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THE EFFECTS OF ALCOHOL INTOXICATION ON THE INITIAL TREATMENT AND HOSPITAL COURSE OF PATIENTS WITH ACUTE BRAIN INJURY

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The effect of alcohol intoxication at the time of injury on hospital outcome was evaluated in 520 adult patients diagnosed with brain injury who were admitted to the emergency department of Harborview Medical Center. Data were collected for each subject's status from field intervention through hospitalization. Serum alcohol levels were measured from blood drawn in the emergency room, and the subjects were stratified into two groups: intoxicated (≥100 mg/dL, n = 191) and nonintoxicated (<100 mg/dL, n = 329). Compared with subjects who were not intoxicated, intoxicated patients were more likely to be intubated in the field or emergency department (relative risk [RR] = 1.3, 95% confidence interval [CI] = 1.1–1.5), require placement of an intracranial pressure bolt (RR = 1.4, 95% CI = 1.1–1.8), develop respiratory distress requiring ventilatory assistance during hospitalization (RR = 1.8, 95% CI = 1.0–3.3), or develop pneumonia (RR = 1.4, 95% CI = 0.9–2.2). The similarities in the clinical presentation of patients with acute brain injury and those who are intoxicated appear to influence prehospital care and also suggest that a more objective assessment of cerebral injury than provided by clinical diagnostic measures alone is required, thus accounting for the elevated likelihood of intracranial pressure monitoring in intoxicated trauma patients.

ALCOHOL INTOXICATION is known to be associated with the occurrence of serious injuries and death from a wide variety of causes including motor vehicle crashes,[1-6] pedestrian collisions,[7] bicycle crashes,[8] drownings,[9] burns, falls, assaults, homicides, and suicides.[10,11] We found relatively few studies, however, that explored the relationship of alcohol intoxication to outcome of hospitalized injured patients. It is unclear to what extent alcohol intoxication affects the hospital course of trauma patients or affects the ability of medical caregivers to accurately assess injuries in these patients.

The purpose of this study was to measure the frequency and degree of alcohol intoxication in trauma patients with brain injuries, and to examine the association of the intoxicated state at the time of injury with the subsequent use of various medical interventions and selected hospital outcomes.

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METHODS AND SUBJECTS

Subjects were identified from patients aged 18 years or older with acute brain injury (BI) resulting from blunt impact and admitted to Harborview Medical Center (HMC), a regional level I trauma center in Seattle, Washington, from March 1989 through June 1990.

All acute trauma patients are initially evaluated in the emergency department (ED), and approximately 75% have blood samples drawn for determination of serum alcohol concentration (SAC). It is from among the latter patients that study subjects were enrolled. Injury diagnoses were determined by the International Classification of Diseases (ICD-9-CM) discharge codes from medical records and included at least one ICD-9-CM head injury code of 800–801.99, 803–804.99, or 850–854.19. Patients with a penetrating brain injury or patients with any of the following primary causes were excluded from the study: hanging or suffocation; drowning or near drowning; burns; electrocutions; hypothermia or hyperthermia; or poisoning. Primary causes were determined from medical records coded using the ICD-9-CM Classification of External Causes of Injury and Poisoning (E-codes). Patients who were admitted and discharged over the same weekend or patients with a hospital stay of less than 1 day (unless they died) were also excluded because of study staff limitations. Study patients readmitted during the enrollment period were not enrolled a second time. Demographic, injury severity, and selected hospital data for non-enrolled patients were obtained from the HMC trauma registry to assess the likelihood and impact of potential selection biases.

