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## Identification of Hazardous/Harmful Drinking among Subcritically Injured Patients

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### ■ ABSTRACT

**Objectives:** To examine the relationship between a saliva alcohol test (SAT) and hazardous/harmful drinking, as measured by the Alcohol Use Disorders Identification Test (AUDIT), among a sample of subcritically injured patients.

**Methods:** Patients ( $n = 78$ ) seeking treatment for a subcritical injury were saliva-tested for alcohol and interviewed regarding their drinking behaviors and related difficulties. Associations of SAT values with AUDIT results were determined.

**Results:** SAT results and hazardous/harmful drinking were not independent events ( $p < 0.001$ ). Estimates of sensitivity and specificity (using a dichotomous SAT result [ $\geq 4$  mmol/L] to identify positive AUDIT patients) were 65.2% and 83.6%, respectively. SAT-positive people had significantly higher AUDIT scores than did SAT-negative individuals ( $p < 0.0001$ ). Patients experiencing assault-type injuries were much more likely to be SAT-positive than were patients incurring other types of injury. Discriminant function analysis suggests that AUDIT scores can successfully identify SAT-positive and SAT-negative patients; the analysis accounted for 42.5% of the variance and correctly classified 84.6% of the sample.

**Conclusions:** The use of an easy-to-administer, noninvasive, routine SAT, among patients presenting for a subcritical injury in a hospital ED, provides a mechanism for the identification of individuals with a history of hazardous/harmful drinking. However, since discrimination of hazardous/harmful drinking is imperfect, some caution is warranted when conducting such screening activities.

**Key words:** injury; alcoholism; behavior; saliva alcohol test; wounds; change behavior; emergency department.

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■ Alcohol has been implicated as a contributory factor in injury occurrence.<sup>1–4</sup> In fact, alcohol is viewed as the principal risk factor for both unintentional and intentional injuries in the United States.<sup>5</sup> As long ago as 1973,

it was reported that alcohol was present in 56% of assault victims, 30% of vehicular victims, and 16% of individuals with job-related injuries seen in an ED.<sup>6</sup> More recently, Gentilello et al.<sup>7</sup> reported that 50% of patients admitted to a trauma service after injury in a motor vehicle crash (MVC) and 80% of stabbing victims were intoxicated.

The association between intoxication and injury seems obvious to many emergency physicians (EPs). In contrast to this perception, overall research findings regarding the association between alcohol ingestion and injury severity among ED patients remain equivocal.<sup>2</sup> While some studies have found a positive correlation,<sup>8,9</sup> others have found either inconsistent associations<sup>1</sup> or even inverse relationships.<sup>10</sup> Although dose–response relationships have been reported<sup>1,4,11,12</sup> in critically injured trauma patients, little research has focused on the relationship between subcritical injury and alcohol ingestion.

We sought to examine the relationship between a saliva alcohol test (SAT) and hazardous/harmful drinking

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behaviors among a sample of subcritically injured patients presenting to a hospital ED. Four specific research questions were of particular interest: 1) Are SAT results and a history of hazardous/harmful drinking independent events? 2) Do SAT-negative and SAT-positive individuals differ with respect to a history of hazardous/harmful drinking and/or injury type? 3) Can information regarding a history of hazardous/harmful drinking and type of injury effectively differentiate SAT-negative and SAT-positive individuals? 4) How useful is an SAT for identifying hazardous/harmful drinkers among a sample of subcritically injured individuals presenting to a hospital ED?

## ■ METHODS

### Study Design

Relevant data were collected within the framework of a cross-sectional study design with the purpose of examining the relationship between an SAT and hazardous/harmful drinking behaviors. Participants were recruited from a convenience sample of patients presenting to the ED for management of a subcritical injury (i.e., patients not requiring hospital admission for the management of the injury). All the study participants signed an informed consent form. The research protocol was reviewed and approved by the hospital's institutional review board.

### Setting and Population

All the patients were treated in a large urban ED and level 1 trauma center located in southeastern New England. This facility is an urban teaching hospital, and the ED manages more than 104,000 visits per year (i.e., approximately 285 per day). In excess of 15,500 adult patients are treated for injuries annually. More than 11,000 of these patients are treated for "subcritical" injuries (see below) each year. The population treated by this hospital is both urban and suburban. The facility has 714 inpatient beds and is a referral center for the greater metropolitan area and 14 outlying community hospitals.

