Research Article

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Trauma & Acute Care
ISSN 2476-2105

2020
Vol.5 No.2:81

DOI: 10.36648/2476-2105.5.2.81

Relationship between Blood Alcohol Content, Injury Severity Score and Mortality in Trauma Patients

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Received date: July 03, 2020; **Accepted date:** July 17, 2020; **Published date:** July 24, 2020

Citation: Lin J, Fujii Q, McCague A (2020) Relationship between Blood Alcohol Content, Injury Severity Score and Mortality in Trauma Patients. Trauma Acute Care.Vol.5 No.2: 81. DOI: 10.36648/2476-2105.5.2.81

Abstract

Background: Alcohol contributes to morbidity and mortality in trauma patients. Alcohol abuse is a leading risk factor for preventable death. This project aims to determine if a relationship exists between trauma outcomes and higher blood alcohol content (BAC) in patients.

Methods: This retrospective cohort study included adult patients seen at Natividad Medical Center *via* trauma activation between 2015 and 2017 who had BAC screening performed. Metrics included injury severity score (ISS), Glasgow Coma Scale (GCS), mortality, length of stay and blood transfusion requirements. The cohort was stratified by BAC and age. The groups were analyzed for differences outcomes. Data formatting was performed using Microsoft Excel. SPSS statistical software version 25 was used to perform ANOVA, followed by post-hoc analysis

Results and conclusion: 2,698 patients were included in the study. Patients with BAC>0.16 g/dL were found to have significantly longer hospital lengths of stay (3.69 days, p value 0.046) and significantly longer ICU lengths of stay (1.63 days, p value 0.047). An age-stratified analysis showed no significant difference in ISS, overall hospital LOS, blood requirements, mortality or major trauma. The one-way ANOVA showed that there were significant differences in the BAC groups for the following variables at the $p<0.05$ level: age (p=0.00), systolic blood pressure (p=0.00), hospital length of stay (p=0.00), heart rate (p=0.00) and GCS (p=0.00).Researchers have still not clearly elicited the role of alcohol and outcomes in trauma patients once they arrive to the hospital. More research is needed on the effects of alcohol on trauma patient outcomes.

Keywords: Blood alcohol content; Injury severity score; Mortality; Retrospective cohort study

Abbreviations: BAC: Blood Alcohol Content; ISS: Injury Severity Score; IRB: Institutional Review Board.

Introduction

Alcohol intake is closely related to mechanisms of trauma such as motor vehicle collisions, assaults, and falls. Driving [1] under the influence of alcohol is a well-known public health issue; 29% of all the motor vehicle fatalities in 2015 were attributable to alcohol impaired driving. A previous study has shown that compared to patients without elevation of Blood Alcohol Content (BAC) who sustain a motor vehicle accident, a BAC of 0.1% can double the risk of death from a given impact and BAC of 0.25% triples the risk [2]. Many studies report that there is no protective relationship between mortality and BAC levels; higher BAC levels are associated with increased mortality [2-9].

However, various articles published previously have shown conflicting data regarding the association of blood alcohol levels and trauma-related mortality. Some studies have shown that elevated blood alcohol level may be an independent protective factor for patients who undergo traumatic injuries [10]. Other studies have shown that elevated blood alcohol level is associated with significant decreases in the rates of sepsis and other complications during critical illness following trauma [11]. In a study comparing patients with extremely high BAC>400 mg/dL with patients with lower BAC, the higher BAC cohort had improved survival and less severe injuries compared to the less intoxicated patients [12].

Given the conflicting findings of various studies in literature, the goal of this project was to assess the demographics of patients who arrive *via* trauma activation and investigate if blood alcohol content has a relationship to patient mortality or other patient outcomes.

Materials and Methods

This study was evaluated and classified as exempt from formal review by the Institutional Review Board (IRB) of Touro University California College of Osteopathic Medicine given its retrospective analysis of de-identified data. Natividad Medical Center is a 172 bed county hospital and level II trauma center that has been providing care for patients in Monterey County, California for over 132 years.

Patients were included in the study if they were over 18 years of age and had recorded data to include BAC as well as descriptive and outcome data including demographic information, mechanism of injury, ISS scores, urine drug screen findings, hospital and ICU lengths of stay, initial vital signs, total transfusion needs and disposition. A deidentified dataset of 3697 trauma activations between January 2015 and January 2017 was analyzed.

