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Complete List of Authors:	Peng, Shu-Hui; Department of Healthcare Administration, I-Shou University, Executive Master Program Hsu, Shiun-Yuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery Kuo, Pao-Jen; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Plastic and Reconstructive Surgery Rau, Cheng-Shyuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Neurosurgery Cheng, Ya-Ai; Executive Master Program, Department of Healthcare Administration, I-Shou University Hsieh, Ching-Hua; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery
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Influence of alcohol use on mortality and expenditure during hospital admission: A cross-sectional study

Shu-Hui Peng[1,2], B.A.; Shiun-Yuan Hsu[2], B.A.; Pao-Jen Kuo[4], M.D.; Cheng-Shyuan Rau[3], M.D.; Cheng,Ya-Ai[1*], Ph.D.; Ching-Hua Hsieh[2*], M.D., Ph.D.

[*] indicated equal contribution in authorship

[1]Executive Master Program, Department of Healthcare Administration, I-Shou University

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[3]Department of Neurosurgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[4]Department of Plastic Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

*indicated equal contribution in authorship as corresponding authors

Shu-Hui Peng; e-mail: pshui@cgmh.org.tw

Shiun-Yuan Hsu; e-mail: ah.lucy@hotmail.com

Pao-Jen Kuo; email: bow110470@gmail.com

Cheng-Shyuan Rau; e-mail: ersh2127@cloud.cgmh.org.tw

Ya-Ai Cheng; e-mail: yaai@isu.edu.tw

Ching-Hua Hsieh; e-mail: m93chinghua@gmail.com

Corresponding author: Ya-Ai, Cheng[1], Ph.D. & Ching-Hua Hsieh, M.D., PhD, FACS

[1]Executive Master Program, Department of Healthcare Administration, I-Shou

University; email: yaai@isu.edu.tw

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

No.123, Ta-Pei Road, Niao-Song District, Kaohsiung City 833, Taiwan

Tel: 886-7-7327476; E-mail: m93chinghua@gmail.com

ABSTRACT

Objectives: Alcohol intoxication may increase the resource use and expenditure of patients admitted to the hospital. This study was designed to investigate the clinical presentation and expenditure of hospitalized adult trauma patients with alcohol intoxication at a Level I trauma center.

Design: Cross-sectional study

Setting: Taiwan

Participants: Detailed data of 929 hospitalized adult trauma patients, aged 20–65 years, with alcohol intoxication and 10,104 corresponding patients without alcohol intoxication were retrieved from the Trauma Registry System between January 1, 2009, and December 31, 2014. Alcohol intoxication was defined as a blood alcohol concentration (BAC) ≥ 50 mg/dL. Patients who had an incomplete registered data or lacked information on expenditure were excluded from the study.

Main outcome measures: In-hospital mortality

Results: Patients with alcohol intoxication were predominantly men, of younger age, and had a lower incidence rate of pre-existing comorbidities and chronic diseases (diabetes mellitus, hypertension, and end-stage renal disease). They also presented with significantly different body-injury patterns, higher injury severity (median, 10 vs. 5, $p < 0.001$), longer hospital stays (11.4 days vs. 9.1 days, respectively, $p < 0.001$), higher proportion of admissions to the intensive care unit (35.4% vs. 15.0%, respectively, $p < 0.001$), and higher short-term mortality (odds ratio: 3.0, 95% confidence interval: 2.0–4.4; $p < 0.001$) than patients without alcohol intoxication. In addition, patients with alcohol intoxication had significantly higher total expenditure (28.3% higher), cost of operation (51.8% higher), cost of examination (71.7% higher), and cost of pharmaceuticals (63.8% higher). Even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication, those with alcohol intoxication had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher).

Conclusions: Patients with alcohol intoxication incur significantly higher short-term mortality and expenditure than patients without alcohol intoxication.

KEY WORDS: Trauma; Alcohol intoxication; Mortality; Length of stay; Cost

ARTICLE SUMMARY

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The patients with alcohol intoxication presented with higher injury severity, longer hospital stays, higher proportion of admission to the ICU, higher short-term mortality, and higher expenditure than patients without alcohol intoxication.
- The patients with alcohol intoxication had sustained significantly higher injury severity and rates of head/neck injury, face injury, thoracic injury, and abdomen injury.
- The injured patients lack of data regarding indication of hospitalization, type of surgery, and the cost of patients at the referring hospital were not included in the sample as well as the lack of available data about the circumstances of the

injuries and the factors influencing the decision making result in bias in the analysis.

BACKGROUND

Alcohol consumption increases the likelihood of injury during activities[1-3]. Consumption of 3–4 alcoholic drinks and 5–6 drinks during the 6 hours preceding an accident led to a 6- and 9-fold increase, respectively, in the odds of injury[4]. A previous case-control study [5] and a case-crossover study, which compares injury between when patients drink before the event and when patients drink during an earlier control period [6], were conducted in emergency-room settings to estimate the risk of injury related to alcohol consumption. These studies revealed a 2.1-fold and 4.7-fold increase, respectively, in drinking-related injury [7]. A multi-level analysis of 28 studies from 16 countries included 8,423 patients with drinking-related injury who arrived in the emergency department (ED) within 6 hours after injury and showed that the overall prevalence of alcohol-related injury was 24% for positive blood alcohol concentration (BAC) [8]. At the time of admission, alcohol intoxication prevalence of 18%–80% has been reported, depending on the study design and inclusion criteria [9-12].

In trauma patients, alcohol intoxication is associated with higher impact speed [13-15] and leads to higher injury severity [10, 13, 16, 17] and mortality [13, 14]. The relative risk of involvement in a fatal vehicle crash increases steadily with increasing driver BAC in every age/gender group among both fatally injured and surviving drivers [1]. Among 16–20 year-old male drivers, a BAC increase of 0.02% was estimated to more than double the relative risk of fatal single-vehicle crash injury[1]. In addition, a previous study has reported a doubled mortality rate due to traffic crashes in patients with alcohol use as compared to sober patients [13]. In the United States, alcohol-impaired driving crashes account for nearly 11,000 crash fatalities, or approximately one-third of all crash fatalities[18, 19]. A total of 35.2% of deaths worldwide were attributable to alcohol consumption in 2012, which resulted in 30.8% of disability-adjusted life years

(DALYs) from injuries [20].

Acute intoxication and dependence on alcohol are both associated with frequent utilization of selected health care resources[21, 22]. In addition, alcohol may negatively influence the body's response to injury [23]. National and international statistics on alcohol-related harm tend to emphasize estimates of the total numbers of deaths [24] or total economic costs [25], but rarely report the financial expense of care per episode of injury. The effect of alcohol intoxication on the expense of caring for injured patients has important implications for trauma care and health care policy. Increased resource use and expenditure have been reported in a subset of minimally injured trauma patients who were BAC positive in trauma centers nationwide[26, 27]. In medical evaluations, physicians often utilize advanced techniques to rule out the presence of potentially unidentified injuries in drunken patients [28]. Alcohol-intoxicated patients had significantly higher chances of undergoing evaluation by abdominal ultrasound and head computed tomography (CT) during the first 24 h of hospital arrival[21]. In alcohol-intoxicated patients with less-severe injuries, brain CT was overused, with a higher proportion of negative findings for intracranial hemorrhage [22]. In an analysis of the sample of ED patient visits, representing approximately 13 million ED visits nationwide, BAC-positive patients underwent more diagnostic tests and had longer ED stays [29].

Substantial regional variability for alcohol-attributable deaths and the burden of alcohol use may exist[24]. In this study, we aimed to investigate the clinical presentation and expenditure of the hospitalized adult trauma patients with alcohol intoxication in a Level I trauma center in Southern Taiwan. The primary hypothesis of this study was that alcohol intoxication increases expenditure for hospitalized trauma patients.

METHODS

Ethics statement

This study was pre-approved by the Institutional Review Board (IRB) of the Chang Gung Memorial Hospital (approval number 104-8665B). Informed consent was waived according to IRB regulations.

Study Design

This retrospective study reviewed data of all 20,106 hospitalized patients registered in the Trauma Registry System from January 1, 2009, to December 31, 2014. The hospital is a 2,400-bed facility and Level I regional trauma center that provides care to trauma patients primarily from southern Taiwan. All adult patients of 20–65 years of age and hospitalized for treatment of traumatic injuries were included in the study. Patients who had incomplete registered data or lacked information on hospital expenditure were excluded. In Taiwan, all drivers involved in traffic accidents are legally compelled to undergo a test to estimate their BAC. In trauma injuries other than traffic accidents, the physician at the ED may perform a BAC test when required or under strong suspicion. A BAC level of 50 mg/dL, which is the legal limit for drivers in Taiwan, was defined as the cut-off value. Therefore, patients with a BAC level ≥ 50 mg/dL at the time of arrival at the hospital were considered intoxicated and were included in the study as BAC (+). Patients for whom an alcohol test was not requested or who had a BAC level < 50 mg/dL at the time of arrival at the hospital were considered to be non-intoxicated and BAC (–). Of the 16,548 registered patients, 1,430 (8.64%) adult motorcycle riders and passengers underwent a BAC test. Patients who did not undergo the BAC test were excluded from the study. Of the total 11,033 adult patients, 929 (8.4%) patients with BAC (+) and 10,104 (91.6%) patients with

BAC (–) were enrolled in this study for further analysis. Detailed patient information was retrieved from the Trauma Registry System of our institution, including data on age; gender; trauma mechanism; initial Glasgow Coma Scale (GCS) in the ED; Abbreviated Injury Scale (AIS) severity score for each body region; Injury Severity Score (ISS); rates of associated injures; number of operation; hospital length of stay (LOS); LOS in ICU; in-hospital mortality; and total expenditure, which included cost of operation (operation fee and operation supply fee), cost of examination (physical examination fee, hematology testing fee, examination fee for radiography, pathological examination fee, examination fee for electrocardiography, echo, endoscopy, electromyography, and cardiac catheterization, and monitoring fee of electroencephalography), cost of pharmaceuticals (medicine service fee, medicine fee, and narcotic drug fee), and other costs (registration fee, administrative fee, ward fees, nursing fee, blood/plasma test fees, hemodialysis fees, anesthesia fees, rehabilitation-treatment fee, special material costs, and personal expenses), which was expressed as cost per victim. The ISS is expressed as the median and interquartile range (IQR, Q1–Q3). Pre-existing comorbidities and chronic diseases including diabetes mellitus (DM), hypertension (HTN), coronary artery diseases (CAD), congestive heart failure (CHF), cerebrovascular accident (CVA), and end-stage renal disease (ESRD) were also identified. Odd ratios (ORs) of the associated conditions and injuries of the patients were calculated with 95% confidence intervals (CIs). The data collected were compared using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). Two-sided Fisher exact or Pearson chi-square test was used to compare categorical data. Unpaired Student's *t*-test was used to analyze normally distributed continuous data, which was reported as mean ± standard deviation. Mann–Whitney *U*-test was used to compare non-normally distributed data.

To minimize confounding effects due to non-randomized assignment in the assessment of the effect of alcohol intoxication on mortality, propensity scores were calculated using a logistic regression model and the following covariates: gender; age, comorbidity, GCS, injuries based on AIS, and ISS. A 1:1 matched study group was created by the Greedy method using NCSS software (NCSS 10; NCSS Statistical software, Kaysville, Utah). After adjusting for these confounding factors, binary logistic regression was used for evaluating the effect of intervention for alcohol intoxication on mortality. In addition, to assess the effect of alcohol intoxication on cost and number of surgeries, two comparable populations of BAC (+) and BAC (–) patients were selected in a 1:4 ratio by the Greedy method using NCSS software, according to the matched propensity scores, which were calculated using a logistic regression model with gender, age, and comorbidity as covariates. P-values < 0.05 were considered statistically significant.