All potential subjects were  $\geq 18$  years of age, lived within a one-hour drive of the hospital, required treatment for a subcritical injury, were released home or back to the community from the hospital ED, were sufficiently proficient with the English language to communicate with the research interviewer, and provided informed consent. Patients initially triaged to critical care rooms were excluded if they received a Champion trauma score of  $\leq 13$ ,<sup>13</sup> had abnormal vital signs, had a loss of consciousness  $> 5$  minutes, experienced major anatomic disruption, or suffered a potentially lethal mechanism of injury (e.g., were involved in an MVC in which the ve-

hicle rolled over), unless the patients were released from the ED after critical care triage. The study was conducted between July 1993 and January 1994.

### Experimental Protocol

Individuals underwent SAT evaluation using an alcohol reagent strip described below. Following a triage nurse assessment, a trained research interviewer inspected the patient's medical chart to determine patient eligibility for study participation. Without interrupting the flow of patient care, the research interviewer then approached subcritically injured patients to recruit them into the study.

Both SAT-positive and SAT-negative patients who were subcritically injured and not being admitted to the hospital were approached by the research interviewer. The nature of the study was explained to the patient. If the patient was interested in participating in the study, the research interviewer read the consent form to the patient, and the patient gave consent by signing the form. The research interviewer then proceeded with the interview. In addition to interviewing the patient using survey instruments, a variety of demographic and patient characteristic data were collected via a review of the medical chart. All the patients were paid \$5.00 for their participation, whether or not they completed the interview.

Subject recruitment was limited to high-volume periods, which were Wednesday, Friday, Saturday, and Sunday evening, night, and early-morning hours. Recruitment procedures were conducted between the hours of 6:00 PM and 12:00 AM or 8:00 PM and 2:00 AM. Subject recruitment activities were limited to a maximum of three six-hour shifts per week.

### Measurements

Materials in this study included the use of an SAT reagent strip. The alcohol reagent strip was developed at the Addiction Research Foundation of Ontario and has a reported sensitivity and specificity of 98% and 99%, respectively, when used in hospital EDs on unselected clinical samples.<sup>14</sup> At the time of this study, saliva alcohol testing was part of the routine assessment of vital signs conducted by the clinical triage nurse upon the patient's arrival to the ED.<sup>15</sup> A positive (+) or a negative (-) symbol was placed on the chart next to the other vital signs to indicate alcohol-positive or alcohol-negative.

The Alcohol Use Disorders Identification Test (AUDIT) was used to assess the patient's drinking behavior. The AUDIT is a ten-item questionnaire assessing frequency, intensity, and overall consumption as well as dependence and alcohol-related problems. The AUDIT has reasonable psychometric properties, including a re-

liability coefficient using Cronbach's  $\alpha$  (i.e., a measure of internal consistency) of 0.80.<sup>16</sup> Of those patients diagnosed in primary care settings as having hazardous or harmful alcohol use, 92% had AUDIT scores of  $\geq 8$ , and 94% of those with nonhazardous alcohol consumption had scores of  $< 8$ .<sup>17,18</sup> Table 1 shows the ten AUDIT items.

The SAT results were scored in a dichotomous manner (i.e.,  $> 4$  mmol/L [ $> 20$  mg/dL], yes/no). The AUDIT yields a measure of hazardous/harmful drinking behaviors, with possible values ranging between 0 and 40. Demographic variables, including the patient's gender, age, and ethnic/racial background, and injury event characteristics (e.g., type of injury) were extracted from the patient's medical chart. Additionally, the results (i.e., positive vs negative) of the SAT were recorded.

### Data Analyses

Demographic variables (i.e., ethnicity/race, gender, and age) were crossed with SAT results (i.e., positive vs negative) to discern the distributions of these patient characteristics with respect to the SAT results. Chi-square tests were used to discern significant differences across SAT results with respect to the variables gender and race/ethnicity. A t-test was used to discern age differences between SAT-positive and SAT-negative individuals.

Chi-square analyses were performed in which the SAT results were compared with a dichotomized AUDIT score (i.e., cutoff level equal to a score of  $\geq 8$  vs  $\leq 7$ ) and a trichotomized injury variable (i.e., injury type was classified as MVC, assault, or other) to ascertain the independence of these measures within this sample of subcritically injured patients. Sensitivity, specificity, predictive value of a positive test, and predictive value of a negative test were estimated to provide more in-depth information regarding the relationship between SAT results and AUDIT scores. To test for differences across SAT results and AUDIT scores, an analysis of variance (ANOVA) procedure was conducted. The independent variable for this analysis was the dichotomously scored SAT (i.e., positive vs negative) variable. The dependent variable was the continuous-measure AUDIT score. To determine the utility of information regarding a history of hazardous/harmful drinking and type of injury as discriminators of SAT-positive and SAT-negative individuals, a discriminant function analysis (DFA) was performed. In the DFA, the dichotomously scored SAT was used as the dependent or classification variable, and AUDIT score (i.e., continuous-measure) and injury type variables (i.e., MVC yes/no and assault yes/no) were used as independent or discriminator variables. Based on the derived discriminant function, a classification analysis was performed to determine the utility of the model for