Subjects were identified by review of the ED admitting log. Consent for enrollment was obtained from the patient, or an immediate relative if the patient was unable to give consent. Data were collected from hospital charts by experienced chart abstractors. A patient's Injury Severity Score (ISS) was calculated using the 1985 Abbreviated Injury Scale (AIS),[12,13] which was derived from up to ten discharge ICD-9-CM codes using the ICD-MAP PC computer program.[14]

Blood samples were obtained by ED medical staff members concurrently with routine admission laboratory blood tests. Standardized laboratory methods were used to determine SAC.[15]

Relative risk (RR) estimates and 95% confidence intervals (95% CI) comparing outcome measures of intoxicated subjects (SAC ≥100 mg/dL) and nonintoxicated subjects were determined from stratified analysis. Multiple logistic regression was performed using EGRET[16] to assess the potential confounding effects of age (<55 vs. ≥55 years), gender, race (white vs. nonwhite), and injury severity (ISS categories 1–15, 16–25, and ≥26). Analyses were also carried out with age and ISS as continuous variables. The relative risk estimates were not changed by the adjustment of any of these variables; therefore unadjusted relative risk estimates are presented.

RESULTS

A total of 520 subjects met eligibility criteria and were entered into the study. The majority (84%) of study subjects were less than 50 years of age and approximately 29% were less than 25 years of age at the time of their injury. Most subjects were also white (83%) and male (77%) (Table 1). The single most common reason for admission (43%) was involvement in an automobile crash, as a driver or occupant. Another 13% of subjects were involved in motorcycle crashes; 9% were injured as pedestrians; more than 17% were injured in falls; and 10% were injured from assaults. The majority (86%) of subjects survived long enough to be discharged or transferred from the hospital. Of the 73 who died, 51 (70%) did so within 1 day of their admission.

Approximately half (53%) of subjects had SACs of zero on admission to the emergency department. Another 10% had measurable SAC levels of less than 100 mg/dL. These two groups were combined to form the nonintoxicated group (n = 329). The remaining 37% of subjects (n = 191) were intoxicated (SAC of ≥100 mg/dL) on admission, including 16% with SAC levels of 100–199 mg/dL, 14% with SACs of 200–299 mg/dL, and nearly 7% with SAC levels of 300 mg/dL or higher. The mean SAC for intoxicated patients was 230 mg/dL.

An additional 99 patients were treated for brain injuries from blunt trauma in the emergency department during the study period but were not included in the study for a variety of reasons: 35.4% were not enrolled because blood samples for determination of alcohol levels were not drawn in the ED and 39.4% because they were admitted and discharged before enrollment. Six patients (6.1%) refused consent for enrollment and four patients (4.0%) were too severely injured to give consent and had no close relative available to provide consent on their behalf. Another 15 persons with brain injuries were not enrolled for unspecified reasons. In general, nonenrolled patients were similar to those who were enrolled with respect to gender (79% male), mean age (36.4 years for nonenrolled vs. 36.9 years for enrolled), and race (76% white). Nonenrolled patients, however, had slightly shorter hospital stays (mean, 8.1 days, vs. 10.6 days for enrolled) and slightly lower mean ISS (14.7 vs. 18.9 for enrolled). Similar proportions of nonenrolled (15%) and enrolled patients (14%) died in the hospital.

Table 1
Characteristics of intoxicated and nonintoxicated patients with traumatic brain injury

Variable	Intoxicated (n = 191)		Nonintoxicated (n = 329)		Total (n = 520)	
	Number	Percent	Number	Percent	Number	Percent
Age (years)						
18–24	46	24.1	103	31.3	149	28.7
25–34	86	45.0	83	25.2	169	32.5
35–49	43	22.5	77	23.4	120	23.1
50–64	11	5.8	22	6.7	33	6.3
≥65	5	2.6	44	13.4	49	9.4
Gender						
Male	167	87.4	231	70.2	398	76.5
Race						
Asian	1	0.5	21	6.4	22	4.2
Black	19	9.9	17	5.2	36	6.9
White	153	80.1	279	84.8	432	83.1
Hispanic	6	3.1	9	2.7	15	2.9
Native American	11	5.8	3	0.9	14	2.7
Other	1	0.5	0	0.0	1	0.2
Mechanism of Injury						
Automobile	75	39.3	148	45.0	223	42.9
Fall	34	17.8	57	17.3	91	17.5
Motorcycle	25	13.1	41	12.5	66	12.7
Assault	36	18.8	17	5.2	53	10.2
Pedestrian	13	6.8	34	10.3	47	9.0
Bicycle	4	2.1	5	1.5	9	1.7
Other	4	2.1	27	8.2	31	6.0
ISS						
1–8	29	15.2	55	16.7	84	16.2
9–15	47	24.6	71	21.6	118	22.7
16–24	63	33.0	106	32.2	169	32.5
25–40	48	25.1	78	23.7	126	24.2
≥41	4	2.1	19	5.8	23	4.4

