



## Original Contribution

# Safety of deferred CT imaging of intoxicated patients presenting with possible traumatic brain injury<sup>☆</sup>



Robert T. Granata, MAS<sup>a,\*</sup>, Edward M. Castillo, PhD, MPH<sup>a,b</sup>, Gary M. Vilke, MD<sup>a,b</sup>

<sup>a</sup> University of California, San Diego School of Medicine

<sup>b</sup> Department of Emergency Medicine

## ARTICLE INFO

## Article history:

Received 20 August 2016

Received in revised form 10 September 2016

Accepted 29 September 2016

## ABSTRACT

**Background:** Patients presenting to the emergency department (ED) with altered mental status and alcohol intoxication can clinically resemble patients with an intracranial hemorrhage. Although intracranial hemorrhage is quickly excluded with a head computed tomographic (CT) scan, it is common practice to defer imaging and allow the patient to metabolize to spare ED resources and minimize radiation exposure to the patient. Although this reduces unnecessary scans, it may delay treatment in patients with occult intracranial hemorrhage, which some fear may increase morbidity and mortality. We sought to evaluate the safety of deferred CT imaging in these patients by evaluating whether time to scan significantly affects the rate of neurosurgical intervention.

**Methods:** In this retrospective medical record review, all clinically alcohol-intoxicated patients presenting to 2 university EDs were included. Time to order CT imaging, findings on imaging, and outcomes of these patients were determined. Patients were assessed in 3 groups: CT ordered within 1 hour of triage, CT ordered 1–3 hours from triage, and CT ordered 3 or more hours from triage.

**Results:** During the study period, 5943 patients were included in the study. Of these, 0 patients scanned in less than 3 hours had intracranial findings on imaging requiring neurosurgery, whereas 1 patient with a deferred CT scan required a neurosurgical intervention; however, it was not emergently performed.

**Conclusion:** Routine CT scanning of alcohol-intoxicated patients with altered mental status is of low clinical value. Deferring CT imaging while monitoring improving clinical status appears to be a safe practice.

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## 1. Introduction

Traumatic brain injury, including intracranial hemorrhage (ICH), can be manifested by confusion, memory impairment, loss of consciousness, headache, dizziness, nausea and vomiting, vacant stare, lack of awareness of surroundings, inability to focus attention, disorientation, delayed verbal expression, slurred or incoherent speech, gross observable incoordination, and emotionality out of proportion to circumstances [1,2]. Many of these symptoms are common to acute alcohol (EtOH) intoxication, which can include ataxia, lack of coordination, slurred speech, nausea and vomiting, altered perception of the environment, amnesia, prolonged reaction time, personality and behavioral changes, and nystagmus, among others [3]. This is problematic because nearly 50% of patients presenting with traumatic brain injury also present with acute drug or alcohol intoxication [4].

The signs and symptoms seen in acute ethanol intoxication can confound a diagnosis of ICH. Distinguishing between acute ethanol intoxication and ICH as an etiology for altered mental status (AMS) is a diagnostic dilemma often definitively resolved with computed tomographic (CT) imaging. However, immediate CT imaging of every patient presenting with AMS secondary to alcohol intoxication imposes unnecessary radiation exposure and cost on those who ultimately do not have an ICH on imaging, in addition to consuming valuable emergency department (ED) resources.

Easter et al [5] have reported similar rates of intracranial injury in intoxicated patients as the general population, which suggest that alcohol intoxication does not add predictive value to clinical decision rules. Further, they demonstrated that the existing clinical decision rules have only moderate sensitivity for intracranial injury in intoxicated patients. Instead, they recommend deferring the CT for several hours in patients with low clinical gestalt of intracranial injury and only scanning patients who fail to show clinical improvement with metabolism of alcohol. Godbout et al [6] have demonstrated the yield of CT imaging in alcohol intoxicated patients to be 1.9% and advocate for a similar watchful waiting strategy prior to imaging.

Although this practice spares radiation exposure, cost, and ED resources in patients without an acute intracranial bleed, it also delays diagnosis and intervention in those patients who ultimately do have

<sup>☆</sup> Sources of support: This research was generously funded by a summer training grant from the National Heart, Lung, and Blood Institute (grant 5T35HL007491-33). We acknowledge and are grateful for their support of this study.

\* Corresponding author at: 9238 Piantino Way, San Diego, CA, 92108.

E-mail address: [rgranata@ucsd.edu](mailto:rgranata@ucsd.edu) (R.T. Granata).

an acute intracranial injury. There is evidence that a delay in treatment in patients with a true ICH may lead to worse outcomes than patients who are treated immediately [7]. With no guidelines regarding the safety of deferring CT imaging as recommended by the studies of Easter et al and Godbout et al, management defaults to the treating physician based on their clinical assessment of each individual case. This study seeks to evaluate the safety of deferred CT imaging in patients with alcohol intoxication and possible ICH by evaluating whether time to scan significantly affects the rate of neurosurgical intervention.