■ **TABLE 1** Alcohol Use Disorders Identification Test (AUDIT) Questionnaire Items

1. How often do you have a drink containing alcohol?
2. How many drinks containing alcohol do you have on a typical day when you are drinking? (Number of standard drinks coded.)
3. How often do you have six or more drinks on one occasion?
4. How often during the last year have you found that you were not able to stop drinking once you had started?
5. How often during the last year have you failed to do what was normally expected from you because of drinking?
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?
7. How often during the last year have you had a feeling of guilt or remorse after drinking?
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?
9. Have you or has someone else been injured as a result of your drinking?
10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested that you should cut down?

classifying SAT-negative and SAT-positive individuals. A significance level of  $p < 0.05$  was used throughout.

### ■ RESULTS

Seventy-eight individuals presenting for emergency management of a subcritical injury agreed to participate in this research project. Of these individuals, 48 (61.5%) were male and 30 (38.5%) were female. The racial distribution was such that 57 (73.1%) were classified as white; 15 (19.2%), black; four (5.1%), Hispanic; one (1.3%), Asian; and one (1.3%), other. The mean age was 32.2 years and ranged from 18 to 71 years. The most frequent injury occurrences were MVCs (33.3%) and assaults (16.7%). Six patients refused to participate in this study, and five of these six patients were alcohol-positive.

Of the 78 people who participated in this study, 24 (30.8%) were SAT-positive. Eighteen (75.0%) of these 24 positive-tested individuals were male and 14 (58.3%) were white. There was no statistically significant difference between the SAT-positive and the SAT-negative individuals with respect to gender, race/ethnicity, or age. Subject demographic characteristics and injury type are cross-tabulated with SAT results in Table 2.

The chi-square analysis testing the independence of SAT and AUDIT results was significant ( $\chi^2 = 18.17$ , df



= 1,  $p < 0.001$ ), indicating that the SAT and the AUDIT results were not independent events. Estimates of sensitivity for identification of a positive AUDIT result, specificity, predictive value of a positive test, and predictive value of a negative test, and the associated 95% confidence intervals, were 0.65 (0.46–0.84), 0.84 (0.74–0.94), 0.63 (0.44–0.82), and 0.85 (0.75–0.95), respectively.

Similarly, the chi-square analysis testing the association between SAT results and injury type yielded significant results ( $\chi^2 = 21.67$ ,  $df = 2$ ,  $p < 0.001$ ). The patients suffering assault-type injuries were much more likely to be SAT-positive (i.e., 11 of 13 assault patients were SAT-positive) than were either the MVC or the other-injury-type patients.

The ANOVA procedure also yielded a significant result ( $F = 29.33$ ,  $df = 1$ ,  $p < 0.0001$ ). The mean AUDIT scores ( $\pm$  SD) associated with SAT-positive and SAT-negative results were 11.83 (7.59) and 4.85 (3.82), respectively. The SAT accounted for 27.8% of the variance associated with AUDIT score.

The DFA yielded a significant Wilks' lambda ( $p < .0001$ ), accounted for 42.5% of the variance, and correctly classified 84.6% of the subjects. This overall correct classification rate reflects a 47.4% improved correct classification rate when compared with the correct classification rate that would be expected on the basis of chance, given the marginal probabilities (i.e., 57.4%). Thus, AUDIT scores successfully differentiated the SAT-negative and the SAT-positive individuals. Additionally, injury type further contributed to the overall correct classification rate. For example, assault patients were over-represented among the SAT-positive subjects (i.e., 11 of 13 SAT-positive); whereas the MVC patients were dis-

proportionately likely to be SAT-negative (i.e., 22 of 26 SAT-negative). Of the 12 people misclassified, four (33.3%) were SAT-negative and classified as positive based on the DFA. Table 3 shows the summary statistics associated with both the DFA and the related classification analysis.