RESULTS

Injury characteristics of patients with alcohol intoxication

A significant predominance in the percentage of men was noted among patients with alcohol intoxication (821 [88.4%] men and 108 [11.6%] women of total 929 patients with alcohol intoxication). The mean ages of the patients with alcohol intoxication and those without alcohol intoxication were 40.4 ± 11.5 years and 43.0 ± 13.6 years, respectively (Table 1). Among patients with alcohol intoxication, a greater number of patients were aged 30–39 years and 40–49 years, but fewer patients were aged between 50–59 years and 60–69 years. A greater number of patients with alcohol intoxication were younger than those without alcohol intoxication. Significantly lower incidence rates of pre-existing comorbidities and chronic diseases including HTN (OR:

0.7, 95% CI: 0.6–0.8; p < 0.001), DM (OR: 0.5, 95% CI: 0.3–0.6; p < 0.001), and ESRD (OR: 0.2, 95% CI: 0.1–0.7; p = 0.009) were found among patients with alcohol intoxication as compared to those without alcohol intoxication. On comparison with patients without alcohol intoxication, those without alcohol intoxication and involved in motorcycle accidents were more commonly admitted, patients involved in motorcycle accidents were most commonly admitted (48.5% vs. 66.0%, respectively, p < 0.001), followed by strike by/against objects (25.0% vs. 11.8%, respectively, p < 0.001), fall accidents (19.9% vs. 10.0%, respectively, p < 0.001), and motor vehicle accidents (2.7% vs. 7.1%, respectively, p < 0.001). More patients with alcohol intoxication were injured in motorcycle and motor vehicle accidents than those without alcohol intoxication. In contrast, a smaller number of patients with alcohol intoxication were injured in strike by/against objects and fall accidents.

Injury severity of the patients with alcohol intoxication

GCS scores were significantly lower (by 1 point) in patients with alcohol intoxication than in patients without alcohol intoxication (12.6 ± 3.7 vs. 14.5 ± 1.9, p < 0.001). A significantly larger number of patients with alcohol intoxication had a GCS ≤ 8 and GCS of 9–12 and a smaller number of patients had a GCS ≥ 13 compared to patients without alcohol intoxication. Analysis of AIS revealed that patients with alcohol intoxication had sustained significantly higher rates of head/neck, face, thoracic, and abdomen injuries than patients without alcohol intoxication, while patients without alcohol intoxication had sustained significantly higher rates of extremity injury. Regarding the associated common injuries in each trauma region, a significantly higher percentage of patients with alcohol intoxication had sustained associated common major injuries of head, maxillofacial, thoracic, abdominal, and extremity trauma (Table 2). In contrast, a significantly lower percentage of patients with alcohol intoxication had sustained humeral fracture and ulnar fracture. In addition, a significantly higher ISS was found in patients with alcohol intoxication than in patients without alcohol intoxication (median [IQR: Q1–Q3], 10 [5–17] vs. 5 [4–9], $p < 0.001$) (Table 1). When stratified by ISS (<16, 16–24, or ≥25), among patients with alcohol intoxication, a larger number of patients had an ISS ≥ 25 and an ISS of 16–24 and a smaller number of patients had an ISS < 16 as compared to patients without alcohol intoxication.

Outcome of patients with alcohol intoxication

Patients with alcohol intoxication had a significantly higher mortality than those without alcohol intoxication (OR 3.0, 95% CI 2.0–4.4; $p < 0.001$). After propensity-score matching, mortality outcome was compared in the 131 well-balanced pairs of patients (Table 3). In these propensity score-matched patients, there was no significant difference in sex, age, co-morbidity (HTN, DM, and ESRD), GCS, injury region based on AIS, and ISS. The logistic regression analysis showed that alcohol intoxication did not significantly influence mortality (OR: 0.8, 95% CI: 0.5–1.4 p = 0.563), implying that the higher mortality of alcohol-intoxicated patients was attributed to the patient characteristics and associated with higher injury severity. Furthermore, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively, $p < 0.001$), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively, $p < 0.001$), and shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively, p < 0. 001).

Expenditure for patients with alcohol intoxication

To compare the expenditure for patients with and those without alcohol intoxication, 929 well-balanced pairs of patients, with a 1:4 ratio after propensity score matching of sex, age, and co-morbidity (HTN, DM, and ESRD), were used for outcome assessment (Table 4). In these propensity score-matched patients, there was no significant difference in sex, age, and co-morbidity (HTN, DM, and ESRD). On comparison with patients without alcohol intoxication, those who had alcohol intoxication spent a significantly higher total expenditure (28.3% higher), cost of operation (51.8% higher), cost of examination (71.7% higher), and cost of pharmaceuticals (63.8% higher) (Table 5). On comparing the selected well-balanced pairs of patients with and those without alcohol intoxication, who had similar personal characteristics regarding sex, age, and co-morbidities, those who had alcohol intoxication still had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher) (Table 6).

DISCUSSION

This study compared the clinical outcome and expenditure in a broad group of adult trauma patients comprising those with alcohol intoxication and those without alcohol intoxication, hospitalized at a Level I trauma center. Patients with alcohol intoxication presented with a significantly different body-injury patterns, higher injury severity, longer hospital stay, higher proportion of admission to the ICU, and higher short-term mortality than those patients without alcohol intoxication. In addition, patients with alcohol intoxication had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals than those without alcohol intoxication, regardless the comparison was made among the total patients or among the selected propensity score-matched patients.

In this study, the mortality was 3-fold higher in the patients with alcohol intoxication than in those without alcohol intoxication. However, because alcohol influences the behavior and severity of injury caused by the accident as well as the body response to the trauma injury, different compositions of the patient populations with and without alcohol intoxication should be considered in the comparison. For example, some studies demonstrated a beneficial effect of alcohol on patients with traumatic brain injury[30-32], although the exact mechanism is unclear. A positive serum alcohol level was associated with a significantly lower pneumonia rate in isolated, moderate-to-severe traumatic brain injury patients and may explain the observed reduced mortality in these patients with a positive alcohol test [33]. In contrast, observational studies have shown an increased susceptibility to pneumonia and infections [34] and development of adult respiratory distress syndrome [35] with an elevated BAC. In this study, patients with alcohol intoxication were predominantly men, of younger age, and had lower incidence rates of pre-existing comorbidities and chronic diseases. In addition, patients with alcohol intoxication had sustained significantly higher injury severity and rates of head/neck injury, face injury, thoracic injury, and abdomen injury, but lower rate of extremity injury than patients without alcohol intoxication. Notably, controlled experimental and epidemiologic studies have shown that alcohol exposure can increase the severity of injury [36], and the adjustment of injury severity in their analyses of outcomes from acute alcohol exposure may have obscured the association of mortality and other outcomes with BAC by over-adjustment [37]. In this study, analysis of the selected propensity score-matched patients with respect to sex, age, co-morbidity, GCS, injury region based on AIS, and

ISS, we found that alcohol intoxication did not significantly influence mortality, implying that the higher mortality of these alcohol-intoxicated patients was attributable to the patient characteristics and the associated higher injury severity. These results are in agreement with the results of some studies that stated that although beneficial effects of alcohol have been controversial [38], its detrimental effects on injury outweigh the beneficial effects [24].

In this study, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively, $p < 0.001$), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively, $p < 0.001$), but shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively, $p < 0.001$). The alcohol-intoxicated patients had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals, regardless the comparison was made among the total patients or among the selected patients with matched propensity score in sex, age, and co-morbidity. Multiple factors may have contributed to the increase in the expenditure of alcohol-intoxicated patients. In addition, more examinations [21, 22, 28], excess charges for laboratory testing and radiologic testing, and extra monitoring and other procedures may be conducted for patients with alcohol intoxication [29]. These alcohol-intoxicated patients were also more likely to have a delay in discharge due to alcohol withdrawal [39] and require a high level of in-hospital care such as in a coronary care unit or ICU[29]. In contrast, previous studies have reported a reduction in the hospital LOS and lower overall costs of care in intoxicated patients [36, 40] However, the descriptive study design prevents further analysis such as assessment of the effects of any particular treatment and the judgment of discharge from the hospital or stay in the ICU, and could only rely on the assumption of uniform assessment and management of patients with and those without alcohol intoxication.

Our study has some limitations that should be acknowledged. First, owing to the retrospective design of the study with its inherent selection bias, it was impossible to fully account for potential confounders of important risk factors such as differentiation between alcohol-induced psychoses, alcohol dependence, and alcohol abuse [41]; between intentional and unintentional injuries; and most importantly, between patterns of drinking and alcohol consumption. Second, the lack of data regarding indication of hospitalization, type of surgery, and the cost of patients at the referring hospital may have led to a bias. Third, the patients declared dead on hospital arrival or at the accident scene were not included in the Trauma Registry Database, and some outcomes such as late mortality were not analyzed, which potentially led to bias in the assessment of mortality and overall cost. Further, in Taiwan, all drivers involved in traffic accidents are legally compelled to undergo a BAC test to estimate their BAC; however, a few patients may have refused to undergo an actual BAC test after alcohol consumption was confirmed using a breathalyzer. Accordingly, these patients might have been included in an incorrect analytical category because the breathalyzer results were registered in the police report but not noted in the medical records. In addition, the combination of psychoactive drugs and alcohol use may have led to bias in the outcome assessment [42]. However, in our experience, such cases are rare.

CONCLUSION

This study of hospitalized adult trauma patients based on the Trauma Registry System at a Level I trauma center, spanning a 6-year period revealed that patients with alcohol intoxication presented with significantly different body-injury patterns, higher injury severity, longer hospital stays, higher proportion of admission to the ICU, higher short-term mortality, and higher expenditure than patients without alcohol intoxication.

AUTHOR CONTRIBUTIONS

SHP analyzed the data and wrote the manuscript, SYH collected the data and performed the statistical analyses, PJK validated and is responsible for the integrity of registered data, SCW edited the tables, YAC revised the manuscript and supervised the proceeding of the study, and CHH designed the study and contributed to the analysis and interpretation of data. All authors read and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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DATA SHARING

No additional data are available.

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References

1. Zador PL, Krawchuk SA, Voas RB. Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. *J Stud Alcohol.* 2000;61:387-395.

2. Taylor B, Irving HM, Kanteres F, et al. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. *Drug Alcohol Depend.* 2010;110:108-116.

3. Liu HT, Liang CC, Rau CS, Hsu SY, Hsieh CH. Alcohol-related hospitalizations of adult motorcycle riders. *World J Emerg Surg.* 2015;10:2.

4. Vinson DC, Maclure M, Reidinger C, Smith GS. A population-based case-crossover and case-control study of alcohol and the risk of injury. *J Stud Alcohol.* 2003;64:358-366.

5. Cherpitel CJ. Alcohol and injuries: a review of international emergency room studies. *Addiction.* 1993;88:923-937.

6. Stockwell T, McLeod R, Stevens M, Phillips M, Webb M, Jelinek G. Alcohol consumption, setting, gender and activity as predictors of injury: a population-based case-control study. *J Stud Alcohol.* 2002;63:372-379.

7. Ye Y, Bond J, Cherpitel CJ, Stockwell T, Macdonald S, Rehm J. Risk of injury due to alcohol: evaluating potential bias using the case-crossover usual-frequency method. *Epidemiology.* 2013;24:240-243.

8. Cherpitel CJ, Ye Y, Bond J, et al. Multi-level analysis of alcohol-related injury among emergency department patients: a cross-national study. *Addiction.* 2005;100:1840-1850.

9. Alcohol and other drug use among victims of motor-vehicle crashes--West Virginia, 2004-2005. *MMWR Morb Mortal Wkly Rep.* 2006;55:1293-1296.

10. Fabbri A, Marchesini G, Morselli-Labate AM, et al. Positive blood alcohol concentration and road accidents. A prospective study in an Italian emergency department. *Emerg Med J.* 2002;19:210-214.

