The impact of alcohol intoxication on injury severity and outcomes of adult patients with different trauma type

Yee-San Lee¹, Chih-Fang Huang¹, Pei-Ming Wang¹, Shu-Hui Peng², Hung-Tsung Liu³, Ching-Hua Hsieh³

Departments of ¹Family Medicine, ²Plastic Surgery and ³Trauma Surgery, Chang Gung University College of Medicine, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan

Abstract

Background: This study was designed to investigate the impact of alcohol intoxication on injury severity and outcomes of adult patients who experienced different modes of trauma.

Materials and Methods: This retrospective study collected data of hospitalized patients who experienced trauma at age ≥ 20 years between January 1, 2009 and December 21, 2015, from the Trauma Registry System of a Level I trauma center. Patients were categorized into two groups according to their blood alcohol concentrations (BACs): alcohol intoxication (BAC of ≥ 50 mg/dL at the time of arrival to the emergency room) and nonalcohol intoxication (BAC of < 50 mg/dL). The Abbreviated Injury Scale (AIS) score of each injured body region, Injury Severity Score, length of stay (LOS) in the hospital, and in-hospital mortality of these trauma patients according to different modes of trauma were compared between patients with or without alcohol intoxication.

Results: Among 20,513 patients included in this study, 1206 had alcohol intoxication and 19,307 did not. Patients with alcohol intoxication were predominantly males and younger than those without alcohol intoxication. Among patients who had a motorcycle accident, bicycle accident, fall accident, and hit by/against an object, AIS of ≥ 3 head/neck injuries more commonly occurred in patients with alcohol intoxication than in those without. In addition, compared to those without alcohol intoxication, patients with alcohol intoxication who experienced motorcycle accidents and hit by/against an object had longer hospital LOS, whereas those who experienced motor vehicle and motorcycle accidents had significantly higher mortality rates.

Conclusions: This study revealed that alcohol intoxication had impacted the injury severity and outcomes in adult patients who experienced different modes of trauma.

Keywords: Abbreviated injury scale, alcohol intoxication, injury severity score, mortality, trauma mechanism

INTRODUCTION

As alcohol consumption is continuously increasing worldwide, it is considered as a major risk factor for disability and mortality associated with diseases and injuries. In 2012, an estimated 3.3 million global deaths were attributable to alcohol consumption. Consuming alcohol before driving increases the risk of vehicular...
accidents and deaths. Many trauma injuries are related to alcohol intoxication, which profoundly affects behaviors and consciousness levels. In addition, not only drunk drinking but also alcohol-intoxicated pedestrian people contribute to the occurrence of road traffic accidents. A positive blood alcohol concentration (BAC) is associated with high Injury Severity Score (ISS) and long hospital length of stay (LOS) of trauma patients. Alcohol intoxication in trauma patients also leads to higher impact speed difference, injury severity, and preclinical mortality.

However, most previous studies focused on the effect of alcohol intoxication while driving a car and rarely explored its effects on patients injured by other modes of trauma such as motorcycles and bicycle accidents, fall accidents, and injuries due to penetration or strike by/against objects. Nonetheless, as motorcycle accidents comprised a major portion of the trauma population and fall accidents predominating in elderly populations, the modes of trauma in Taiwan differ from those in Western countries. Whether the effect of alcohol intoxication on injury severity and outcome is similar in patients injured by different modes of trauma remains unclear. Therefore, this study aimed to investigate the impact of alcohol intoxication on injury severity and outcomes of adult patients with different modes of trauma.

MATERIALS AND METHODS

Ethics statement

This study was approved by the Institutional Review Board (IRB) of the Chang Gung Memorial Hospital (approval number 201601396B0). Informed consent was obtained according to IRB regulations.

Definition

BAC of 50 mg/dL, the legal limit for drivers in Taiwan, was defined as the cutoff value for alcohol intoxication in this study. Patients with BAC of ≥50 mg/dL at the time of arrival to the emergency room were considered intoxicated and included in the study as BAC (+). Patients who did not undergo an alcohol test or who had a BAC of <50 mg/dL at the time of arrival to the emergency room were considered nonintoxicated and categorized as BAC (−). An Abbreviated Injury Scale (AIS) score of six body regions including the head/neck, face, chest, abdomen, extremities, and external regions were recorded according to the 1998 version of the AIS. The ISS is an international anatomical scoring system for patients with multiple injuries. ISS ranges from 1 to 75 and is obtained as the sum of squares of the three highest AIS scores in different body regions.

