two categories of the New Orleans Criteria that were inclusion criteria for our study (intoxication and signs of trauma above the clavicle) yielded a sensitivity of 87% for clinically important intracranial injury.

The worrisome number of occult injuries found in our study supports the need for caution when applying common clinical decision rules to intoxicated patients with head injury. Application of the New Orleans Criteria would successfully identify all intoxicated patients with clinically important injuries, but would necessitate CT acquisition on all intoxicated patients with signs of trauma above the clavicle. This would increase CT acquisition, exposing patients to potentially unnecessary risks from radiation. Future studies should focus on developing clinical decision rules to identify intoxicated patients at low risk for injury who do not require CT and also compare the performance of these rules to clinician judgment. In the meantime, to avoid missing injuries or obtaining CT on all intoxication patients in regions of high alcohol abuse such as our area, we obtain imaging for those intoxicated patients with high clinical gestalt for injury and perform monitored observation for those patients deemed safe enough to await sobriety and application of existing clinical decision rules. Observed patients require frequent monitoring and should have CTs obtained if they are not sobering appropriately or experience any deterioration in their condition.

LIMITATIONS

We identified only one patient who required neurosurgical intervention, rendering it impossible to identify clinical factors associated with this outcome in intoxicated patients. We did focus on clinically important injuries and suspect that most physicians would want to identify these injuries, even if they do not require neurosurgical intervention.

We included only patients with alcohol intoxication. There are many other substances that can produce intoxication and likely limit the diagnostic potential of the history and physical examination. It is unclear if intracranial injury is as prevalent in these individuals.

This study cannot provide direct comparisons with published clinical decision rules, because our inclusion criteria were different. We included all intoxicated patients, while existing rules focused on patients with loss of consciousness, amnesia, or disorientation. We suspected that these factors would be unreliable in intoxicated patients. Therefore, we elected to evaluate all patients presenting with intoxication and as a result our population differs from the derivation populations for the clinical decision rules. Due to these differences in study population, we anticipated a substantial reduction in the specificity of the rules. However, our primary interest was the rules′ sensitivities and minimizing missed injuries. The sensitivities should not have been adversely affected by our inclusion criteria. In the future, it will be important to assess the specificities of the rules in intoxicated patients. Finally, we included only patients with evidence of trauma to the head. This was the only objective criterion we believed to be a reliable indicator of head trauma in intoxicated patients. This may render our population slightly higher risk compared to patients presenting with complaints of head injury but no evidence of trauma to the head.

CONCLUSIONS

Intoxicated patients with minor head injury are at significant risk for intracranial injury, with 8% of intoxicated patients in our cohort suffering clinically important intracranial injuries. The Canadian CT Head Rule and National Emergency X-Radiography Utilization Study criteria did not have adequate sensitivity for detecting clinically significant intracranial injuries in a cohort of intoxicated patients.

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APPENDIX

Indications for CT Acquisition Provided by Clinical Decision Rules for Patients With Minor Head Injury

	New Orleans Criteria[3]	Canadian CT Head Rule[8]	NEXUS Head CT Rule[6]
Study population	Loss of consciousness or amnesia	Loss of consciousness, amnesia, or disorientation	All patients undergoing CT regardless of historical or physical exam factors
	GCS score of 15	GCS score of 13-15	
Indications for CT scan	Headache	GCS score <15 at 2 hours	Abnormal alertness/behavior
	Vomiting	Suspect skull fracture	Skull fracture
	Seizure	Vomiting ≥2 times	Scalp hematoma
	Intoxication	Age ≥65 yr	Persistent vomiting
	Short-term memory deficit	Amnesia >30 minutes	Neurologic deficit
	Trauma above clavicle	Dangerous mechanism	Age ≥65 yr
	Age >60 yr		Coagulopathy