11. Schwan R, Allen JP. Unhealthy alcohol use. *N Engl J Med.* 2005;352:2139-2140; author reply 2139-2140.

12. Guilherme Borges SM, Cheryl J. et al. Variation in alcohol-related injury by type and cause of injury. In: Cheryl J. Cherpitel GB, Norman Giesbrecht, et al., ed. *Alcohol and Injuries:Emergency Department Studies in an International Perspective. geneva, switzerland: World health organization*; 2009:15-25.

13. Stubig T, Petri M, Zeckey C, et al. Alcohol intoxication in road traffic accidents leads to higher impact speed difference, higher ISS and MAIS, and higher preclinical mortality. *Alcohol.* 2012;46:681-686.

14. Phillips DP, Brewer KM. The relationship between serious injury and blood alcohol concentration (BAC) in fatal motor vehicle accidents: BAC = 0.01% is associated with significantly more dangerous accidents than BAC = 0.00%. *Addiction.* 2011;106:1614-1622.

15. McCoy GF, Johnstone RA, Nelson IW, Duthie RB. A review of fatal road accidents in Oxfordshire over a 2-year period. *Injury.* 1989;20:65-68.

16. Tulloh BR, Collopy BT. Positive correlation between blood alcohol level and ISS in road trauma. *Injury.* 1994;25:539-543.

17. Pories SE, Gamelli RL, Vacek P, Goodwin G, Shinozaki T, Harris F. Intoxication and injury. *J Trauma.* 1992;32:60-64.

18. Scheyerer MJ, Dutschler J, Billeter A, et al. Effect of elevated serum alcohol level on the outcome of severely injured patients. *Emerg Med J.* 2014;31:813-817.

19. Vital signs: alcohol-impaired driving among adults--United States, 2010. *MMWR*

Morb Mortal Wkly Rep. 2011;60:1351-1356.

20. WHO. Global status report on alcohol and health 2014. 2014.

21. Roudsari B, Caetano R, Field C. Alcohol intoxication/dependence, ethnicity and utilisation of health care resources in a level I trauma center. *Injury.* 2011;42:66-71.

22. Rau CS, Liu HT, Hsu SY, Cho TY, Hsieh CH. Alcohol-related hospitalisations of trauma patients in Southern Taiwan: a cross-sectional study based on a trauma registry system. *BMJ Open.* 2014;4:e005947.

23. Guo R, Ren J. Alcohol and acetaldehyde in public health: from marvel to menace. *Int J Environ Res Public Health.* 2010;7:1285-1301.

24. Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y, Patra J. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet.* 2009;373:2223-2233.

25. Kyu HH, Pinho C, Wagner JA, et al. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. *JAMA Pediatr.* 2016;170:267-287.

26. O'Keeffe T, Shafi S, Sperry JL, Gentilello LM. The implications of alcohol intoxication and the Uniform Policy Provision Law on trauma centers; a national trauma data bank analysis of minimally injured patients. *J Trauma.* 2009;66:495-498.

27. Rivara FP, Koepsell TD, Jurkovich GJ, Gurney JG, Soderberg R. The effects of alcohol abuse on readmission for trauma. *JAMA.* 1993;270:1962-1964.

28. Moore EE. Alcohol and trauma: the perfect storm. *J Trauma.* 2005;59:S53-56; discussion S67-75.

29. O'Keeffe T, Rhee P, Shafi S, Friese RS, Gentilello LM. Alcohol use increases diagnostic testing, procedures, charges, and the risk of hospital admission: a population-based study of injured patients in the emergency department. *Am J Surg.* 2013;206:16-22.

30. Berry C, Salim A, Alban R, Mirocha J, Margulies DR, Ley EJ. Serum ethanol levels in patients with moderate to severe traumatic brain injury influence outcomes: a surprising finding. *Am Surg.* 2010;76:1067-1070.

31. Salim A, Teixeira P, Ley EJ, DuBose J, Inaba K, Margulies DR. Serum ethanol levels: predictor of survival after severe traumatic brain injury. *J Trauma.* 2009;67:697-703.

32. Salim A, Ley EJ, Cryer HG, Margulies DR, Ramicone E, Tillou A. Positive serum ethanol level and mortality in moderate to severe traumatic brain injury. *Arch Surg.* 2009;144:865-871.

33. Hadjibashi AA, Berry C, Ley EJ, et al. Alcohol is associated with a lower pneumonia rate after traumatic brain injury. *J Surg Res.* 2012;173:212-215.

34. Ruiz M, Ewig S, Torres A, et al. Severe community-acquired pneumonia. Risk factors and follow-up epidemiology. *Am J Respir Crit Care Med.* 1999;160:923-929.

35. Afshar M, Smith GS, Terrin ML, et al. Blood alcohol content, injury severity, and adult respiratory distress syndrome. *J Trauma Acute Care Surg.* 2014;76:1447-1455.

36. Jurkovich GJ, Rivara FP, Gurney JG, et al. The effect of acute alcohol intoxication and chronic alcohol abuse on outcome from trauma. *JAMA.* 1993;270:51-56.

37. VanderWeele TJ. On the relative nature of overadjustment and unnecessary adjustment. *Epidemiology.* 2009;20:496-499.

38. Fuchs FD, Chambless LE. Is the cardioprotective effect of alcohol real? *Alcohol.* 2007;41:399-402.

39. Williams RJ, Hittinger R, Glazer G. Resource implications of head injuries on an acute surgical unit. *J R Soc Med.* 1994;87:83-86.

40. Fuller MG. Alcohol use and injury severity in trauma patients. *J Addict Dis.* 1995;14:47-54.

41. Murray CJ, Lopez AD. Quantifying disability: data, methods and results. *Bull World Health Organ.* 1994;72:481-494.

42. Watt K, Purdie DM, Roche AM, McClure RJ. Risk of injury from acute alcohol consumption and the influence of confounders. *Addiction.* 2004;99:1262-1273.

TABLES

Table 1. Demographics and injury characteristics of the adult trauma patients with and without alcohol intoxication.

Variables	BAC(+) N=929	BAC(-) N=10104	*Odds Ratio (95%CI)*	*p*
Sex				
Male	821(88.4)	6113(60.5)	5.0(4.0-6.1)	<0.001
Female	108(11.6)	3991(39.5)	0.2(0.2-0.2)	<0.001
Age	40.4±11.5	43.0±13.6	—	<0.001
20-29 years	197(21.2)	2302(22.8)	0.9(0.8-1.1)	0.287
30-39 years	242(26.0)	1847(18.3)	1.6(1.3-1.8)	<0.001
40-49 years	262(28.2)	1986(19.7)	1.6(1.4-1.9)	<0.001
50-59 years	181(19.5)	2656(26.3)	0.7(0.6-0.8)	<0.001
60-64 years	47(5.1)	1313(13.0)	0.4(0.3-0.5)	<0.001
Co-morbidity				
DM	41(4.4)	923(9.1)	0.5(0.3-0.6)	<0.001
HTN	102(11.0)	1546(15.3)	0.7(0.6-0.8)	<0.001
CAD	6(0.6)	124(1.2)	0.5(0.2-1.2)	0.150
CHF	2(0.2)	27(0.3)	0.8(0.2-3.4)	1.000
CVA	5(0.5)	127(1.3)	0.4(0.2-1.0)	0.057
ESRD	3(0.3)	138(1.4)	0.2(0.1-0.7)	0.009
Alcohol Level (mg/dL)	191.1±74.6	15.5±15.0	— —	
Mechanism				
Motor vehicle	66(7.1)	269(2.7)	2.8(2.1-3.7)	<0.001
Motorcycle	613(66.0)	4900(48.5)	2.1(1.8-2.4)	<0.001
Bicycle	29(3.1)	260(2.6)	1.2(0.8-1.8)	0.333
Pedestrian	18(1.9)	135(1.3)	1.5(0.9-2.4)	0.141
Fall	93(10.0)	2010(19.9)	0.4(0.4-0.6)	<0.001
Strike by/against	110(11.8)	2530(25.0)	0.4(0.3-0.5)	<0.001
GCS	12.6±3.7	14.5±1.9	—	<0.001
≤8	158(17.0)	337(3.3)	5.9(4.9-7.3)	<0.001
9-12	122(13.1)	248(2.5)	6.0(4.8-7.5)	<0.001
≥13	649(69.9)	9519(94.2)	0.1(0.1-0.2)	<0.001
AIS				
Head/Neck	485(52.2)	2184(21.6)	4.0(3.5-4.5)	<0.001
Face	373(40.2)	1646(16.3)	3.4(3.0-4.0)	<0.001
Thorax	184(19.8)	1183(11.7)	1.9(1.6-2.2)	<0.001
Abdomen	117(12.6)	642(6.4)	2.1(1.7-2.6)	<0.001
Extremity	538(57.9)	7430(73.5)	0.5(0.4-0.6)	<0.001
ISS (median, IQR)	10(5-17)	5(4-9)	—	<0.001

<16	626(67.4)	8905(88.1)	0.3(0.2-0.3)	<0.001
16-24	209(22.5)	822(8.1)	3.3(2.8-3.9)	<0.001
≥25	94(10.1)	377(3.7)	2.9(2.3-3.7)	<0.001
Mortality	33(3.6)	124(1.2)	3.0(2.0-4.4)	<0.001
LOS in Hospital (days)	11.4±11.2	9.1±10.0	—	<0.001
ICU admission, n (%)	329(35.4)	1517(15.0)	3.1(2.7-3.6)	<0.001
LOS in ICU (days)	7.1±8.5	9.4±12.1	—	<0.001

AIS = Abbreviated Injury Scale; BAC= blood alcohol concentration; CAD = coronary artery disease; CHF = congestive heart failure; CI = confidence interval; CVA = cerebral vascular accident; DM = diabetes mellitus; ESRD = end-stage renal disease; GCS = Glasgow Coma Scale; HTN = hypertension; ICU = intensive care unit; IQR = interquartile range; ISS = injury severity score; LOS = length of stay; OR = odds ratio.

Table 2. Significant associated injuries among the adult trauma patients with and without alcohol intoxication.

Variables	BAC(+) N=929	BAC(-) N=10104	*Odds Ratio (95%CI)*	*p*
Head trauma, n (%)				
Neurologic deficit	35(3.8)	181(1.8)	2.1(1.5-3.1)	<0.001
Cranial fracture	150(16.1)	482(4.8)	3.8(3.2-4.7)	<0.001
Epidural hematoma (EDH)	98(10.5)	298(2.9)	3.9(3.1-4.9)	<0.001
Subdural hematoma (SDH)	180(19.4)	630(6.2)	3.6(3.0-4.3)	<0.001
Subarachnoid hemorrhage (SAH)	186(20.0)	716(7.1)	3.3(2.7-3.9)	<0.001
Intracerebral hematoma (ICH)	43(4.6)	150(1.5)	3.2(2.3-4.6)	<0.001
Cerebral contusion	89(9.6)	407(4.0)	2.5(2.0-3.2)	<0.001
Maxillofacial trauma, n (%)				
Orbital fracture	53(5.7)	173(1.7)	3.5(2.5-4.8)	<0.001
Nasal fracture	25(2.7)	101(1.0)	2.7(1.8-4.3)	<0.001
Maxillary fracture	147(15.8)	557(5.5)	3.2(2.6-3.9)	<0.001
Mandibular fracture	47(5.1)	217(2.1)	2.4(1.8-3.4)	<0.001
Thoracic trauma, n (%)				
Rib fracture	122(13.1)	825(8.2)	1.7(1.4-2.1)	<0.001
Hemothorax	27(2.9)	158(1.6)	1.9(1.2-2.9)	0.004
Pneumothorax	23(2.5)	154(1.5)	1.6(1.1-2.6)	0.030
Hemopneumothorax	21(2.3)	140(1.4)	1.6(1.0-2.6)	0.044
Lung contusion	20(2.2)	107(1.1)	2.1(1.3-3.3)	0.005

Abdominal trauma, n (%)				
Intra-abdominal injury	35 (3.8)	163 (1.6)	2.4 (1.6-3.5)	<0.001
Hepatic injury	55 (5.9)	166 (1.6)	3.8 (2.8-5.2)	<0.001
Splenic injury	20 (2.2)	96 (1.0)	2.3 (1.4-3.7)	0.002
Renal injury	10 (1.1)	47 (0.5)	2.3 (1.2-4.6)	0.019
Extremity trauma, n (%)				
Scapular fracture	26 (2.8)	156 (1.5)	1.8 (1.2-2.8)	0.006
Clavicle fracture	106 (11.4)	839 (8.3)	1.4 (1.1-1.8)	0.001
Humeral fracture	21 (2.3)	482 (4.8)	0.5 (0.3-0.7)	0.001
Ulnar fracture	34 (3.7)	525 (5.2)	0.7 (0.5-1.0)	0.042
Pelvic fracture	38 (4.1)	276 (2.7)	1.5 (1.1-2.1)	0.019
Tibial fracture	72 (7.8)	497 (4.9)	1.6 (1.3-2.1)	<0.001

Table 3. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:1 greedy propensity score matching for mortality assessment.