Study design

This retrospective study reviewed data of 23,705 trauma patients registered in the Trauma Registry System of a single urban trauma center in Southern Taiwan from January 1, 2009 to December 31, 2015. Patients aged <20 years (n = 2710) and with incomplete registered data (n = 482) were excluded from the study. Detailed patient information was retrieved from the Trauma Registry System of our institution, including data on age, sex, modes of trauma, AIS score for each body region, ISS, hospital LOS, and mortality. In this study, only data on in-hospital mortality were included but not data at 30 days or beyond. Different modes of trauma included motor vehicle accident, motorcycle accident, bicycle accident, fall accident, penetration injury, and strike by/against an object.

Statistical analysis

The ISS was expressed as median and interquartile range (Q1–Q3). The hospital LOS was expressed as median and standard deviation. Two-sided Fisher's exact or Pearson Chi-square tests were used to compare categorical data. Odds ratios (ORs) of associated injuries in each body region with AIS of ≥3 were calculated with 95% confidence intervals (CIs). Collected data were compared using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, New York, USA).

RESULTS

Patient demographics

Of 20,513 enrolled eligible adult trauma patients, 1206 (5.9%) were categorized into the alcohol intoxication group, whereas 19,307 (94.1%) were considered nonintoxicated [Table 1]. Male sex predominated in the alcohol intoxication group: 1065 (88.3%) male and 141 (11.7%) female patients. The average age of BAC (+) patients was lower than that of BAC (−) patients (41.7 ± 12.6 vs. 53.2 ± 19.4 years, respectively, P < 0.001). Motorcycle accidents were the most common mode of injury in both alcohol intoxication and nonintoxication groups, followed by fall accidents and strike by/against an object. Rates of motor vehicle and motorcycle accidents were significantly higher and rates of fall accident and strike by/against an object were significantly lower in patients with alcohol intoxication than in those without alcohol intoxication. No differences in the rates of bicycle accidents and penetration injuries were observed between patients with and without alcohol intoxication.

Patient injury severity

These trauma patients were also divided into groups according to their mode of injury [Table 2]. Among those with motor vehicle accidents, AIS of ≥3 abdominal
injuries was significantly higher in patients with alcohol intoxication than in those without (19.7% vs. 8.6%, OR 2.6, 95% CI 1.34–5.04, P < 0.004). No significant difference in the injury severity was observed between patients with motor vehicle accidents with or without alcohol intoxication, as illustrated by the comparable distribution figures among all ISS stratification levels (<16, 16–24, or ≥25).

Among motorcycle accidents, rates of AIS of ≥3 injuries to the head/neck (41.4% vs. 18.2%, OR 3.2, 95% CI 2.72–3.69, P < 0.001), thorax (12.9% vs. 9.0%, OR 1.5, 95% CI 1.20–1.87, P < 0.001), and abdomen (3.8% vs. 2.4%, OR 1.6, 95% CI 1.11–2.43, P = 0.013) were higher, but the rate of extremity injury (20.2% vs. 23.8%, OR 0.8, 95% CI 0.68–0.97, P = 0.023) was lower in patients with alcohol intoxication as compared to those without alcohol intoxication. Among those involved in motorcycle accidents, patients with alcohol intoxication also had higher injury severity than those without alcohol intoxication (median [Q1–Q3]; 11 [5–20] vs. 8 [4–10] P < 0.001). A significantly higher rate of patients with alcohol intoxication had ISS of 16–24 and ≥25; however, the rate of patients with ISS of <16 was lower than that in patients without alcohol intoxication.

Among bicycle accidents, the rate of patients with alcohol intoxication with an AIS of ≥3 head/neck injury (37.8% vs. 23.4%, OR 2.0, 95% CI 1.0–4.0, P = 0.015) was significantly higher and those with an AIS of ≥3 extremity injury was lower than those without alcohol intoxication (13.5% vs. 32.7%, OR 0.3, 95% CI 0.1–0.8, P = 0.015). No significant difference in injury severity was observed in patients who experienced bicycle accidents with and without alcohol intoxication, as illustrated by the comparable distribution figures among all ISS stratification levels (<16, 16–24, or ≥25).
Among fall accidents, rates of patients with an AIS of ≥3 injuries to the head/neck (47.7% vs. 15.7%, OR 4.9, 95% CI 3.5–7.0, P < 0.001) and face (0.8% vs. 0.0%, OR 47.7, 95% CI 3.0–766.3, P = 0.041) were higher and those in the extremity injury (12.1% vs. 47.1%, OR 0.2, 95% CI 0.1–0.3, P < 0.001) were lower in the intoxicated group than those in nonintoxicated group. Among those who experienced fall accidents, patients with alcohol intoxication had a higher injury severity than those without (median [Q1–Q3]: 9 [5–16] vs. 9 [4–9], P < 0.001). The number of patients with alcohol intoxication with ISS 16–24 and ≥25 was higher and those with an ISS <16 was lower than those without alcohol intoxication.