A total 999 patient were excluded for inadequate data in the dataset. Demographic data of the included patients is presented in **Table 1**. Patients were then stratified into four distinct groups based on BAC. The four groups included no alcohol (BAC<0.01 g/dL), BAC of 0.01 g/dL to 0.08 g/dL, BAC of >0.08 g/dL to 0.16 g/dL, and BAC of >0.16 g/dL. These ranges were chosen as to compare to other previously published studies [12]. The metrics that were compared between the four BAC groups included: age, hospital and ICU length of stay, systolic blood pressure on arrival, heart rate on arrival, temperature on arrival, GCS on arrival, Injury Severity Score, amount of packed red blood cells transfused, amount of platelets transfused, amount of fresh frozen plasma transfused, and the amount of cryopreciptate transfused. The primary outcome of disposition status (surviving to discharge versus expired) was compared between each BAC stratification. An odds ratio was calculated for each BAC group and disposition status. A secondary analysis of a one way ANOVA was performed between each BAC group and the variables mentioned to see if there was a difference between each BAC group and the measured variables; post-hoc analysis was performed using SPSS.

Table 1: Demographics of Dataset.

	Patients	Percentage
Total Cases	2698	
Males	1865	69.13%
Females	833	30.87%
Disposition: Living	2627	97.37%
Disposition: Expired	71	2.63%
Mean Age (Years)	41.7	
Mean ICU LOS (Days)	3.95	
Mean Hospital LOS (Days)	4.65	
Mean ISS Score	8.47	
Mean Systolic BP on Arrival (mmHg)	135.78	
Mean Heart Rate on Arrival (beats/min)	92.7	
Mean Temperature on Arrival (Celsius)	36.49	
Mean GCS on Arrival	14.03	

A second arm of the study was performed to see if the data had any further relationship with age. A secondary stratification based on age of the patients separated patients into four distinct groups<21 years old, 21 to 38 years old, 39 to 55 years old, and >55 years old. A two-way ANOVA was performed assessing if there was any relationship between age and mortality or any relationship between age and BAC. Any significant differences found by ANOVA were then tested with post-hoc analysis using Tukey HSD to find which individual groups were significant. For this analysis, the mortality variable was coded with a disposition of " living "=0.00 and "expired"=1.00.

The data was initially compiled into a Microsoft Excel database (Microsoft Excel; Microsoft Corporation, Redmond, WA) and then was transferred into SPSS (IBM SPSS Statistics, IBM Corporation, Armonk, NY) format for subsequent analysis. All graphs and tables were made using either Microsoft Excel or IBM SPSS. Descriptive statistics were initially calculated for all the primary variables as a whole in addition to their stratified groups. Means of the primary outcomes were compared between the stratified groups and odds ratios calculated.

Results

An initial dataset of 3697 patients was analyzed, 999 of these were excluded for not meeting including criteria due to lack of data. The 2698 remaining patients were included in the study.

BAC levels ranged from 0.00 g/dL to 0.570 g/dL and 69.1% men and 30.9% women with a mean age of 41.7 years old and mean ISS was 8. There were 71 deaths (2.6%) in the data set. The mean BAC of the study population was 0.05 ± 0.92 g/dL. The minimum recorded BAC was 0.00 g/dL and the maximum recorded BAC was 0.57 g/dL. Descriptive data of the stratified BAC groups are shown in **Table 2**.

Table 2: Demographics of stratified BAC groups.

Variable	Group 1:<0.010 g/dL	Group 2: 0.010-0.079 g/dL	Group 3: 0.080-0.160 g/dL	Group 4:>0.16 g/dL
n (%)	584 (21.6%)	1568 (58.1%)	172 (6.4%)	374 (13.9%)
Average Age (Years)	42.2	43.1	33.8	39
Mean ISS Score	8.4	8.4	8.9	8.6
Mean Length of Stay - Hospital (Days)	3.2	4.1	4	4.8
Mean Length of Stay - ICU (Days)	5.4	4.6	4	4.4
Mortality (%)	2.74%	2.61%	3.49%	2.14%
Mean Systolic Blood Pressure (mmHg)	137.1	138.3	134.4	133.4
Mean Heart Rate (bpm)	88	89.3	96.7	96.8
SystMean Temperature (Celsius)	36.4	36.5	36.6	36.5
Mean GCS	14.4	14.3	14.1	13.3