Mortality (OR: 0.81, 95% CI: 0.46-1.432, p= 0.470)

	Before				After			
	Death n=157	Survival n=10876	*OR(95%CI)*	*P*	Death n=131	Survival n=131	*OR(95%CI)*	*P*
Sex								
Male	122(77.7)	6812(62.6)	2.1(1.4-3.0)	<0.001	111(84.7)	111(84.7)	1.0(0.5-2.0)	1.000
Female	35(22.3)	4064(37.4)	0.5(0.3-0.7)	<0.001	20(15.3)	20(15.3)	1.0(0.5-2.0)	1.000
Age	46.7±13.5	42.7±13.5	—	<0.001	45.8±13.5	44.8±12.3	—	0.560
Co-Morbidity								
HTN	23(14.6)	1625(14.9)	1.0(0.6-1.5)	1.000	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
DM	16(10.2)	948(8.7)	1.2(0.7-2.0)	0.568	10(7.6)	10(7.6)	1.0(0.4-2.5)	1.000
ESRD	9(5.7)	132(1.2)	5.0(2.5-9.9)	<0.001	4(3.1)	4(3.1)	1.0(0.2-4.1)	1.000
GCS	7.2±4.8	14.5±1.9	—	<0.001	7.5±4.8	8.0±4.8	—	0.418
AIS,n(%)								
Head/Neck	128(81.5)	2541(23.4)	14.5(9.7-21.7)	<0.001	105(80.2)	105(80.2)	1.0(0.5-1.8)	1.000
Face	22(14.0)	1997(18.4)	0.7(0.5-1.1)	0.177	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
Thorax	54(34.4)	1313(12.1)	3.8(2.7-5.3)	<0.001	46(35.1)	46(35.1)	1.0(0.6-1.7)	1.000
Abdomen	26(16.6)	733(6.7)	2.7(1.8-4.2)	<0.001	22(16.8)	22(16.8)	1.0(0.5-1.9)	1.000
Extremity	47(29.9)	7921(72.8)	0.2(0.1-0.2)	<0.001	38(29.0)	38(29.0)	1.0(0.6-1.7)	1.000

ISS	30.8±17.8	7.7±6.5	—	<0.001	27.0±13.3	25.0±13.4	—	0.247
BAC(+)	33 (21.0)	896 (8.2)	3.0 (2.0-4.4)	<0.001	29 (22.1)	34 (26.0)	0.8 (0.5-1.4)	0.563

Table 4. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:4 greedy propensity score matching for cost assessment.

	Before				After			
	BAC(+) n=929	BAC(-) n=10104	*OR(95%CI)*	*P*	BAC(+) n=929	BAC(-) n=3716	*OR(95%CI)*	*P*
Sex								
Male	821 (88.4)	6113 (60.5)	5.0 (4.0-6.1)	<0.001	821 (88.4)	3284 (88.4)	1.0 (0.8-1.3)	1.000
Female	108 (11.6)	3991 (39.5)	0.2 (0.2-0.2)	<0.001	108 (11.6)	432 (11.6)	1.0 (0.8-1.3)	1.000
Age	40.4±11.5	43.0±13.6	—	<0.001	40.4±11.5	40.4±11.5	—	0.989
Co-Morbidity								
HTN	102 (11.0)	1546 (15.3)	0.7 (0.6-0.8)	<0.001	102 (11.0)	408 (11.0)	1.0 (0.8-1.3)	1.000
DM	41 (4.4)	923 (9.1)	0.5 (0.3-0.6)	<0.001	41 (4.4)	164 (4.4)	1.0 (0.7-1.4)	1.000
ESRD	3 (0.3)	138 (1.4)	0.2 (0.1-0.7)	0.009	3 (0.3)	12 (0.3)	1.0 (0.3-3.6)	1.000

Table 5. The cost during the hospitalization of the adult trauma patients with and without alcohol intoxication.

	BAC(+)	BAC(-)	Difference	*p*
Total expenditure	(n=929)	(n=10104)		
(US$)	3656±5104	2850±4355	28.3%↑	<0.001
Cost of operation	(n=601)	(n=7558)		
(US$)	958±864	631±706	51.8%↑	<0.001
Cost of examination	(n=791)	(n=8474)		
(US$)	249±353	145±289	71.7%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=10103)		
(US$)	285±773	174±859	63.8%↑	<0.001

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

Table 6. The cost during the hospitalization of the selected propensity score-matched adult trauma patients with and without alcohol intoxication.

	BAC(+)	BAC(-)	Difference	*p*
Total expenditure	(n=929)	(n=3716)		
(US$)	3656±5104	3113±5278	17.4%↑	0.004
Cost of operation	(n=601)	(n=2758)		
(US$)	958±864	683±860	40.3%↑	<0.001
Cost of examination	(n=791)	(n=3037)		
(US$)	249±353	163±336	52.8%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=3715)		
(US$)	285±773	206±706	38.3%↑	0.005

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-12
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-12
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	-
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	-
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Influence of alcohol use on mortality and expenditure during hospital admission: A cross-sectional study

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Complete List of Authors:	Peng, Shu-Hui; Department of Healthcare Administration, I-Shou University, Executive Master Program Hsu, Shiun-Yuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery Kuo, Pao-Jen; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Plastic and Reconstructive Surgery Rau, Cheng-Shyuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Neurosurgery Cheng, Ya-Ai; Executive Master Program, Department of Healthcare Administration, I-Shou University Hsieh, Ching-Hua; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery
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Influence of alcohol use on mortality and expenditure during hospital admission: A cross-sectional study

Shu-Hui Peng[1,2], B.A.; Shiun-Yuan Hsu[2], B.A.; Pao-Jen Kuo[4], M.D.; Cheng-Shyuan Rau[3], M.D.; Cheng,Ya-Ai[1*], Ph.D.; Ching-Hua Hsieh[2*], M.D., Ph.D.

[*] indicated equal contribution in authorship

[1]Executive Master Program, Department of Healthcare Administration, I-Shou University

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[3]Department of Neurosurgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[4]Department of Plastic Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

*indicated equal contribution in authorship as corresponding authors

Shu-Hui Peng; e-mail: pshui@cgmh.org.tw

Shiun-Yuan Hsu; e-mail: ah.lucy@hotmail.com

Pao-Jen Kuo; email: bow110470@gmail.com

Cheng-Shyuan Rau; e-mail: ersh2127@cloud.cgmh.org.tw

Ya-Ai Cheng; e-mail: yaai@isu.edu.tw

Ching-Hua Hsieh; e-mail: m93chinghua@gmail.com

Corresponding author: Ya-Ai, Cheng[1], Ph.D. & Ching-Hua Hsieh, M.D., PhD, FACS

[1]Executive Master Program, Department of Healthcare Administration, I-Shou

University; email: yaai@isu.edu.tw

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

No.123, Ta-Pei Road, Niao-Song District, Kaohsiung City 833, Taiwan

Tel: 886-7-7327476; E-mail: m93chinghua@gmail.com

ABSTRACT

Objectives: This study was designed to investigate the effect of alcohol intoxication on clinical presentation of hospitalized adult trauma patients at a Level I trauma center according to the selected propensity score–matched subjects.

Design: Cross-sectional study

Setting: Taiwan

Participants: Detailed data of 929 hospitalized adult trauma patients, aged 20–65 years, with alcohol intoxication and 10,104 corresponding patients without alcohol intoxication were retrieved from the Trauma Registry System between January 1, 2009, and December 31, 2014. Alcohol intoxication was defined as a blood alcohol concentration (BAC) ≥ 50 mg/dL.

Main outcome measures: In-hospital mortality and expenditure.

Results: Patients with alcohol intoxication presented with significantly higher short-term mortality (odds ratio: 3.0, 95% confidence interval (CI): 2.0–4.4; $p < 0.001$) than patients without alcohol intoxication. However, on comparison with the patients with matched propensity score regarding sex, age, co-morbidity, Glasgow Coma Scale (GCS), injury region based on Abbreviated Injury Scale (AIS), and Injury Severity Score (ISS), alcohol intoxication did not significantly influence mortality (OR: 0.8, 95% CI: 0.5–1.4; $p = 0.563$), implying that the higher mortality of alcohol-intoxicated patients was attributed by the patient characteristics and associated with higher injury severity but not the body response to the alcohol intoxication. Even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication, patients with alcohol intoxication still had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher).

Conclusions: The higher mortality associated with the adult trauma patients with alcohol intoxication was totally attributed by the patient characteristics and associated injury severity but not the body response under alcohol effect. However, patients with alcohol intoxication incur significantly higher expenditure than patients without alcohol intoxication, even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication.

KEY WORDS: Trauma; Alcohol intoxication; Mortality; Length of stay; Cost

Article Summary

Strengths and limitations of this study

- Additional comparison with selected propensity score-matched patients help to attenuate the confounding effect of different patient characteristic and associated injury severity in the assessment of the effect of alcohol intoxication on mortality and expenditure.
- An arbitrary cut-off value of a BAC level of 50 mg/dL as alcohol intoxication may present an information bias to generalize the conclusion, considering that the BAC level that define the alcohol intoxication is different in many countries and cognitive function may be impaired even less than a BAC level of 50 mg/dL.
- The injured patients lack of data regarding indication of hospitalization, type of surgery, and the cost of patients at the referring hospital were not included in the sample as well as the lack of available data about the circumstances of the injuries and the factors influencing the decision making result in bias in the analysis.

BACKGROUND

Alcohol consumption increases the likelihood of injury during activities[1-3]. Consumption of 3–4 alcoholic drinks and 5–6 drinks during the 6 hours preceding an accident led to a 6- and 9-fold increase, respectively, in the odds of injury[4]. A previous case-control study [5] and a case-crossover study, which compares injury between when patients drink before the event and when patients drink during an earlier control period [6], were conducted in emergency-room settings to estimate the risk of injury related to alcohol consumption. These studies revealed a 2.1-fold and 4.7-fold increase, respectively, in drinking-related injury [7]. A multi-level analysis of 28 studies from 16 countries included 8,423 patients with drinking-related injury who arrived in the emergency department (ED) within 6 hours after injury and showed that the overall prevalence of alcohol-related injury was 24% for positive blood alcohol concentration (BAC) [8]. At the time of admission, alcohol intoxication prevalence of 18%–80% has been reported, depending on the study design and inclusion criteria [9-12].

In trauma patients, alcohol intoxication is associated with higher impact speed [13-15] and leads to higher injury severity [10 13 16 17] and mortality [13 14]. The relative risk of involvement in a fatal vehicle crash increases steadily with increasing driver BAC in every age/gender group among both fatally injured and surviving drivers [1]. Among 16–20 year-old male drivers, a BAC increase of 0.02% was estimated to more than double the relative risk of fatal single-vehicle crash injury[1]. In addition, a previous study has reported a doubled mortality rate due to traffic crashes in patients with alcohol use as compared to sober patients [13]. In the United States, alcohol-impaired driving crashes account for nearly 11,000 crash fatalities, or approximately one-third of all crash fatalities[18 19]. A total of 35.2% of deaths worldwide were attributable to alcohol consumption in 2012, which resulted in 30.8% of disability-adjusted life years

(DALYs) from injuries [20].