A greater proportion of intoxicated subjects required intubation in the field or ED (59.7%) than did nonintoxicated subjects (46.8%, RR = 1.3, 95% CI = 1.1–1.5) (Table 2). Intoxicated subjects were also more likely to develop pneumonia (16.2%) than were nonintoxicated subjects (11.6%, RR = 1.4, 95% CI = 0.9–2.2) and more likely to have had an episode of respiratory distress requiring ventilatory assistance during hospitalization (10.5% of intoxicated vs. 5.8% of nonintoxicated, RR = 1.8, 95% CI = 1.0–3.3). Intoxicated patients were also more likely to require placement of an intracranial pressure monitor (38.7%) than were nonintoxicated patients (28.3%, RR = 1.4, 95% CI = 1.1–1.8). Intoxicated patients were only slightly more likely to be hypotensive in the field, were no more likely to undergo a head CT scan in the ED or to require intracranial surgery, and were slightly less likely to have one or more medical complications (excluding pneumonia and respiratory distress)

Table 2
Occurrence of field and hospital interventions and conditions in patients with traumatic brain injury

Outcome	Intoxicated (n = 191)		Nonintoxicated (n = 329)		RR	95% CI
	Number	Percent	Number	Percent		
Hypotension in field*	29	19.6	40	16.6	1.2	0.8–1.8
Intubated in field or ED	114	59.7	154	46.8	1.3	1.1–1.5
Head CT scan in ED	172	90.1	281	85.4	1.0	1.0–1.1
Intracranial pressure bolt	74	38.7	93	28.3	1.4	1.1–1.8
Intracranial surgery	21	11.0	38	11.6	1.0	0.5–1.7
Pneumonia	31	16.2	38	11.6	1.4	0.9–2.2
Respiratory distress	20	10.5	19	5.8	1.8	1.0–3.3
Medical complications†	13	8.6	33	11.7	0.7	0.4–1.3
Hospital stay ≥3 days	130	68.1	228	69.3	1.0	0.9–1.1
Hospital stay ≥8 days	81	42.4	153	46.5	0.9	0.7–1.1
Any ICU stay	128	67.0	206	62.6	1.1	0.9–1.2
ICU stay ≥3 days	76	59.4	121	58.7	1.0	0.8–1.2

* Systolic blood pressure <90 mm Hg; 22 subjects had no field care and 109 subjects had no field SBP values recorded, therefore, total n = 389.

† Complications included any of the following: abscess (either intra-abdominal or other), cardiac arrest, coagulopathy, decubitus, empyema, liver failure, myocardial infarction, pressor drugs used, pulmonary embolus, renal failure, sepsis syndrome, septicemia-fungal, septicemia-positive culture, shock, urinary tract infection, and wound infection. Pneumonia and respiratory distress were evaluated separately, therefore, total n = 434.

during hospitalization (Table 2). Brain injury severity, measured by comparing maximum head AIS distributions, was similar for exposure groups (chi-square test for heterogeneity, 4 $df = 4.37$, $p > 0.30$).

