Injury, Int. J. Care Injured xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Injured patients with very high blood alcohol concentrations

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ARTICLE INFO

Article history:
Accepted 22 October 2015

Keywords:
Injury
Injury prevention
Blood alcohol level
Ethanol
Trauma recidivism
Alcohol consumption
Alcohol use disorder
Blunt trauma
Forensic toxicology
Alcohol poisoning

ABSTRACT

Objective: Most data regarding high blood alcohol concentrations (BAC) ≥400 mg/dL have been from alcohol poisoning deaths. Few studies have described this group and reported their alcohol consumption patterns or outcomes compared to other trauma patients. We hypothesised trauma patients with very high BACs arrived to the trauma centre with less severe injuries than their sober counterparts.
Method: Historical cohort of 46,222 patients admitted to a major trauma centre between January 1, 2002 and October 31, 2011. BAC was categorised into ordinal groups by 100 mg/dL intervals. Alcohol questionnaire data on frequency and quantity was captured in the BAC ≥400 mg/dL group. The primary analysis was for BAC ≥400 mg/dL.
Results: BAC was recorded in 44,502 (96.3%) patients. Those with a BAC ≥400 mg/dL accounted for 1.1% (147) of BAC positive cases. These patients had the lowest proportion of severe trauma and in-hospital death in comparison with the other alcohol groups ($p < 0.001$). In adjusted analysis, the risk for severe injury increased with the BAC groups between 1 and 199 mg/dL and was not different or decreased for groups above 200 mg/dL in reference to the BAC negative group (test for trend $p = 0.001$). BAC ≥400 group encountered more injuries caused by blunt trauma in comparison with the other alcohol groups ($p < 0.001$), and the group comprised mainly of falls. Admission Glasgow Coma Scale was a poor predictor for traumatic brain injury in the high BAC group. Readmission occurred in 22.4% (33) of patients the BAC ≥400 group. The majority of these patients reported drinking alcohol 4 or more days per week (81, 67.5%) and five or more drinks per day (79, 65.8%), evident of risky alcohol use.
Conclusions: Most traumas admitted with BAC ≥400 mg/dL survived and their injuries were less severe than their less intoxicated and sober counterparts. They also had evidence for risky alcohol use and nearly one-quarter returned to the trauma centre with another injury over the study period. Recognition of this highest BAC group presents an opportunity to provide focused care for their risky alcohol use.

Introduction

Between 2010 and 2012, acute alcohol poisoning deaths in the United States accounted for 8.8 deaths per 1 million populations, an average of six deaths daily [1]. Although these deaths were the most severe form of alcohol intoxication, they only accounted for 1.9% of alcohol-related mortality and 3.3% of mortality from acute effects of alcohol [2]. Forensic Medicine textbooks and studies of acute alcohol poisoning suggested blood alcohol concentrations (BAC) in excess of 400 mg per 100 ml should result in fatality [3–6] but no cohort studies, including trauma patients have examined outcomes in patients with BAC ≥400 mg/dL.

BAC is a common biomarker used at trauma centres to assess acute alcohol exposure in patients [7]. Elevated BACs have been found in 30–50% of trauma patients [8–10], and risky alcohol users accounted for 25–67% of patients admitted with a positive BAC [11–13]. Cohort observational studies in alcohol-related trauma

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http://dx.doi.org/10.1016/j.injury.2015.10.063
0020–1383/

have not examined survivorship in trauma patients admitted with BAC ≥400 mg/dL, levels fatal for most people. Only a handful of case reports mentioned survivors with BAC above these levels, and large epidemiologic studies using trauma registries sometimes excluded very high BACs because they were assumed erroneous [14]. Several studies describe non-lethal BACs above 300 mg/dL including a case-series of 81 drivers apprehended by law enforcement with BAC above 400 mg/dL [15]. However, none of the studies examined drinking behaviours or outcomes.

We aimed to characterise the cohort of trauma patients with BAC ≥400 mg/dL across 10 years from a high volume statewide referral trauma centre with routine BAC testing and detailed alcohol questionnaire data. We hypothesised trauma patients with very high BACs will be less injured than their sober counterparts.

Methods

Environment

We conducted a historical cohort study of patients admitted directly from the injury scene to trauma centre between January 1, 2002 and October 31, 2011. The trauma centre is a free-standing, urban, adult trauma centre, admitting over 5000 primary trauma patients annually from a catchment of over 6 million people in urban, suburban, and rural communities. The trauma centre has been the central referral resource for critically injured adults in the state for more than three decades and has maintained a trauma registry since the mid-1980s. All trauma admissions arrived via ambulance or medevac directly to the trauma centre, separate from the Emergency Department. BAC is routinely measured on all patients on admission. Re-admissions for follow-up care of the same injury and transfers from outside hospitals were excluded. The institutional review board of the trauma centre approved this study.