## DISCUSSION

Research focusing on severe injuries has indicated a high incidence of substance use disorders in patients arriving at a trauma center with a measurable blood ethanol level.<sup>19</sup> In studies of head trauma, the use of ethanol/drugs was apparent in 25% to 68% of the patients being treated in the ED.<sup>20–22</sup> If presenting to the ED for treatment of a subcritical injury under the influence of ethanol is indicative of a history of hazardous/harmful drinking, then it is feasible that the ED would be an appropriate site for brief interventions targeted toward the amelioration of alcohol-related difficulties. Prior to the implementation of such interventions, however, it must be determined to what extent injury occurrence while under the influence of alcohol is suggestive of hazardous/harmful drinking. Available data suggest that ethanol ingestion may play a contributory role in subcritical injury as well. Furthermore, patients presenting for treatment of injuries, both subcritical and critical, in the ED are more likely to have ethanol in their systems than are patients seen for other medical concerns.<sup>2,7,15,23</sup>

The clinical identification of ethanol ingestion among ED patients tends to be less than adequate. For example, Becker et al.<sup>15</sup> found that EPs and emergency nurses correctly identified only 52% of SAT-positive patients. To enhance the likelihood of successful ethanol screening,

TABLE 2 Subject Demographic Characteristics and Injury Type by Saliva Alcohol Test (SAT) Results

	Total (n = 78)	SAT-positive (n = 24)	SAT-negative (n = 54)
Gender			
Male	48 (61.5%)	18 (75.0%)	30 (55.6%)
Female	30 (38.5%)	6 (25.0%)	24 (44.4%)
Race			
Asian	1 (1.3%)	0 (0.0%)	1 (1.9%)
Black	15 (19.2%)	8 (33.3%)	7 (12.9%)
Hispanic	4 (5.1%)	2 (8.3%)	2 (3.7%)
White	57 (73.1%)	14 (58.4%)	43 (79.6%)
Other	1 (1.3%)	0 (0.0%)	1 (1.9%)
Injury type			
Assault	13 (16.7%)	11 (45.8%)	2 (3.7%)
Motor vehicle crash	26 (33.3%)	4 (16.7%)	22 (40.7%)
Other	39 (50.0%)	9 (37.5%)	30 (55.6%)
Age—mean (SD)	32.2 yr (11.6)	33.9 yr (12.5)	31.4 yr (11.2)

it is important that ED staff sustain such screening efforts. Administration time, ED staff comfort regarding the inquiry of patient drinking behaviors, and training and costs required to administer more complicated screening procedures, as well as a host of other factors, all contribute to diminished compliance rates. Given the essentially innocuous administration and associated relative low costs, the administration of the SAT is likely to be associated with high ED staff compliance.

The results of this study indicate that the routine administration of SAT to subcritically injured ED patients can be an effective mechanism for the identification of individuals with a history of hazardous/harmful drinking. Using the SAT, a significant proportion of those individuals experiencing hazardous/harmful drinking, as measured by the AUDIT, may be identified. The inclusion of injury type as a discriminator variable further improves the overall correct identification of such individuals.

The detection of ethanol in the patient's system upon arrival to the hospital ED does not necessarily mean that the individual has an alcohol problem. Nor should the presence of ethanol automatically be implicated as a contributory factor with respect to the injury. All injury occurrence post-ethanol ingestion is not caused by the ethanol. The injury risk attributable to ethanol will be less than their joint occurrence (i.e., attributable vs relative risks). Thus, a number of persons injured while drinking may have incurred their injury independent of their drinking. Furthermore, even when ethanol has been determined to be a contributory factor, it does not follow necessarily that the individual has a history of hazardous/harmful drinking necessitating intervention. However, an intervention, based on a primary prevention model (i.e., risk factor modification), implemented at this time may prove fruitful with respect to reducing the likelihood of further injury resulting from ethanol ingestion.

Our estimates of the sensitivity of the SAT for hazardous/harmful drinking may have been negatively affected by delays from ethanol ingestion until care was sought, despite ethanol's having been a contributory factor with respect to injury occurrence. It is not uncommon that individuals seek treatment for an injury hours or even days after the injury was incurred, thereby causing the individual to be classified as a false-negative (i.e., SAT-negative and AUDIT-positive). Cherpitel<sup>2</sup> noted that a number of studies have shown that many problem drinkers, to include those labeled as alcoholic, seeking treatment in an ED will be alcohol-free upon arrival. Nevertheless, the identification of those with alcohol in their systems upon arrival and who have a history of alcohol-related problems will aid prevention/intervention activities.

Alternatively, our estimate of the specificity of SAT

■ **TABLE 3** Summary Multivariate Statistics and Classification Analysis Associated with the Discriminant Function Analysis

Statistic	Value	F-ratio	NDF*	DDF†	p-value
Wilks' lambda	0.57456	18.26	3	74	0.0001

Squared canonical correlation = 0.425

Actual Group	Classification Summary§		
	Predicted Group		Total
SAT‡	Positive	Negative	
Positive	16 (66.7%)	8 (33.3%)	24 (100%)
Negative	4 (7.4%)	50 (92.6%)	54 (100%)
Total	20 (25.6%)	58 (74.4%)	78 (100%)
Priors	0.3077	0.6923	

\*NDF = degrees of freedom for numerator variable (number of canonical variables = 3).