Hospital and intensive care unit lengths of stay were similar among intoxicated and nonintoxicated subjects. Length of hospitalization, however, varied for certain subgroups of the intoxicated and nonintoxicated. Among those with pneumonia, the mean length of hospitalization was 29 days for intoxicated patients compared with 24 days for nonintoxicated patients. A similar result was found among the subgroup of patients who experienced respiratory distress requiring ventilatory support during hospitalization: intoxicated patients were hospitalized for a mean of 26 days, compared with 19 days for nonintoxicated patients.

DISCUSSION

It is possible that injuries to intoxicated patients differ from those to nonintoxicated patients in ways that we were unable to measure. However, to the extent that the injuries were similar among these two groups in this study, it appears that intoxicated patients were more likely to require certain diagnostic and management procedures and to suffer more adverse respiratory outcomes than those who were not intoxicated.

The 40% elevation in the relative likelihood of receiving an intracranial pressure (ICP) monitor procedure among intoxicated patients may indicate the presence of relatively greater brain damage as a result of alcohol,[17] or it may reflect an unwillingness by medical personnel to rely solely on clinical diagnostic variables to assess cerebral injury in persons who also show signs of alcohol intoxication. The general guidelines for the placement of an ICP monitoring device following head injury in this institution are (1) significant abnormality on CT scan (e.g., high-density areas indicating blood, or low-density areas indicating edema or compression of the mesencephalic cisterns); (2) a Glasgow Coma Scale (GCS) score of ≤8; or (3) inability to clinically observe the patient (e.g., unconscious patients who are scheduled to undergo long surgical procedures). The similarities in clinical presentation of patients with acute alcohol intoxication to those with an acute brain injury, and the accompanying diagnostic dilemma, have been well described in several previous studies.[18–22] The GCS, commonly used to assess severity of brain injury,[23–25] has been shown not to be reliable when used for intoxicated patients, especially when SAC levels are above 200 mg/dL.[20,21] Use of the GCS in severely intoxicated patients can result in an initial overestimation of brain injury severity, which has prompted some researchers to delay brain injury severity assessment until 6 or more hours after ED admission.[21] Clinicians who care for patients with brain injuries, however, cannot delay treatment and may be more likely to use more objective, invasive measures of assessment, such as ICP pressure monitoring, rather than relying on the GCS. The fact that we did not also find an increased frequency of intracranial surgery among intoxicated patients suggests that the increased risk for ICP monitoring is the result of an unwillingness on the part of clinicians to rely on clinical signs in intoxicated patients rather than a higher incidence of cerebral pathologic conditions from alcohol exposure. However, another possibility that was not examined in this study is that intoxicated patients may have had more abnormalities on CT scans, such as small amounts of blood that did not require surgery but contributed to an increased likelihood of ICP monitoring.

The 30% greater likelihood of intubation in the field or ED among intoxicated subjects could be the result of ethanol-potentiated impairment of respiratory function in brain-injured persons. The risk for respiratory distress requiring ventilatory assistance during hospitalization was about 80% higher in the intoxicated subjects than the nonintoxicated subjects, and intoxicated patients were 40% more likely to be treated for pneumonia, findings that appear to support this conclusion. The greater risk of pneumonia among the intoxicated subjects may also be a result of decreased immune function owing to ethanol exposure[26] or because of a higher risk of aspiration.[27] It may, however, be because of a higher prevalence of pre-existing pneumonia among the intoxicated patients, which we were unable to assess. It has also been reported that intubated patients have a higher rate of nosocomial pneumonia than do patients with no respiratory therapy device[28,29]; we explored this association and found that although a higher proportion of intubated patients acquired pneumonia (21.3%) than nonintubated patients (4.8%), the effect of alcohol intoxication on acquiring pneumonia was slightly higher among the nonintubated patients (RR = 1.6, 95% CI = 0.5–5.0) than among those who were intubated in the field or ED (RR = 1.1, 95% CI = 0.7–1.8). It therefore appears that the increased relative risk of pneumonia among intoxicated patients may not be attributable to initial intubation status. To further evaluate these respiratory outcomes we assessed the relationship of respiratory distress in the hospital to the occurrence of pneumonia and use of intubation in the field or ED; the increased risk of respiratory distress among intoxicated patients was independent of both pneumonia and initial intubation status. It is also plausible that the elevated relative risk of intubation in the field or ED among intoxicated subjects could be a result of more frequent use of paralyzing agents in intoxicated patients (necessitating intubation) because of combativeness, both to protect the patients from further injury and to help emergency medical personnel in the management of the patients.