Acute intoxication and dependence on alcohol are both associated with frequent utilization of selected health care resources[21 22]. National and international statistics on alcohol-related harm tend to emphasize estimates of the total numbers of deaths [23] or total economic costs [24], but rarely report the financial expense of care per episode of injury. The effect of alcohol intoxication on the expense of caring for injured patients has important implications for trauma care and health care policy. Increased resource use and expenditure have been reported in a subset of minimally injured trauma patients who were BAC positive in trauma centers nationwide[25 26]. In medical evaluations, physicians often utilize advanced techniques to rule out the presence of potentially unidentified injuries in drunken patients [27]. Alcohol-intoxicated patients had significantly higher chances of undergoing evaluation by abdominal ultrasound and head computed tomography (CT) during the first 24 h of hospital arrival[21]. In alcohol-intoxicated patients with less-severe injuries, brain CT was overused, with a higher proportion of negative findings for intracranial hemorrhage [22]. In an analysis of the sample of ED patient visits, representing approximately 13 million ED visits nationwide, BAC-positive patients underwent more diagnostic tests and had longer ED stays [28].

Although the alcohol use had reported to be associated with a higher mortality and expenditure in the literature, however, because alcohol influences not only the behavior and severity of injury caused by the accident but also the body response to the trauma injury, different compositions of the patient populations in the assessment of the effect of alcohol intoxication should be considered in the comparison. In particular, alcohol had been reported to negatively influence the body's response to injury [29]. For example, some studies demonstrated a beneficial effect of alcohol on patients with traumatic brain injury[30-32], although the exact mechanism is unclear. In addition, a positive serum alcohol level was associated with a significantly lower pneumonia rate in isolated, moderate-to-severe traumatic brain injury patients and may explain the observed reduced mortality in these patients with a positive alcohol test [33]. In contrast, observational studies have shown an increased susceptibility to pneumonia and infections [34] and development of adult respiratory distress syndrome [35] with an elevated BAC. Therefore, by using the propensity score–matching to attenuate the confounding effects of different patient characteristic and associated injury severity, this study was designed to assess the effect of alcohol intoxication on clinical presentation of hospitalized adult trauma patients in a Level I trauma center in Southern Taiwan.

METHODS

Ethics statement

This study was pre-approved by the Institutional Review Board (IRB) of the Chang Gung Memorial Hospital (approval number 104-8665B). Informed consent was waived according to IRB regulations.

Study Design

This retrospective study reviewed data of all 20,106 hospitalized patients registered in the Trauma Registry System from January 1, 2009, to December 31, 2014 (Figure 1). The hospital is a 2,400-bed facility and Level I regional trauma center that provides care to trauma patients primarily from southern Taiwan. All adult patients of 20–65 years of age and hospitalized for treatment of traumatic injuries were included in the study. Patients who had incomplete registered data (n=182) or lacked information on hospital expenditure (n=3,289) were excluded. In Taiwan, all drivers involved in traffic accidents are legally compelled to undergo a test to estimate their BAC. In trauma injuries other than traffic accidents, the physician at the ED may perform a BAC test when required or under strong suspicion. A BAC level of 50 mg/dL, which is the legal limit for drivers in Taiwan, was defined as the cut-off value. Therefore, patients with a BAC level ≥ 50 mg/dL at the time of arrival at the hospital were considered intoxicated and were included in the study as BAC (+). Patients for whom an alcohol test was not requested or who had a BAC level < 50 mg/dL at the time of arrival at the hospital were considered to be non-intoxicated and BAC (–). Of the total 11,033 adult patients, 929 (8.4%) patients with BAC (+) and 10,104 (91.6%) patients with BAC (–) were enrolled in this study for further analysis. Detailed patient information was retrieved from the Trauma Registry System of our institution, including data on age; gender; trauma mechanism; initial Glasgow Coma Scale (GCS) in the ED; Abbreviated Injury Scale (AIS) severity score for each body region; Injury Severity Score (ISS); rates of associated injures; number of operation; hospital length of stay (LOS); LOS in ICU; in-hospital mortality; and total expenditure, which included cost of operation (operation fee and operation supply fee), cost of examination (physical examination fee, hematology testing fee, examination fee for radiography, pathological examination fee, examination fee for electrocardiography, echo, endoscopy, electromyography, and cardiac catheterization, and monitoring fee of electroencephalography), cost of pharmaceuticals (medicine service fee, medicine fee, and narcotic drug fee), and other costs (registration fee, administrative fee, ward fees, nursing fee, blood/plasma test fees, hemodialysis fees, anesthesia fees, rehabilitation-treatment fee, special material costs, and personal expenses), which was expressed as cost per victim. The ISS is expressed as the median and interquartile range (IQR, Q1–Q3). Pre-existing comorbidities and chronic diseases including diabetes mellitus (DM), hypertension (HTN), coronary artery diseases (CAD), congestive heart failure (CHF), cerebrovascular accident (CVA), and end-stage renal disease (ESRD) were also identified. Odd ratios (ORs) of the associated conditions and injuries of the patients were calculated with 95% confidence intervals (CIs). The data collected were compared using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). Two-sided Fisher exact or Pearson chi-square test was used to compare categorical data. Unpaired Student's *t*-test was used to analyze normally distributed continuous data, which was reported as mean ± standard deviation. Mann–Whitney *U*-test was used to compare non-normally distributed data. To minimize confounding effects due to non-randomized assignment in the assessment of the effect of alcohol intoxication on mortality, propensity scores were calculated using a logistic regression model and the following covariates: gender; age, comorbidity, GCS, injuries based on AIS, and ISS. A 1:1 matched study group was created by the Greedy method using NCSS software (NCSS 10; NCSS Statistical software, Kaysville, Utah). After adjusting for these confounding factors, binary logistic regression was used for evaluating the effect of intervention for alcohol intoxication on mortality. In addition, to assess the effect of alcohol intoxication on cost and number of surgeries, two comparable populations of BAC (+) and BAC (–) patients were selected in a 1:4 ratio by the Greedy method using NCSS software, according to the matched propensity scores, which were calculated using a logistic regression model with gender, age, and comorbidity as covariates. P-values < 0.05 were considered statistically significant.

RESULTS

Injury characteristics of patients with alcohol intoxication

A significant predominance in the percentage of men was noted among patients with alcohol intoxication (821 [88.4%] men and 108 [11.6%] women of total 929 patients with alcohol intoxication). The mean ages of the patients with alcohol intoxication and those without alcohol intoxication were 40.4 ± 11.5 years and 43.0 ± 13.6 years, respectively (Table 1). Among patients with alcohol intoxication, a greater number of patients were aged 30–39 years and 40–49 years, but fewer patients were aged between 50–59 years and 60–69 years. A greater number of patients with alcohol intoxication were younger than those without alcohol intoxication. Significantly lower incidence rates of pre-existing comorbidities and chronic diseases including HTN (OR: 0.7, 95% CI: 0.6–0.8; $p < 0.001$), DM (OR: 0.5, 95% CI: 0.3–0.6; $p < 0.001$), and ESRD (OR: 0.2, 95% CI: 0.1–0.7; $p = 0.009$) were found among patients with alcohol intoxication as compared to those without alcohol intoxication. On comparison with patients without alcohol intoxication, those without alcohol intoxication and involved in motorcycle accidents were more commonly admitted, patients involved in motorcycle accidents were most commonly admitted (48.5% vs. 66.0%, respectively, $p < 0.001$), followed by strike by/against objects (25.0% vs. 11.8%, respectively, $p < 0.001$), fall accidents (19.9% vs. 10.0%, respectively, $p < 0.001$), and motor vehicle accidents (2.7% vs. 7.1%, respectively, $p < 0.001$). More patients with alcohol intoxication were injured in motorcycle and motor vehicle accidents than those without alcohol intoxication. In contrast, a smaller number of patients with alcohol intoxication were injured in strike by/against objects and fall accidents.

Injury severity of the patients with alcohol intoxication

GCS scores were significantly lower (by 1 point) in patients with alcohol intoxication than in patients without alcohol intoxication (12.6 ± 3.7 vs. 14.5 ± 1.9, p < 0.001). A significantly larger number of patients with alcohol intoxication had a GCS ≤ 8 and GCS of 9–12 and a smaller number of patients had a GCS ≥ 13 compared to patients without alcohol intoxication. Analysis of AIS revealed that patients with alcohol intoxication had sustained significantly higher rates of head/neck, face, thoracic, and abdomen injuries than patients without alcohol intoxication, while patients without alcohol intoxication had sustained significantly higher rates of extremity injury. Regarding the associated common injuries in each trauma region, a significantly higher percentage of patients with alcohol intoxication had sustained associated common major injuries of head, maxillofacial, thoracic, abdominal, and extremity trauma (Table 2). In contrast, a significantly lower percentage of patients with alcohol intoxication had sustained humeral fracture and ulnar fracture. In addition, a significantly higher ISS was found in patients with alcohol intoxication than in patients without alcohol intoxication (median [IQR: Q1–Q3], 10 [5–17] vs. 5 [4–9], p < 0.001) (Table 1). When stratified by ISS (<16, 16–24, or ≥25), among patients with alcohol intoxication, a larger number of patients had an ISS ≥ 25 and an ISS of 16–24 and a smaller number of patients had an ISS < 16 as compared to patients without alcohol intoxication.

Outcome of patients with alcohol intoxication

Patients with alcohol intoxication had a significantly higher mortality than those without alcohol intoxication (OR 3.0, 95% CI 2.0–4.4; p < 0.001). After propensity-score matching, mortality outcome was compared in the 131 well-balanced pairs of patients (Table 3). In these propensity score-matched patients, there was no significant difference in sex, age, co-morbidity (HTN, DM, and ESRD), GCS, injury region based on AIS, and ISS. The logistic regression analysis showed that alcohol intoxication did not significantly influence mortality (OR: 0.8, 95% CI: 0.5–1.4 $p = 0.563$), implying that the higher mortality of alcohol-intoxicated patients was attributed by the patient characteristics and associated with higher injury severity. Furthermore, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively, $p < 0.001$), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively, $p < 0.001$), and shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively, $p < 0.001$).

Expenditure for patients with alcohol intoxication

To compare the expenditure for patients with and those without alcohol intoxication, 929 well-balanced pairs of patients, with a 1:4 ratio after propensity score matching of sex, age, and co-morbidity (HTN, DM, and ESRD), were used for outcome assessment (Table 4). In these propensity score-matched patients, there was no significant difference in sex, age, and co-morbidity (HTN, DM, and ESRD). On comparison with patients without alcohol intoxication, those who had alcohol intoxication spent a significantly higher total expenditure (28.3% higher), cost of operation (51.8% higher), cost of examination (71.7% higher), and cost of pharmaceuticals (63.8% higher) (Table 5). On comparing the selected well-balanced pairs of patients with and those without alcohol intoxication, who had similar personal characteristics regarding sex, age, and co-morbidities, those who had alcohol intoxication still had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher) (Table 6).

Discussion

This study compared the clinical outcome and expenditure in a broad group of adult trauma patients comprising those with alcohol intoxication and those without alcohol intoxication, hospitalized at a Level I trauma center. Patients with alcohol intoxication presented with a significantly different body-injury patterns, higher injury severity, longer hospital stay, higher proportion of admission to the ICU, and higher short-term mortality than those patients without alcohol intoxication. In addition, patients with alcohol intoxication had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals than those without alcohol intoxication, regardless the comparison was made among the total patients or among the selected propensity score-matched patients.