Among penetration injuries, a significantly higher rate of patients with alcohol intoxication had an AIS of ≥3 abdominal injuries than those without alcohol intoxication (8.6% vs. 1.2%, OR 7.9, 95% CI 3.4–18.4, P = 0.002). No significant difference in injury severity was observed between patients with and without alcohol intoxication in terms of penetration injuries, regardless of ISS stratification (<16, 16–24, or ≥25).

Among those who had injury caused by strike by/against an object, injury severity was higher in patients with those without alcohol intoxication (median [Q1–Q3]: 6 [4–13] vs. 4 [4–8], P < 0.001). The rate of ISS of 16–24 was significantly higher and ISS of <16 was lower in patients with those without alcohol intoxication.

Accordingly, patients with alcohol intoxication had a higher injury severity than those without when they were injured via motorcycle accidents, fall accidents, or when injuries were caused by strike by/against object. However, in patients who were injured in motor vehicular accidents, bicycle accidents, and in those who had penetration injuries, no significant difference in injury severity was observed between patients with or without alcohol intoxication.

## DISCUSSION

This study revealed that patients with alcohol intoxication had a significantly higher mortality rate than those without alcohol intoxication when they were injured via motorcycle accidents, fall accidents, or when injuries were caused by strike by/against an object. However, in patients who were injured in motor vehicle accidents, bicycle accidents, and who had penetration injuries, no significant difference in injury severity was observed between patients with and without alcohol intoxication. In addition, patients with alcohol intoxication had a significantly higher mortality rate than those without alcohol intoxication when they

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**Table 2: Contd...**

| Trauma types       | BAC (+) | BAC (−) | OR (95% CI) | P   |
|--------------------|---------|---------|-------------|-----|
| Abdomen            | 2 (1.8) | 36 (1.5) | 1.2 (0.3-5.2) | 0.677 |
| Extremity          | 13 (11.7) | 321 (12.9) | 0.9 (0.5-1.6) | 0.706 |
| ISS, median (IQR)  | 5 (4-13) | 4 (4-8) | -            | <0.001 |
| <16, n (%)         | 91 (82.0) | 2275 (91.7) | 0.4 (0.3-0.7) | <0.001 |
| 16-24, n (%)       | 15 (13.5) | 141 (5.7) | 2.6 (1.5-4.6) | 0.001 |
| ≥25, n (%)         | 5 (4.5) | 65 (2.6) | 1.8 (0.7-4.4) | 0.223 |

AIS: Abbreviated Injury Scale, BAC: Blood alcohol concentration, CI: Confidence interval, IQR: Interquartile range, ISS: Injury Severity Score, OR: Odds ratio

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**Table 3: Outcomes of patients with and without alcohol intoxication injured due to different trauma types**

| Trauma types       | BAC (+) | BAC (−) | OR (95% CI) | P   |
|--------------------|---------|---------|-------------|-----|
| Motor vehicle accident | n=76   | n=405  |             |     |
| LOS in hospital (days) | 13.7±13.3 | 13.5±14.2 | - | 0.892 |
| Mortality           | 6 (7.9) | 9 (2.2) | 3.8 (1.3-10.9) | 0.020 |
| Motorcycle accident  | n=788   | n=7975  |             |     |
| LOS in hospital (days) | 12.0±11.5 | 9.8±10.2 | - | <0.001 |
| Mortality           | 35 (4.4) | 133 (1.7) | 2.7 (1.9-4.0) | <0.001 |
| Bicycle accident     | n=37    | n=689  |             |     |
| LOS in hospital (days) | 6.8±6.4 | 8.8±10.3 | 0.238 |
| Mortality           | 2 (5.4) | 26 (3.8) | 1.5 (0.3-6.4) | 0.648 |
| Fall accident        | n=132   | n=6246  |             |     |
| LOS in hospital (days) | 10.6±10.6 | 9.1±9.2 | - | 0.100 |
| Mortality           | 8 (6.1) | 180 (2.9) | 2.2 (1.1-4.5) | 0.059 |
| Penetration injury   | n=58    | n=920  |             |     |
| LOS in hospital (days) | 4.8±5.7 | 5.2±6.9 | - | 0.642 |
| Mortality           | 1 (1.7) | 4 (0.4) | 4.0 (0.4-36.5) | 0.264 |
| Strike by/against object | n=111  | n=2481  |             |     |
| LOS in hospital (days) | 10.7±10.3 | 8.8±9.6 | - | 0.047 |
| Mortality           | 1 (0.9) | 38 (1.5) | 0.6 (0.1-4.3) | 1.000 |

LOS: Length of stay, BAC: Blood alcohol concentration, OR: Odds ratio, CI: Confidence interval
were injured via motor vehicle or motorcycle accidents. However, in other modes of trauma (bicycle accident, fall accident, penetration injury, and strike by/against an object), the difference in mortality rates between patients with and without alcohol intoxication was not significant.