Length of hospital stay did not vary according to intoxication status, a finding which is consistent with several alcohol-trauma studies[2,30,31] but not with others.[7,32-34] We did, however, find that intoxicated patients who developed pneumonia required longer hospitalizations (mean, 29 days) than did nonintoxicated patients with pneumonia (24 days). A similar pattern was evident for intoxicated patients with respiratory distress (mean, 26 days, compared with 19 days for nonintoxicated). These differences have public health implications, considering the elevated relative risks that were observed in the intoxicated patients for pneumonia and respiratory distress and the high likelihood that a trauma victim will be intoxicated.

Potential confounders, such as age and injury severity, did not change the risk estimates for any of the outcomes we explored. The apparent control of injury severity and age in this analysis may have been, at least to some extent, the result of our attempt to include only patients with fairly similar injuries in an effort to better distinguish any effects of alcohol intoxication. Waller has described the difficulty in generalizing findings of alcohol-injury studies conducted in trauma centers because of nonrepresentative sampling.[35]

Several limitations should be considered when evaluating the results of this study. We were not able to control for the potential confounding effects of smoking in this analysis. Since smoking is known to be associated with both pneumonia and alcohol consumption, it is possible that our risk estimates relating pneumonia to alcohol intoxication could be biased. Pre-existing pneumonia, as mentioned, was also not assessed and could have resulted in an overestimation of the risk estimate for pneumonia. Potential selection bias because of the exclusion of patients who were admitted and discharged on the same weekend may have occurred. It has been reported in previous studies that patients admitted to a hospital on weekends for head injuries had higher proportions of positive SACs than those admitted on weekdays.[19,20] If this is true for our study, and if an elevated SAC is truly associated with these adverse outcomes, then we may have had an under-representation of patients with higher SACs, and our relative risk estimates may in fact be underestimates of the true risks. It has also been observed that hospital admissions for head injuries are more frequent on Fridays and Saturdays than during the rest of the week.[20] The mean ISS for the 30 nonenrolled weekend patients with brain injuries in our study was 8.6, compared with 14.7 for all nonenrolled brain-injured patients and 18.9 for enrolled patients. It therefore appears that we had a slight under-representation of mild head injuries as a result of this exclusion.

Mortality was not evaluated in this study, since such an analysis would be limited to evaluating only hospital mortality and would ignore persons with brain injuries who died at the scene of the injury. Persons who survive long enough to be admitted to an emergency department and then die following admission may be a biased sample. Other outcome studies relating alcohol exposure to mortality have produced conflicting results, some reporting no relationship,[2,30] others reporting lower mortality associated with alcohol exposure,[31,33] and still others reporting higher mortality with alcohol exposure.[36,37]

During 1985–1986, $36 million were spent in the State of Washington on hospitalization costs for the care of patients with brain injuries, with 41% of the costs paid by public funds.[38] Nationally, acute brain injury was the principal diagnosis in about 300,000 patients hospitalized in 1985,[39] and the annual cost of caring for these patients approaches $25 billion.[38] Whereas other reports have documented the strong association between alcohol intoxication and injury occurrence, this study demonstrates that intoxication also affects the acute management of patients with acute brain injury, increasing the likelihood of intubation, ventilatory support, intracranial pressure monitoring, and perhaps the development of pneumonia. These results provide further evidence that the association between alcohol intoxication and injury is a serious public health problem.

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