In this study, patients with alcohol intoxication were predominantly men, of younger age, and had lower incidence rates of pre-existing comorbidities and chronic diseases. In addition, patients with alcohol intoxication had sustained significantly higher injury severity and rates of head/neck injury, face injury, thoracic injury, and abdomen injury, but lower rate of extremity injury than patients without alcohol intoxication. In addition, the mortality was 3-fold higher in the patients with alcohol intoxication than in those without alcohol intoxication in this study. Notably, controlled experimental and epidemiologic studies have shown that alcohol exposure can increase the severity of injury [36], and the adjustment of injury severity in their analyses of outcomes from acute alcohol exposure may have obscured the association of mortality and other outcomes with BAC by over-adjustment [37]. In this study, analysis of the selected propensity score-matched patients with respect to sex, age, co-morbidity, GCS, injury region based on AIS, and ISS, we found that alcohol intoxication did not significantly influence mortality, implying that the higher mortality of these alcohol-intoxicated patients was attributable to the patient characteristics and the associated higher injury severity. These results are in agreement with the results of some studies that stated that although beneficial effects of alcohol have been controversial [38], its detrimental effects on injury outweigh the beneficial effects [23].

In this study, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively, $p < 0.001$), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively, $p < 0.001$), but shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively, $p < 0.001$). The alcohol-intoxicated patients had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals, regardless the comparison was made among the total patients or among the selected patients with matched propensity score in sex, age, and co-morbidity. Multiple factors may have contributed to the increase in the expenditure of alcohol-intoxicated patients. In addition, more examinations [21 22 27], excess charges for laboratory testing and radiologic testing, and extra monitoring and other procedures may be conducted for patients with alcohol intoxication [28]. These alcohol-intoxicated patients were also more likely to have a delay in discharge due to alcohol withdrawal [39] and require a high level of in-hospital care such as in a coronary care unit or ICU[28]. In contrast, previous studies have reported a reduction in the hospital LOS and lower overall costs of care in intoxicated patients [36 40] However, the descriptive study design prevents further analysis such as assessment of the effects of any particular treatment and the judgment of discharge from the hospital or stay in the ICU, and could only rely on the assumption of uniform assessment and management of patients with and those without alcohol intoxication.

Our study has some limitations that should be acknowledged. First, owing to the retrospective design of the study with its inherent selection bias, it was impossible to fully account for potential confounders of important risk factors such as differentiation between alcohol-induced psychoses, alcohol dependence, and alcohol abuse [41]; between intentional and unintentional injuries; and most importantly, between patterns of drinking and alcohol consumption. Second, the lack of data regarding indication of hospitalization, type of surgery, and the cost of patients at the referring hospital may have led to a bias. Third, the patients declared dead on hospital arrival or at the accident scene were not included in the Trauma Registry Database, and some outcomes such as late mortality were not analyzed, which potentially led to bias in the assessment of mortality and overall cost. Further, in Taiwan, all drivers involved in traffic accidents are legally compelled to undergo a BAC test to estimate their BAC; however, a few patients may have refused to undergo an actual BAC test after alcohol consumption was confirmed using a breathalyzer. Accordingly, these patients might have been included in an incorrect analytical category because the breathalyzer results were registered in the police report but not noted in the medical records. In addition, the combination of psychoactive drugs and alcohol use may have led to bias in the outcome assessment [42]. However, in our experience, such cases are rare. At last, considering that the cognitive function may be impaired even less than a BAC level of 50 mg/dL [14 43] and the BAC level that define the alcohol intoxication is different in many countries, an arbitrary cut-off value of a BAC level of 50 mg/dL as alcohol intoxication may present an information bias to generalize the conclusion. Moreover, the facts that most commonly trauma injuries were motorcycle accidents in Taiwan but not those car accidents observed in Western countries may also hinder the generalization of the assessment of alcohol intoxication effect.

Conclusion

This study of hospitalized adult trauma patients based on the Trauma Registry System at a Level I trauma center, spanning a 6-year period revealed that a higher mortality associated with the adult trauma patients with alcohol intoxication was totally attributed by the patient characteristics and associated injury severity but not the body response under alcohol effect. However, patients with alcohol intoxication incur significantly higher expenditure than patients without alcohol intoxication, even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication.

Competing interests

The authors declare that they have no competing interests.

Author contributions

SHP analyzed the data and wrote the manuscript, SYH collected the data and performed the statistical analyses, PJK validated and is responsible for the integrity of registered data, SCW edited the tables, YAC revised the manuscript and supervised the proceeding of the study, and CHH designed the study and contributed to the analysis and interpretation of data. All authors read and approved the final manuscript.

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Data Sharing

No additional data are available.

References

1. Zador PL, Krawchuk SA, Voas RB. Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. J Stud Alcohol 2000;**61**(3):387-95.

2. Taylor B, Irving HM, Kanteres F, et al. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug Alcohol Depend 2010;**110**(1-2):108-16.

3. Liu HT, Liang CC, Rau CS, et al. Alcohol-related hospitalizations of adult motorcycle riders. World journal of emergency surgery : WJES 2015;**10**(1):2.

4. Vinson DC, Maclure M, Reidinger C, et al. A population-based case-crossover and case-control study of alcohol and the risk of injury. J Stud Alcohol 2003;**64**(3):358-66.

5. Cherpitel CJ. Alcohol and injuries: a review of international emergency room studies. Addiction 1993;**88**(7):923-37.

6. Stockwell T, McLeod R, Stevens M, et al. Alcohol consumption, setting, gender and activity as predictors of injury: a population-based case-control study. J Stud

Alcohol 2002;**63**(3):372-9.

7. Ye Y, Bond J, Cherpitel CJ, et al. Risk of injury due to alcohol: evaluating potential bias using the case-crossover usual-frequency method. Epidemiology 2013;**24**(2):240-3.

8. Cherpitel CJ, Ye Y, Bond J, et al. Multi-level analysis of alcohol-related injury among emergency department patients: a cross-national study. Addiction 2005;**100**(12):1840-50.

9. Alcohol and other drug use among victims of motor-vehicle crashes--West Virginia, 2004-2005. MMWR Morb Mortal Wkly Rep 2006;**55**(48):1293-6.

10. Fabbri A, Marchesini G, Morselli-Labate AM, et al. Positive blood alcohol concentration and road accidents. A prospective study in an Italian emergency department. Emerg Med J 2002;**19**(3):210-4.

11. Schwan R, Allen JP. Unhealthy alcohol use. N Engl J Med 2005;**352**(20):2139-40; author reply 39-40.

12. Guilherme Borges SM, Cheryl J. et al. Variation in alcohol-related injury by type and cause of injury. In: Cheryl J. Cherpitel GB, Norman Giesbrecht, et al., ed. Alcohol and Injuries:Emergency Department Studies in an International Perspective geneva, switzerland: World health organization, 2009:15-25.

13. Stubig T, Petri M, Zeckey C, et al. Alcohol intoxication in road traffic accidents

leads to higher impact speed difference, higher ISS and MAIS, and higher preclinical mortality. Alcohol 2012;**46**(7):681-6.

14. Phillips DP, Brewer KM. The relationship between serious injury and blood alcohol concentration (BAC) in fatal motor vehicle accidents: BAC = 0.01% is associated with significantly more dangerous accidents than BAC = 0.00%. Addiction 2011;**106**(9):1614-22.

15. McCoy GF, Johnstone RA, Nelson IW, et al. A review of fatal road accidents in Oxfordshire over a 2-year period. Injury 1989;**20**(2):65-8.

16. Tulloh BR, Collopy BT. Positive correlation between blood alcohol level and ISS in road trauma. Injury 1994;**25**(8):539-43.

17. Pories SE, Gamelli RL, Vacek P, et al. Intoxication and injury. J Trauma 1992;**32**(1):60-4.

18. Scheyerer MJ, Dutschler J, Billeter A, et al. Effect of elevated serum alcohol level on the outcome of severely injured patients. Emerg Med J 2014;**31**(10):813-7.

19. Vital signs: alcohol-impaired driving among adults--United States, 2010. MMWR Morb Mortal Wkly Rep 2011;**60**(39):1351-6.

20. WHO. Global status report on alcohol and health 2014. 2014.

21. Roudsari B, Caetano R, Field C. Alcohol intoxication/dependence, ethnicity and

utilisation of health care resources in a level I trauma center. Injury 2011;**42**(1):66-71.

22. Rau CS, Liu HT, Hsu SY, et al. Alcohol-related hospitalisations of trauma patients in Southern Taiwan: a cross-sectional study based on a trauma registry system. BMJ open 2014;**4**(10):e005947.

23. Rehm J, Mathers C, Popova S, et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet 2009;**373**(9682):2223-33.

24. Kyu HH, Pinho C, Wagner JA, et al. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. JAMA pediatrics 2016;**170**(3):267-87.

25. O'Keeffe T, Shafi S, Sperry JL, et al. The implications of alcohol intoxication and the Uniform Policy Provision Law on trauma centers; a national trauma data bank analysis of minimally injured patients. J Trauma 2009;**66**(2):495-8.

26. Rivara FP, Koepsell TD, Jurkovich GJ, et al. The effects of alcohol abuse on readmission for trauma. JAMA 1993;**270**(16):1962-4.

27. Moore EE. Alcohol and trauma: the perfect storm. J Trauma 2005;**59**(3 Suppl):S53-6; discussion S67-75.

28. O'Keeffe T, Rhee P, Shafi S, et al. Alcohol use increases diagnostic testing, procedures, charges, and the risk of hospital admission: a population-based study of injured patients in the emergency department. Am J Surg 2013;**206**(1):16-22.

29. Guo R, Ren J. Alcohol and acetaldehyde in public health: from marvel to menace. Int J Environ Res Public Health 2010;**7**(4):1285-301.

30. Berry C, Salim A, Alban R, et al. Serum ethanol levels in patients with moderate to severe traumatic brain injury influence outcomes: a surprising finding. Am Surg 2010;**76**(10):1067-70.

31. Salim A, Teixeira P, Ley EJ, et al. Serum ethanol levels: predictor of survival after severe traumatic brain injury. J Trauma 2009;**67**(4):697-703.

32. Salim A, Ley EJ, Cryer HG, et al. Positive serum ethanol level and mortality in moderate to severe traumatic brain injury. Arch Surg 2009;**144**(9):865-71.

33. Hadjibashi AA, Berry C, Ley EJ, et al. Alcohol is associated with a lower pneumonia rate after traumatic brain injury. J Surg Res 2012;**173**(2):212-5.

34. Ruiz M, Ewig S, Torres A, et al. Severe community-acquired pneumonia. Risk factors and follow-up epidemiology. Am J Respir Crit Care Med 1999;**160**(3):923-9.

35. Afshar M, Smith GS, Terrin ML, et al. Blood alcohol content, injury severity,

and adult respiratory distress syndrome. The journal of trauma and acute care surgery 2014;**76**(6):1447-55.

36. Jurkovich GJ, Rivara FP, Gurney JG, et al. The effect of acute alcohol intoxication and chronic alcohol abuse on outcome from trauma. JAMA 1993;**270**(1):51-6.

37. VanderWeele TJ. On the relative nature of overadjustment and unnecessary adjustment. Epidemiology 2009;**20**(4):496-9.

38. Fuchs FD, Chambless LE. Is the cardioprotective effect of alcohol real? Alcohol 2007;**41**(6):399-402.

39. Williams RJ, Hittinger R, Glazer G. Resource implications of head injuries on an acute surgical unit. J R Soc Med 1994;**87**(2):83-6.

40. Fuller MG. Alcohol use and injury severity in trauma patients. J Addict Dis 1995;**14**(1):47-54.

41. Murray CJ, Lopez AD. Quantifying disability: data, methods and results. Bull World Health Organ 1994;**72**(3):481-94.

42. Watt K, Purdie DM, Roche AM, et al. Risk of injury from acute alcohol consumption and the influence of confounders. Addiction 2004;**99**(10):1262-73.