Injury and alcohol data

BAC was categorised into ordinal groups by 100 mg/dL intervals. We defined severe injury as an injury severity score (ISS) ≥16 [16] and serious traumatic brain injury (TBI) as injury with an abbreviated injury score (AIS) for brain ≥3. The Glasgow coma score (GCS) is a physiologic trauma score used as part of the assessment for brain injury, separate from the anatomical AIS score for traumatic brain injury. GCS is scored between 3 and 15 and composed of best eye response, best verbal response, and best motor response. GCS ≤8 represents serious brain injury [17]. Chart reviews were performed on all patients with BAC ≥400 mg/dL (M.A.). Patients' responses to questions from an alcohol questionnaire were recorded in the medical record as part of an Alcohol Screening, Brief Intervention and Referral to Treatment (SBIRT) programme performed during the trauma nurse's intake interview. The alcohol questions used in the trauma centre's programme regarding alcohol frequency and quantity in screening for risky or hazardous alcohol use was previously validated to have 83% sensitivity and 84% specificity [18,19]. The alcohol questions were administered during hosptial stay once the patient was assessed by the providing nurse as capable of answering the questions adequately. We performed chart reviews with laboratory data to verify that all BACs ≥400 mg/dL were accurately recorded in the trauma registry. To further verify BAC values, we calculated serum osmolalities for each patient and compared it to the recorded level of BAC; all osmolalities were consistent with the recorded BAC [20] (Supplemental Table 1). For each BAC case ≥400 mg/dL, recidivism at the trauma centre was identified by review of the electronic medical record for subsequent admissions due to a separate injury between the patient's first admission date and June 1, 2014.

Missing alcohol data in trauma deaths

A large proportion of missing BAC (640/2062) occurred in patients who had no laboratory data collected because they were pronounced dead soon after arrival, and the body was transferred to the medical examiner before testing could be conducted. To improve the BAC data for all in-hospital deaths, we reduced the proportion of missing alcohol laboratory data by retrieving toxicology reports from the post-mortem investigations conducted by the state's Office of the Medical Examiner (OCME) on our cases dying soon after arrival to the trauma centre. Valid BAC results were obtained from OCME toxicology reports on 74% (474/640) of deaths in which BAC values were missing. OCME samples for alcohol testing were often tested from multiple sources and we selected specimens to include in the analysis in the following order: hospital blood (3/474), heart (272/474), peripheral blood (81/474), pericardial blood (1/474), cavity blood (116/474), and liver (1/474). After post-mortem alcohol levels were retrieved from the medical examiner, the proportion of alcohol testing on in-hospital trauma deaths improved to 92.0% (1896) from 69.0% (1422).

Analytic approach

The primary analysis was for patients with BAC ≥400 mg/dL. Baseline characteristics were presented as medians with interquartile ranges. Comparison of the ordinal alcohol groups was performed using a chi-square test or Fisher's exact test for proportions or the Kruskal–Wallis one-way analysis of variance for continuous variables. Both unadjusted and adjusted analyses were performed with logistic regression model for the outcomes injury severity, blunt injury, and in-hospital death. The final analysis cohort used in logistic regression comprised of complete BAC, demographic, and injury information (Fig. 1). The ordinal groups of alcohol were compared with reference to the BAC = 0 mg/dL group. Covariates included in the model for adjustment included age, sex, and race. To test for significant trend between the ordinal BAC groups, quadratic contrasts in the coefficients corresponding to the variables representing the BAC groups were used in logistic regression. Likelihood ratio test was used for comparison of nested models, and covariates that did not cause a significant change in the overall model were removed ($p > 0.05$). The Spearman's rank correlation coefficient was used to test the correlation between Brain AIS and admission GCS. The traditional threshold of $p \leq 0.05$ was used to determine statistical significance. Analysis was performed using SAS Version 9.4 (SAS Institute, Cary, NC).

Results

Blood alcohol was recorded in 44,502 (96.3%) of patients. Between January 2002 and October 2011, 12,535 (28.2%) trauma admissions had a positive BAC. The greatest proportion of patients with positive BAC was in the 100–199 mg/dL group with 4260 (34.0%). Patients with BAC ≥400 mg/dL accounted for 1.1% (147) of the BAC-positive cases (Table 1), and had the highest median age of any BAC group (44 years old, interquartile range (IQR) 36–49). Similar to the other BAC groups, most patients in the BAC ≥400 mg/dL were male (79.6% 117/147). In the BAC ≥400 mg/dL group, no significant differences in injury mechanism, ISS, or admission GCS occurred between males and females (data not shown). Across the 10-year study period, 21 patients had BAC ≥500 mg/dL and the highest recorded BAC was 613 mg/dL (30-year-old male who fell down steps).

Please cite this article in press as: Afshar M, et al. Injured patients with very high blood alcohol concentrations. Injury (2015), http://dx.doi.org/10.1016/j.injury.2015.10.063