The results of this study revealed that motorcycle accidents were the most common mode of injury in both alcohol intoxication and nonintoxication groups. This finding is in agreement with the report by the Ministry of Transportation and Communications that motorcycles are the most commonly used vehicles in Taiwan and that approximately 60% of driving fatalities are motorcycle-related. Comparisons of the injury characteristics and clinical outcomes according to different modes of trauma for patients with and without alcohol intoxication in this study revealed that the alcohol-intoxicated group predominantly comprised male and younger aged patients as compared to those in the nonintoxicated group. In addition, rates of motor vehicle and motorcycle accidents were significantly higher and fall accidents and strike by/against an object were fewer in the alcohol-intoxicated group as compared to the nonintoxicated group.

In this study, the head and neck were the most commonly injured body regions. Among patients who experienced motorcycle accident, bicycle accident, fall accident, and strike by/against an object, the head and neck were injured significantly more often in patients with alcohol intoxication than in those without. This may be attributed to the direct impact of the head-and-neck region during the injury. Attention, judgment, and physical balance are also strictly required when riding motorcycles and bicycles; thus, traffic accidents or injuries more likely occur in patients with alcohol intoxication. The current literature has shown that, in addition to the extremities, head injuries are the most common causes of morbidity and mortality in motorcycle accidents. Inadequate regional protection in motorcycle and bicycle accidents may also lead to severe injuries to the head-and-neck region. Helmets are important to reduce the impact force associated with head injury in motorcycle accidents. Without a helmet, head-and-neck injuries such as brain hemorrhage, cervical spine injury, and facial bone fracture are caused by the direct impact of the head on the road after being separated from the motorcycle or bicycle. Bicycle helmet use may also reduce the risks of injury to the head and face and have larger effects among drunk than sober cyclists.

The results of this study revealed higher rates of thoracic injury in motorcycle accidents and strikes by/against an object in patients with alcohol intoxication than those without. In addition, rates of abdominal injury in motor vehicle accidents and penetration injuries were higher in patients with alcohol intoxication than those without. Reduced use of seatbelts in patients with alcohol intoxication might contribute to this result, which requires further investigation and validation.

The relationship between alcohol intoxication and ISS remained controversial. In motorcycle accidents, the high rate of riding speed and less protection are reportedly as the primary cause of higher ISS. Although alcohol intoxication may be associated with higher injury severity, impaired judgment and control in individuals with alcohol intoxication may make them more prone to injury, even in less speedy riding or walking conditions. Jou et al. demonstrated that patients with alcohol consumption had lower frequencies of specific body injuries and reduced likelihood of sustaining a severe injury, with ISS of ≥25. Furthermore, our results showed that patients with alcohol intoxication had a higher ISS than those without in motorcycle accidents, fall accidents, and strikes by/against objects. However, a difference in sustained injury severity was not observed in motor vehicular accident, bicycle accident, and penetration injury. These results indicate that modes of trauma mattered in determining the injury severity between patients with and without alcohol intoxication.

This study revealed that, compared to those without alcohol intoxication, patients with alcohol intoxication who experienced motorcycle accidents or strike by/against objects had a longer hospital LOS, whereas those who experienced motor vehicular and motorcycle accidents had a significantly higher mortality rate.

**Limitations**

The retrospective design of this study and unknown conditions such as alcoholic psychosis, alcohol dependence, and alcohol abuse may have led to a selection bias. The lack of circumstantial data including road condition, intentional and unintentional injuries, and use of protective devices in this study may also have resulted in bias. The speed of the vehicle or motorcycle that may determine the severity of injury was not recorded in the registered database, thus may also lead to a bias in the analysis. Moreover, the binary division of patients according to BAC may have oversimplified the conditions associated with alcohol consumption. Furthermore, the Trauma Registry data only included cases of in-hospital mortality but not data at ≥30 days; therefore, results may not reflect the full scope of mortality associated with alcohol intoxication according to different modes of trauma. Finally, the population...
included in this study was limited to that of a single urban trauma center in Southern Taiwan; as such, our results may not be applicable to a wider population.

CONCLUSIONS

This study revealed that alcohol intoxication had different effects on the injury severity and outcomes in adult patients with different modes of trauma. Patients with alcohol intoxication had a higher injury severity than those without alcohol intoxication when they were injured via motorcycle accidents, fall accidents, or when injuries were caused by strike by/against an object. In addition, patients with alcohol intoxication had a significantly higher mortality rate than those without alcohol intoxication when they were injured via motor vehicular or motorcycle accidents.

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Conflicts of interest

There are no conflicts of interest.

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