## 2. Materials and methods

### 2.1. Study design

This is a structured retrospective medical record review of all alcohol-related visits to the University of California, San Diego Hillcrest Medical Center and Thornton Hospital Emergency Departments with a combined census of approximately 80 000 annual visits between 01 January 2008 and 03 June 2012. The study was approved by the internal review board of the university (#130863), and the requirement for informed consent was waived.

### 2.2. Patients and data collection

The electronic medical record was queried for all ED visits during the study period with a chief concern or *International Classification of Diseases, Ninth Revision* (ICD9) diagnosis relating to alcohol (concern code: 46, ICD9: 303, 303.01, 303.02, 303.9, 303.91, 303.92, 305), and these patients were included in the study. These represent patients who were determined to be intoxicated clinically or through measurement of blood alcohol level. Patients with restricted records were excluded from the study.

### 2.3. Data abstraction

The time to CT scan for each patient was determined by the difference of the triage time and head CT order time. Patients were placed into 1 of 4 groups: those who did not receive a CT scan, those whose CT scan was ordered less than 60 minutes from triage, those whose CT scan was ordered more than 60 minutes but less than 180 minutes from triage, and those whose CT scan was ordered 180 minutes or more from triage.

The radiology reports for each CT scan were reviewed, and each patient was further classified into 1 of 3 groups: normal head CT findings, acute intracranial findings (including acute-on-chronic findings), and chronic findings.

Medical records were reviewed in patients with acute findings in their head CT scans to determine whether these patients required a neurosurgical intervention and the circumstances surrounding the intervention. We also reviewed the medical records of each patient with acute findings on CT scan as well as a random sample of 100 of the remaining cases to determine the accuracy of the chief concern coding.

### 2.4. Statistical analysis

Given that neurosurgical intervention was a binary outcome, binary logistic regression was used to test the significance of time to scan on the odds of a patient having a neurosurgery while controlling for age and sex. Time to scan was treated as a continuous variable for the statistical analysis.

## 3. Results

Of the 5947 patients meeting the inclusion criteria, 4 patients' records were restricted, and these were excluded from the study for a total N of

5943. Of the remaining patients, 4458 (75.0%) were male, and the mean (SD) age was 43 (13.9).

There were 42 subjects whose CTs were ordered but were discharged before the CTs were either acquired or interpreted, and 1 subject whose scan was nondiagnostic. These patients were included in the no-CT group for a total of 5479 EtOH patients (92.2%) clinically cleared of acute intracranial pathology requiring neurosurgery without CT scans. Demographic and disposition data are described in [Tables 1 and 2](#), respectively. [Table 3](#) describes the classification of the CT scans of each group.

Of the 311 patients with CT scans ordered in less than 60 minutes, 13 (4.1%) had acute findings. One of these 13 patients received an Integra Camino Intracranial Pressure (ICP) bolt for monitoring but did not require a neurosurgical intervention. Of the 94 patients with CT scans deferred more than 60 minutes but less than 180 minutes, 2 (2.1%) had acute findings on imaging. Neither required neurosurgical intervention. Of the 59 patients with CT scans deferred more than 180 minutes, 3 (5.1%) had acute findings. One of these 3 was noted to have a subarachnoid hemorrhage due to an aneurysm. Although the aneurysm was clipped approximately 30 hours after the diagnosis and not in an emergent manner, this was still a neurosurgical procedure.

After adjusting for age and sex, time to scan did not significantly affect the odds of neurosurgical intervention ( $P = .331$ ) in binary logistic regression. When the patient receiving the ICP bolt was also treated as receiving a neurosurgical intervention, time to scan was still not significant ( $P = .597$ ).

## 4. Discussion

The majority of patients in this study metabolized and clinically cleared without the need of a CT scan. Of the remaining 7.8% of patients that ultimately received a CT scan, there were no significant injuries requiring emergent neurosurgical intervention. Deferring CT imaging did not appear to worsen the outcome of patients as measured by the incidence of neurosurgery.

Although men are more represented than women in this study, men were slightly more likely to receive a CT scan, as were older patients.

The 2 most notable cases identified in our patient population were a patient in the <60-minute group who received an ICP bolt and a patient in the >180-minute group who was found to have an aneurysm. Regarding the former, this patient was found to have bifrontal intraparenchymal hemorrhage, but the Neurosurgery service determined the patient to be nonoperative and instead opted for ICP monitoring. This patient was subsequently started on a 3% NaCl drip and admitted to the intensive care unit for a brief stay before being discharged home neurologically intact, without further neurosurgical intervention beyond the ICP bolt.

In addition, 1 case from the >180-minute group had an acute finding with subsequent neurosurgical intervention; however, this was an aneurysm clipping performed in an inpatient setting the following day (approximately 30 hours after initial consultation) and not performed emergently. Upon further review, it was determined that this patient was included in the study for a chief concern of alcohol intoxication; however, the patient quickly had a breathalyzer reading of 0.00, suggesting that there was no concern for alcohol intoxication, another reason for the AMS needing to be determined.