43. Breitmeier D, Seeland-Schulze I, Hecker H, et al. The influence of blood alcohol concentrations of around 0.03% on neuropsychological functions--a

double-blind, placebo-controlled investigation. Addict Biol 2007;**12**(2):183-9.

Tables

Table 1. Demographics and injury characteristics of the adult trauma patients with and without alcohol intoxication.

Table 1.

Variables	BAC(+) N=929	BAC(-) N=10104	*Odds Ratio (95%CI)*	*p*
Sex				
Male	821 (88.4)	6113 (60.5)	5.0 (4.0-6.1)	<0.001
Female	108 (11.6)	3991 (39.5)	0.2 (0.2-0.2)	<0.001
Age	40.4±11.5	43.0±13.6	—	<0.001
20-29 years	197 (21.2)	2302 (22.8)	0.9 (0.8-1.1)	0.287
30-39 years	242 (26.0)	1847 (18.3)	1.6 (1.3-1.8)	<0.001
40-49 years	262 (28.2)	1986 (19.7)	1.6 (1.4-1.9)	<0.001
50-59 years	181 (19.5)	2656 (26.3)	0.7 (0.6-0.8)	<0.001
60-64 years	47 (5.1)	1313 (13.0)	0.4 (0.3-0.5)	<0.001
Co-morbidity				
DM	41 (4.4)	923 (9.1)	0.5 (0.3-0.6)	<0.001
HTN	102 (11.0)	1546 (15.3)	0.7 (0.6-0.8)	<0.001
CAD	6 (0.6)	124 (1.2)	0.5 (0.2-1.2)	0.150
CHF	2 (0.2)	27 (0.3)	0.8 (0.2-3.4)	1.000
CVA	5 (0.5)	127 (1.3)	0.4 (0.2-1.0)	0.057
ESRD	3 (0.3)	138 (1.4)	0.2 (0.1-0.7)	0.009
Alcohol Level (mg/dL)	191.1±74.6	15.5±15.0	—	—
Mechanism				
Motor vehicle	66 (7.1)	269 (2.7)	2.8 (2.1-3.7)	<0.001
Motorcycle	613 (66.0)	4900 (48.5)	2.1 (1.8-2.4)	<0.001
Bicycle	29 (3.1)	260 (2.6)	1.2 (0.8-1.8)	0.333
Pedestrian	18 (1.9)	135 (1.3)	1.5 (0.9-2.4)	0.141
Fall	93 (10.0)	2010 (19.9)	0.4 (0.4-0.6)	<0.001
Strike by/against	110 (11.8)	2530 (25.0)	0.4 (0.3-0.5)	<0.001
GCS	12.6±3.7	14.5±1.9	—	<0.001
≤8	158 (17.0)	337 (3.3)	5.9 (4.9-7.3)	<0.001
9-12	122 (13.1)	248 (2.5)	6.0 (4.8-7.5)	<0.001
≥13	649 (69.9)	9519 (94.2)	0.1 (0.1-0.2)	<0.001
AIS				
Head/Neck	485 (52.2)	2184 (21.6)	4.0 (3.5-4.5)	<0.001
Face	373 (40.2)	1646 (16.3)	3.4 (3.0-4.0)	<0.001
Thorax	184 (19.8)	1183 (11.7)	1.9 (1.6-2.2)	<0.001
Abdomen	117 (12.6)	642 (6.4)	2.1 (1.7-2.6)	<0.001
Extremity	538 (57.9)	7430 (73.5)	0.5 (0.4-0.6)	<0.001
ISS (median, IQR)	10 (5-17)	5 (4-9)	—	<0.001

<16	626 (67.4)	8905 (88.1)	0.3 (0.2-0.3)	<0.001
16-24	209 (22.5)	822 (8.1)	3.3 (2.8-3.9)	<0.001
≥25	94 (10.1)	377 (3.7)	2.9 (2.3-3.7)	<0.001
Mortality	33 (3.6)	124 (1.2)	3.0 (2.0-4.4)	<0.001
LOS in Hospital (days)	11.4±11.2	9.1±10.0	—	<0.001
ICU admission, n (%)	329 (35.4)	1517 (15.0)	3.1 (2.7-3.6)	<0.001
LOS in ICU (days)	7.1±8.5	9.4±12.1	—	<0.001

AIS = Abbreviated Injury Scale; BAC= blood alcohol concentration; CAD = coronary artery disease; CHF = congestive heart failure; CI = confidence interval; CVA = cerebral vascular accident; DM = diabetes mellitus; ESRD = end-stage renal disease; GCS = Glasgow Coma Scale; HTN = hypertension; ICU = intensive care unit; IQR = interquartile range; ISS = injury severity score; LOS = length of stay; OR = odds ratio.

Table 2. Significant associated injuries among the adult trauma patients with and without alcohol intoxication.

Variables	**BAC(+) N=929**	**BAC(-) N=10104**	***Odds Ratio (95%CI)***	***p***
Head trauma, n (%)				
Neurologic deficit	35 (3.8)	181 (1.8)	2.1 (1.5-3.1)	<0.001
Cranial fracture	150 (16.1)	482 (4.8)	3.8 (3.2-4.7)	<0.001
Epidural hematoma (EDH)	98 (10.5)	298 (2.9)	3.9 (3.1-4.9)	<0.001
Subdural hematoma (SDH)	180 (19.4)	630 (6.2)	3.6 (3.0-4.3)	<0.001
Subarachnoid hemorrhage (SAH)	186 (20.0)	716 (7.1)	3.3 (2.7-3.9)	<0.001
Intracerebral hematoma (ICH)	43 (4.6)	150 (1.5)	3.2 (2.3-4.6)	<0.001
Cerebral contusion	89 (9.6)	407 (4.0)	2.5 (2.0-3.2)	<0.001
Maxillofacial trauma, n (%)				
Orbital fracture	53 (5.7)	173 (1.7)	3.5 (2.5-4.8)	<0.001
Nasal fracture	25 (2.7)	101 (1.0)	2.7 (1.8-4.3)	<0.001
Maxillary fracture	147 (15.8)	557 (5.5)	3.2 (2.6-3.9)	<0.001
Mandibular fracture	47 (5.1)	217 (2.1)	2.4 (1.8-3.4)	<0.001

Thoracic trauma, n (%)				
Rib fracture	122 (13.1)	825 (8.2)	1.7 (1.4-2.1)	<0.001
Hemothorax	27 (2.9)	158 (1.6)	1.9 (1.2-2.9)	0.004
Pneumothorax	23 (2.5)	154 (1.5)	1.6 (1.1-2.6)	0.030
Hemopneumothorax	21 (2.3)	140 (1.4)	1.6 (1.0-2.6)	0.044
Lung contusion	20 (2.2)	107 (1.1)	2.1 (1.3-3.3)	0.005
Abdominal trauma, n (%)				
Intra-abdominal injury	35 (3.8)	163 (1.6)	2.4 (1.6-3.5)	<0.001
Hepatic injury	55 (5.9)	166 (1.6)	3.8 (2.8-5.2)	<0.001
Splenic injury	20 (2.2)	96 (1.0)	2.3 (1.4-3.7)	0.002
Renal injury	10 (1.1)	47 (0.5)	2.3 (1.2-4.6)	0.019
Extremity trauma, n (%)				
Scapular fracture	26 (2.8)	156 (1.5)	1.8 (1.2-2.8)	0.006
Clavicle fracture	106 (11.4)	839 (8.3)	1.4 (1.1-1.8)	0.001
Humeral fracture	21 (2.3)	482 (4.8)	0.5 (0.3-0.7)	0.001
Ulnar fracture	34 (3.7)	525 (5.2)	0.7 (0.5-1.0)	0.042
Pelvic fracture	38 (4.1)	276 (2.7)	1.5 (1.1-2.1)	0.019
Tibial fracture	72 (7.8)	497 (4.9)	1.6 (1.3-2.1)	<0.001

441 Table 3. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:1 greedy propensity score matching for
442 mortality assessment.

443 Mortality (OR: 0.81, 95% CI: 0.46-1.432, p= 0.470)

	Before				After			
	Death n=157	Survival n=10876	*OR(95%CI)*	*P*	Death n=131	Survival n=131	*OR(95%CI)*	*P*
Sex								
Male	122(77.7)	6812(62.6)	2.1(1.4-3.0)	<0.001	111(84.7)	111(84.7)	1.0(0.5-2.0)	1.000
Female	35(22.3)	4064(37.4)	0.5(0.3-0.7)	<0.001	20(15.3)	20(15.3)	1.0(0.5-2.0)	1.000
Age	46.7±13.5	42.7±13.5	—	<0.001	45.8±13.5	44.8±12.3	—	0.560
Co-Morbidity								
HTN	23(14.6)	1625(14.9)	1.0(0.6-1.5)	1.000	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
DM	16(10.2)	948(8.7)	1.2(0.7-2.0)	0.568	10(7.6)	10(7.6)	1.0(0.4-2.5)	1.000
ESRD	9(5.7)	132(1.2)	5.0(2.5-9.9)	<0.001	4(3.1)	4(3.1)	1.0(0.2-4.1)	1.000
GCS	7.2±4.8	14.5±1.9	—	<0.001	7.5±4.8	8.0±4.8	—	0.418
AIS,n(%)								
Head/Neck	128(81.5)	2541(23.4)	14.5(9.7-21.7)	<0.001	105(80.2)	105(80.2)	1.0(0.5-1.8)	1.000
Face	22(14.0)	1997(18.4)	0.7(0.5-1.1)	0.177	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
Thorax	54(34.4)	1313(12.1)	3.8(2.7-5.3)	<0.001	46(35.1)	46(35.1)	1.0(0.6-1.7)	1.000
Abdomen	26(16.6)	733(6.7)	2.7(1.8-4.2)	<0.001	22(16.8)	22(16.8)	1.0(0.5-1.9)	1.000

Extremity	47 (29.9)	7921 (72.8)	0.2 (0.1-0.2)	<0.001	38 (29.0)	38 (29.0)	1.0 (0.6-1.7)	1.000
ISS	30.8±17.8	7.7±6.5	—	<0.001	27.0±13.3	25.0±13.4	—	0.247
BAC(+)	33 (21.0)	896 (8.2)	3.0 (2.0-4.4)	<0.001	29 (22.1)	34 (26.0)	0.8 (0.5-1.4)	0.563

Table 4. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:4 greedy propensity score matching for cost assessment.

	Before				After			
	BAC(+) n=929	BAC(-) n=10104	*OR(95%CI)*	*P*	BAC(+) n=929	BAC(-) n=3716	*OR(95%CI)*	*P*
Sex								
Male	821 (88.4)	6113 (60.5)	5.0 (4.0-6.1)	<0.001	821 (88.4)	3284 (88.4)	1.0 (0.8-1.3)	1.000
Female	108 (11.6)	3991 (39.5)	0.2 (0.2-0.2)	<0.001	108 (11.6)	432 (11.6)	1.0 (0.8-1.3)	1.000
Age	40.4±11.5	43.0±13.6	—	<0.001	40.4±11.5	40.4±11.5	—	0.989
Co-Morbidity								
HTN	102 (11.0)	1546 (15.3)	0.7 (0.6-0.8)	<0.001	102 (11.0)	408 (11.0)	1.0 (0.8-1.3)	1.000
DM	41 (4.4)	923 (9.1)	0.5 (0.3-0.6)	<0.001	41 (4.4)	164 (4.4)	1.0 (0.7-1.4)	1.000
ESRD	3 (0.3)	138 (1.4)	0.2 (0.1-0.7)	0.009	3 (0.3)	12 (0.3)	1.0 (0.3-3.6)	1.000

Table 5. The cost during the hospitalization of the adult trauma patients with and without alcohol intoxication.