†DDF = degrees of freedom for denominator variable (number of cases - number of canonical variables - 1 = 74).

‡SAT = saliva alcohol test (positive if >4 mmol/L).

§Percentage correct classification = 84.6%; correct classification by chance given marginal distribution of group membership = 57.4%; percentage improved classification accuracy = 47.4%.

results for hazardous/harmful drinking histories, as measured by the AUDIT, may be affected by ethanol ingestion that is inconsequential to the injury or an isolated instance of ethanol ingestion. For example, individuals ingest ethanol after their injury occurrence but prior to arrival at the hospital ED and report few or no alcohol-related difficulties.

Screening efforts are not diagnostic (i.e., results are not conclusive—false-positives and false-negatives exist) and the potential harm that can result from such efforts must be considered (e.g., legal prosecution, denial of insurance payments, or even insurance cancellation, as a consequence of information recorded in the medical record). Individuals present to the ED seeking medical assistance and do not expect to be harmed as a consequence of their decisions to use a health facility. Consequently, prior to the widespread clinical implementation of procedures to routinely screen subcritically injured ED patients for alcohol ingestion, it is extremely important to develop procedures and guidelines to minimize any potential harm resulting to patients as a consequence of their being screened. Problematic drinking behavior, including alcoholism, is a major medical and public health concern, and it appears that the ED may provide an excellent opportunity to intervene with people experiencing alcohol-related difficulties. The earlier identification of such problems has the potential to ameliorate the severity of problems experienced by the individual, his or her family, and/or society as well as enhancing the efficacy of any alcohol-specific treatment

that the individual may receive as a consequence of being screened.

## ■ LIMITATIONS AND FUTURE QUESTIONS

Although the routine administration of an SAT may be beneficial with respect to the identification of individuals with a history of hazardous/harmful drinking, some caution is warranted when interpreting study results. Given the observational design of the present study as well as possible selection bias resulting from the recruitment procedures used (i.e., subject recruitment was limited to periods of high volume; thus, subjects recruited into the study may not be representative of the ED's overall subcritically injured population), spurious factors contributing to observed correlations cannot be ruled out. Consequently, further research focused on examining the relationship between a positive SAT and a history of hazardous/harmful drinking behaviors is recommended. Additionally, studying larger samples that permit cross-validation of obtained study results would be profitable.

Another difficulty concerns the accuracy of the AUDIT as a criterion measure. Typically, estimates of sensitivity and specificity are obtained from comparisons between a screening instrument and a definitive diagnostic test. However, in the present study two screening procedures were compared (i.e., the SAT and the AUDIT). Consequently, true hazardous/harmful drinkers may be missed by both the AUDIT and the SAT. Thus, sensitivity and specificity estimation may not be accurate. Nevertheless, it is important to point out that the AUDIT has been shown to possess high levels of sensitivity and specificity, 92% and 94%, respectively, when used to screen individuals in primary care settings.<sup>19,20</sup> Furthermore, 66 of the 78 subjects in the present study showed classification concordance, demonstrating a high degree of correspondence between the measures used.

Given that the AUDIT is a self-report screening instrument, it is quite possible that individuals experiencing alcohol-related difficulties may underestimate the extent of their drinking behaviors (i.e., frequency, quantity, and frequency  $\times$  quantity) and resulting negative consequences. Individuals with SAT-positive results may either underestimate or fail to report specific drinking-related behaviors. Also, an individual suffering alcohol-related difficulties could sustain an injury in which alcohol played no contributory role.

## ■ CONCLUSIONS

Despite the limitations of the present study, it appears that the routine administration of an SAT among subcritically injured ED patients may be an effective mechanism for the identification of individuals with a history

of hazardous/harmful drinking. Nevertheless, caution must be exercised: 1) there is the possibility of falsely identifying someone as a hazardous/harmful drinker; 2) it must be remembered that having ingested ethanol and incurred an injury does not, in and of itself, indicate hazardous/harmful drinking behavior, and further assessment is required; and 3) patients must not be saddled with the label "problem drinker" based solely on the results of an SAT. Nevertheless, the identification of individuals who may be experiencing hazardous/harmful drinking is prerequisite to an effective intervention. Consequently, screening for hazardous/harmful drinkers in an ED population presenting for the management of a subcritical injury seems warranted and beneficial, provided adequate procedures are implemented to minimize potential patient harm. Given this constraint, the potential benefits warrant evaluation of intervention measures in SAT-positive individuals.

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