The safety of allowing selected EtOH intoxicated patients the opportunity to metabolize with ongoing monitoring and reassessments, as recommended by Easter et al [5] and Godbout et al [6], was previously unknown. Although the studies of Easter et al and Godbout et al measured the rate of neurosurgical intervention as secondary end points, neither study examined the rate as a function of time to CT scan. Given that we found no cases of intracranial hemorrhage requiring emergency surgery exacerbated by a delayed diagnosis, that time to scan did not significantly affect the odds of neurosurgical intervention, and that there is not a marked increase in incidence of emergent

**Table 1**  
Demographic information

	No CT (n = 5479)	CT < 60 min (n = 311)	60 min < CT < 180 min (n = 94)	180 min < CT (n = 59)
Mean age (SD)	42.3 (13.9)	47.2 (13.4)	47.5 (11.1)	47.0 (12.4)
Male (%)	4059 (74.1)	272 (87.5)	78 (83.0)	49 (83.1)
Female (%)	1420 (25.9)	39 (12.5)	16 (17.0)	10 (16.9)

Demographics of each study group. A larger proportion of men received scans than those that did not, and those receiving scans tended to be slightly older than those who were cleared without imaging. However, the age and sex distribution was similar across time strata.

**Table 2**  
Disposition information

	No CT (n = 5479)	CT < 60 min (n = 311)	60 min < CT < 180 min (n = 94)	180 min < CT (n = 59)
Discharged from ED	4812 (87.8)	248 (79.7)	74 (78.7)	35 (59.3)
Admitted to hospital	300 (5.5)	42 (13.5)	12 (12.8)	23 (39.0)
AMA	195 (3.6)	9 (2.9)	4 (4.3)	0 (0.0)
Eloped	1 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Left after seen by MD	150 (2.7)	9 (2.9)	3 (3.2)	1 (1.7)
Left before seen by MD	12 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
Transfer to other facility	27 (0.5)	3 (1.0)	1 (1.1)	0 (0.0)

Abbreviation: AMA, Left against medical advice.

Disposition of patients in each study group. Patients cleared without CT tended to be discharged, whereas those with CT scans tended to be admitted.

**Table 3**  
CT result classification.

	Discharge without CT (n = 5479)	CT < 60 min (n = 311)	60 min < CT < 180 min (n = 94)	180 min < CT (n = 59)
No abnormalities	5479	154	41	25
Acute abnormalities	0	13	2	3
Chronic abnormalities	0	144	51	31

Results of CT classification for each study group. Patients discharged without a head CT were clinically cleared and assumed to be normal.

neurosurgical intervention between the 3 groups, these findings suggest that the practice of deferred CT scanning in intoxicated patients appears to be safe.

There does not appear to be a significant number of patients who have missed emergent neurosurgical lesions that are negatively impacted by delaying the ordering of a head CT after a period of ED observation. Our findings are consistent with the study of Easter et al who found several patients with intracranial injuries that did not meet existing clinical decision rules; however, none of these patients required neurosurgery. Notably, we identified a lower rate of intracranial injury in intoxicated patients (3.9% vs 8%); however, we suspect that our study population may have a lower risk of intracranial injury because we included all alcohol-intoxicated patients, whereas Easter et al only scanned intoxicated patients with visible trauma above the clavicles [5].

#### 4.1. Limitations

The primary limitation of the study is a lack of follow-up. The study design did not include any mechanism for tracking the outcomes of patients who were discharged home rather than admitted. There is a possibility that a nonzero number of patients experienced a poor outcome or some degree of decline once they were discharged home. Future studies clarifying the outcomes of these patients discharged home without CT imaging would be helpful in describing the safety of this practice.

Second, the study may be underpowered, as only 1 patient met the primary end point of neurosurgical intervention. We had anticipated that, over a 5-year period and 2 EDs, there would be a sufficient number of patients to adequately power the study; however, this limitation suggests that intracranial injury requiring neurosurgical intervention is extremely rare in patients with acute alcohol intoxication.

Another limitation of the study is the use of CT order time rather than CT acquisition time. There are many factors that influence the time to execution of the CT that are out of the provider's control, such as department load and scanner availability. Although both times were available to us, we elected to measure the time to CT order because the provider has control over how quickly the scan is ordered, and we are seeking to evaluate the safety of intentionally deferred scans rather than unintentionally delayed scans.

Lastly, we attempted to capture all patients with alcohol intoxication by using search criteria that included patients with a chief concern of alcohol intoxication and those who were coded as alcohol intoxicated (ICD9 codes 303–309). It is possible that patients presenting with primary head trauma and secondary intoxication were not coded as intoxicated because the primary concern of the providers was the head trauma. These patients theoretically would not have been identified by our search criteria. However, in these patients, the indication for CT is obvious, and there is no debate about whether or not to scan.

#### 4.2. Conclusion

This study suggests that deferring CT imaging while monitoring improving clinical status in alcohol-intoxicated patients with AMS and possible ICH is a safe ED practice. This practice follows the individual emergency physician's comfort in waiting and will vary from one physician to another.

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