Mean pRBC, if Transfused (units)	10.9	8.2	5.2	5.7
Mean Platelets, if Transfused (units)	1.6	1.3	0.7	1.3
Mean Cryopreciptate, if Transfused (units)	0.3	0.5	0.1	0.1

Outcome frequency tables were generated to calculate odds ratios for mortality as well as odds ratios for suffering major trauma, defined by Injury Severity Score (ISS)>15. Student's T-tests were performed to compare mean ISS, overall hospital length of stay (LOS), ICU length of stay (ICU LOS) and units of packed red blood cells (PRBCs) received. Our results are outlined in **Table 3**.

Table 3: Odds Ratios and p values for endpoints of interest.

Variable	Group 1:<0.010 g/dL	Group 2: 0.010-0.079 g/dL	Group 3: 0.080-0.160 g/dL	Group 4:>0.16 g/dL
Mortality				
Percentage	2.91%	3.11%	3.55%	2.16%
Odds ratio	--	1.07 ± 0.46	1.22 ± 0.75	0.73 ± 0.42
Major Trauma				
Percentage	16.81%	17.49%	19.16%	19.78%
Odds Ratio	--	1.05 ± 0.24	1.17 ± 0.42	1.22 ± 0.87
Injury Severity				
Score Mean	8.36	8.45	8.73	8.6
p value	--	0.844	0.656	0.7
Overall LOS				
Mean	2.93	2.8	3.3	3.69
p value	--	0.569	0.386	0.046
ICU LOS				
Mean	1.15	1.19	1.22	1.63
p value	--	0.811	0.816	0.047
Units of PRBCs				
Mean	0.411	0.318	0.278	0.137
p value	--	0.467	0.629	0.137

95% confidence interval for each of our odds ratios contained the null value, indicating that mortality was not significantly different between any group. Similarly, suffering major trauma did not differ significantly between groups. Student's T-tests resulted in p>0.05 for all but two groups. There was no statistically significant difference in Injury Severity Score or units of PRBCs received between groups. Patients with BAC>0.16 g/dL were found to have significantly longer hospital lengths of stay (3.69 days, p value 0.046) and significantly longer ICU lengths of stay (1.63 days, p value 0.047). An age-stratified analysis showed no significant difference in ISS, overall hospital LOS, blood requirements, mortality or major trauma. Patients from 18-21 years of age had slightly higher lengths of stay in the ICU with increasing BAC which was found to be statistically significant.

A one-way ANOVA analysis was performed to assess the relationship between BAC group and a variety of outcomes. The one-way ANOVA showed that there were significant differences in the BAC groups for the following variables at the p<0.05 level: age (p=0.00), systolic blood pressure (p=0.00), hospital length of stay (p=0.00), heart rate (p=0.00) and GCS (p=0.00).

The post-hoc analysis for age showed that the mean age for each group was significantly different with BAC<0.01 g/dL being the oldest group and BAC 0.08-0.16 g/dL being the youngest group. For hospital length of stay, patients with<0.01 g/dL BAC had the shortest length of stay but patients with>0.16 g/dL BAC had the longest length of stay. For blood pressure, the only comparison that was significant showed that patients with>0.16 g/dL BAC had lower systolic blood pressure than patients with 0.01-0.079 g/dL BAC. Finally the heart rate comparison showed that patients with<0.01 g/dL BAC had lower HR than patients with 0.08-0.16 g/dL BAC and >0.16 g/dL BAC. Additionally patients with 0.01-0.079 g/dL BAC had lower heart rate than 0.08-0.16 g/dL BAC and >.16 g/dL BAC but there was no difference in heart rate between patients with 0.08-0.16 g/dL

BAC and>0.16 g/dL BAC. These results suggest that patients in our database with higher BAC are generally younger and have worse vital signs on arrival including higher heart rate, lower BP and end up staying in the hospital longer compared to those with lower recorded BAC levels.

Further stratification by age on top of BAC was performed to observe if there was interaction between age and BAC as a contributor to mortality. Analysis of each variable alone confirmed that BAC had no effect on mortality as presented earlier, p=0.71. There was no interaction between age and BAC, p=0.95. However, the analysis of age stratification on mortality showed p=0, indicating a statistically significant effect of age on mortality. Post-hoc testing was performed showing that the oldest patients (>55 years old) had the highest mortality rate compared to the three younger groups (<21, 21-38, 39-55). **Figure 1** shows the representation of mortality versus the stratified BAC and age groups.

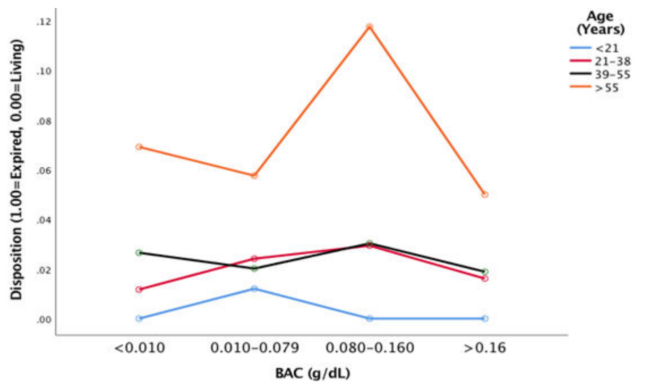

Figure 1: Mortality vs. Age vs. BAC.

Discussion

The analysis of the 2698 patients shows no significant relationship between blood alcohol content and mortality rate. However, patients with higher BAC tended to be younger, have lower systolic blood pressure readings on arrival, faster heart rates on arrival and have lower GCS scores on arrival. Additionally, analysis showed that older patients over the age of 55 in general had the highest risk of mortality compared to younger patients regardless of BAC.

Although the study did not show an association between mortality outcomes and BAC compared to previous findings of other studies [3,13,14], several of the outcomes measured in patients with higher BAC correspond with a more unstable presentation on arrival to ED. Lower GCS scores with higher heart rates and lower blood pressure are suggestive of more critical injuries or signs of shock in patients with higher BAC. This finding corresponds with numerous other studies that have shown negative outcomes associated with higher alcohol consumption [14-16] The data does not correspond with some of the previously published studies that indicate a protective effect of BAC.3,9 It appears, however, that the literature is still not absolutely clear regarding the association of BAC, morbidity and mortality rates [10-12].

There are several limitations to address with the study performed. The biggest limitation with the sample is the large number of patients (999) that did not have a recorded BAC in the electronic health record (EHR). This was likely due to a variety of situations. Some situations included emergent stabilization where the patient was taken to the OR immediately from the ED and could not get a serum ethanol done in time, others who just didn't receive the test because it wasn't ordered and there is no record of it in the hospital EHR. It is unknown if these blank values are true cases of BAC of 0 or if they had a positive BAC, but that it just was not tested. Having a more complete data set would provide more accurate results. Additional limitations with this dataset include the retrospective nature of the trauma registry where data can be missed or inputted incorrectly. Another possible flaw of this study is that the mortality rate is based on patients with recorded BAC who ended up being treated at the hospital. Patients who may not make it to the hospital and are deceased at the scene may be significantly more intoxicated leading to unavoidable selection bias with our trauma registry. An additional area that the study did not assess was to see if illicit substance use has some interaction with BAC in regards to mortality and a selection bias due to referral of more severely injured patients from the scene directly to Level II trauma centers. This should be evaluated in a future study.

This study reviews the outcomes of trauma patient seen at a Level II trauma center and evaluates the effects of alcohol. In this study we found no difference in mortality based on BAC. This study does demonstrate that a higher age is associated with increased mortality and a higher BAC is associated with lower blood pressure, higher heart rates and lower GCS score suggesting more clinical instability. Older individuals had generally higher mortality compared to younger individuals. More research is needed on the effects of alcohol on trauma patient outcomes.

Conclusion

In this study we looked at the effects of alcohol on patients with traumatic injuries. After doing an analysis based on grouped alcohol level we did not find a significant difference in outcomes including ISS score, length of stay, mortality or resuscitative measures seen. There remains controversy on the effects on patients after the injuries have occurred.

Conflict of Interest

We acknowledge the trauma department staff at Natividad Medical Center for their ongoing support and care for the people of Monterey County.

Funding

There is no funding support.

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