	BAC(+)	**BAC(-)**	**Difference**	***p***
Total expenditure	(n=929)	(n=10104)		
(US$)	3656±5104	2850±4355	28.3%↑	<0.001
Cost of operation	(n=601)	(n=7558)		
(US$)	958±864	631±706	51.8%↑	<0.001
Cost of examination	(n=791)	(n=8474)		
(US$)	249±353	145±289	71.7%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=10103)		
(US$)	285±773	174±859	63.8%↑	<0.001

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

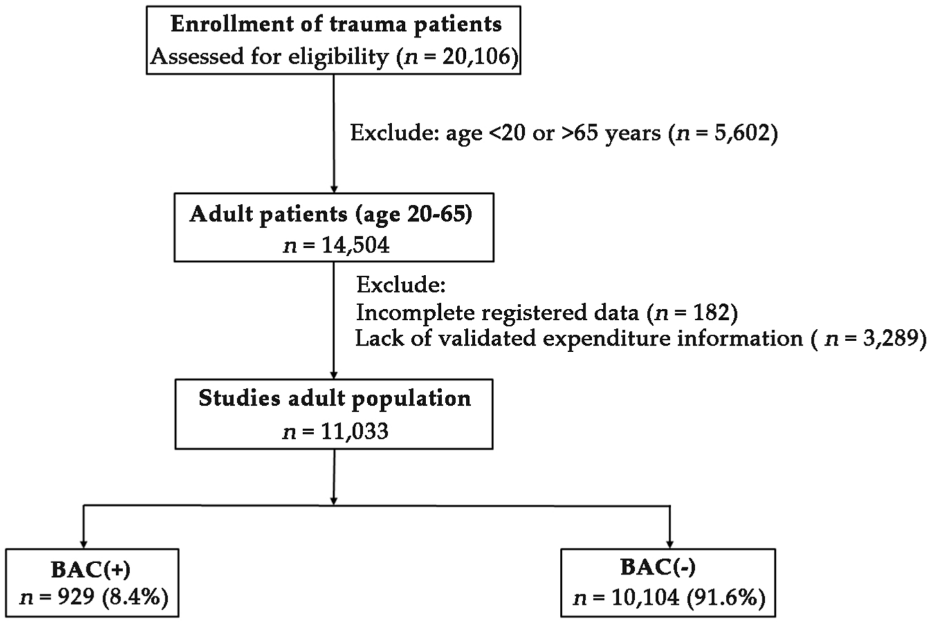
Table 6. The cost during the hospitalization of the selected propensity score-matched adult trauma patients with and without alcohol intoxication.

	BAC(+)	**BAC(-)**	**Difference**	***p***
Total expenditure	(n=929)	(n=3716)		
(US$)	3656±5104	3113±5278	17.4%↑	0.004
Cost of operation	(n=601)	(n=2758)		
(US$)	958±864	683±860	40.3%↑	<0.001
Cost of examination	(n=791)	(n=3037)		
(US$)	249±353	163±336	52.8%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=3715)		
(US$)	285±773	206±706	38.3%↑	0.005

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

Figure Legends

Fig. 1 Flow chart of the studied adult trauma patients



Flow chart of the studied adult trauma patients

122x84mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-12
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-12
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	-
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	-
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Influence of alcohol use on mortality and expenditure during hospital admission: A cross-sectional study

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Complete List of Authors:	Peng, Shu-Hui; Department of Healthcare Administration, I-Shou University, Executive Master Program Hsu, Shiun-Yuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery Kuo, Pao-Jen; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Plastic and Reconstructive Surgery Rau, Cheng-Shyuan; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Neurosurgery Cheng, Ya-Ai; Executive Master Program, Department of Healthcare Administration, I-Shou University Hsieh, Ching-Hua; Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Department of Trauma Surgery
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Influence of alcohol use on mortality and expenditure during hospital admission: A cross-sectional study

Shu-Hui Peng[1,2], B.A.; Shiun-Yuan Hsu[2], B.A.; Pao-Jen Kuo[4], M.D.; Cheng-Shyuan Rau[3], M.D.; Cheng,Ya-Ai[1*], Ph.D.; Ching-Hua Hsieh[2*], M.D., Ph.D.

[*] indicated equal contribution in authorship

[1]Executive Master Program, Department of Healthcare Administration, I-Shou University

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[3]Department of Neurosurgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

[4]Department of Plastic Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

*indicated equal contribution in authorship as corresponding authors

Shu-Hui Peng; e-mail: pshui@cgmh.org.tw

Shiun-Yuan Hsu; e-mail: ah.lucy@hotmail.com

Pao-Jen Kuo; email: bow110470@gmail.com

Cheng-Shyuan Rau; e-mail: ersh2127@cloud.cgmh.org.tw

Ya-Ai Cheng; e-mail: yaai@isu.edu.tw

Ching-Hua Hsieh; e-mail: m93chinghua@gmail.com

Corresponding author: Ya-Ai, Cheng[1], Ph.D. & Ching-Hua Hsieh, M.D., PhD, FACS

[1]Executive Master Program, Department of Healthcare Administration, I-Shou

University; email: yaai@isu.edu.tw

[2]Department of Trauma Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan

No.123, Ta-Pei Road, Niao-Song District, Kaohsiung City 833, Taiwan

Tel: 886-7-7327476; E-mail: m93chinghua@gmail.com

ABSTRACT

Objectives: This study was designed to investigate the effect of alcohol intoxication on clinical presentation of hospitalized adult trauma patients at a Level I trauma center using propensity score matching.

Design: Cross-sectional study

Setting: Taiwan

Participants: Detailed data of 929 hospitalized adult trauma patients with alcohol intoxication, aged 20–65 years, and 10,104 corresponding patients without alcohol intoxication were retrieved from the Trauma Registry System between January 1, 2009 and December 31, 2014. Alcohol intoxication was defined as a blood alcohol concentration (BAC) ≥50 mg/dL.

Main outcome measures: In-hospital mortality and expenditure.

Results: Patients with alcohol intoxication presented with significantly higher short-term mortality (odds ratio: 3.0, 95% confidence interval [CI]: 2.0–4.4; $p < 0.001$) than patients without alcohol intoxication. However, on comparison with propensity score-matched patients with respect to sex, age, co-morbidity, Glasgow Coma Scale (GCS), injury region based on Abbreviated Injury Scale (AIS), and Injury Severity Score (ISS), alcohol intoxication did not significantly influence mortality (OR: 0.8, 95% CI: 0.5–1.4; $p = 0.563$). This implied that the higher mortality of alcohol-intoxicated patients was attributable to patient characteristics such as a higher injury severity rather than alcohol intoxication. Even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication, patients with alcohol intoxication still had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher).

Conclusions: The associated higher mortality of adult trauma patients with alcohol intoxication was completely attributable to other patient characteristics and associated injury severity rather than the effects of alcohol. However, patients with alcohol intoxication incurred significantly higher expenditure than patients without alcohol intoxication, even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication.

KEY WORDS: Trauma; Alcohol intoxication; Mortality; Length of stay; Cost

Article Summary

Strengths and limitations of this study

- Use of propensity score matching in this assessment helped to attenuate the confounding effects of various patient characteristics and associated injury severity on hospital mortality and expenditure.
- Defining the cut-off value for alcohol intoxication at an arbitrary BAC level of 50 mg/dL and higher may present a bias in the comparison between patients with and without alcohol intoxication; the definition of alcohol intoxication (BAC level) varies by country, and cognitive function may be impaired even at a lower BAC level.
- Bias in this analysis may result from a lack of available data in the following areas: indication of hospitalization, type of surgery, patient costs associated with a referring hospital, circumstances of the injuries, and factors influencing decision-making.

BACKGROUND

Alcohol consumption increases the likelihood of injury during activities[1-3]. Consumption of 3–4 alcoholic drinks and 5–6 alcoholic drinks during the 6 hours preceding an accident led to a 6- and 9-fold increase in the odds of injury, respectively[4]. A previous case-control study[5] and a case-crossover study, which compares injury between when patients drink before the event and when patients drink during an earlier control period[6], were conducted in emergency-room settings to estimate the risk of injury related to alcohol consumption. These studies revealed a 2.1-fold and 4.7-fold increase, respectively, in drinking-related injury[7]. A multi-level analysis of 28 studies from 16 countries included 8,423 patients with alcohol-related injuries who arrived in the emergency department (ED) within 6 hours of injury and showed that the overall prevalence of alcohol-related injuries was 24% for patients with a blood alcohol concentration (BAC) of ≥50 mg/dL[8]. An alcohol intoxication prevalence of 18%–80% has been reported at the time of admission, depending on the study design and inclusion criteria[9-12].

In trauma patients, alcohol intoxication is associated with higher impact speed[13-15], which leads to higher injury severity[10,13,16,17] and mortality[13,14]. The relative risk of involvement in a fatal vehicle crash increases with increasing BAC of the driver in every age/gender group among both fatally injured and surviving drivers[1]. Among 16–20 year-old male drivers, a BAC increase of 0.02% was estimated to more than double the relative risk of fatal single-vehicle crash injury[1]. In addition, a previous study has reported that the mortality rate associated with traffic crashes doubled in patients with alcohol intoxication as compared to that of sober patients[13]. In the United States, alcohol-impaired driving crashes account for nearly 11,000 crash fatalities, or approximately one-third of all crash fatalities[18,19]. A total of 35.2% of deaths worldwide were attributable to alcohol consumption in 2012, which resulted in 30.8% of disability-adjusted life years (DALYs) from injuries [20].

Acute intoxication and dependence on alcohol are both associated with frequent utilization of health-care resources[21,22]. National and international statistics on alcohol-related harm tend to emphasize estimates of the total numbers of deaths[23] or total economic costs[24], but rarely report the financial expenditure of healthcare per episode of injury. The effect of alcohol intoxication on the expenditure of caring for injured patients has important implications for trauma care and healthcare policy. Increased resource use and expenditure have been reported in a subset of minimally injured trauma patients who were BAC positive in trauma centers nationwide[25,26]. In medical evaluations, physicians often utilize advanced techniques to rule out the presence of potentially unidentified injuries in drunken patients[27]. Alcohol-intoxicated patients had significantly higher chances of undergoing evaluation by abdominal ultrasound and head computed tomography (CT) during the first 24 h of hospital arrival[21]. In alcohol-intoxicated patients with less-severe injuries, brain CT was overused, with a higher proportion of negative findings for intracranial hemorrhage[22]. In an analysis of the sample of ED patient visits, representing approximately 13 million ED visits nationwide, BAC-positive patients underwent more diagnostic tests and had longer ED stays[28].

Previous studies have reported alcohol use to be associated with higher hospital mortality and expenditure. Since the patient's behavior, the severity of the injury caused by the accident, and the response of the body to the traumatic injury are all influenced by alcohol, it is important to consider the differences in patient population in this assessment. In particular, alcohol has been reported to negatively influence the body’s response to injury[29]. For example, some studies demonstrated a beneficial effect of alcohol on patients with traumatic brain injury[30-32], although the exact mechanism is unclear. In addition, a positive serum alcohol level was associated with a significantly lower pneumonia rate in patients with isolated, moderate-to-severe traumatic brain injury and may explain the observed reduced mortality[33]. In contrast, observational studies have shown that an elevated BAC is associated with an increased susceptibility to pneumonia, infections,[34] and the development of adult respiratory distress syndrome[35]. Therefore, by using propensity score matching to attenuate the confounding effects of various patient characteristics and associated injury severity, this study was designed to assess the effect of alcohol intoxication on clinical presentation of hospitalized adult trauma patients in a Level I trauma center in Southern Taiwan.

METHODS

Ethics statement

This study was pre-approved by the Institutional Review Board (IRB) of the Chang Gung Memorial Hospital (approval number 104-8665B). Informed consent was waived according to IRB regulations.

Study Design

This retrospective study reviewed data of all 20,106 hospitalized patients registered in the Trauma Registry System from January 1, 2009, to December 31, 2014 (Figure 1). The hospital is a 2,400-bed facility and Level I regional trauma center that provides care to trauma patients primarily from southern Taiwan. All adult patients aged 20–65 years and hospitalized for treatment of traumatic injuries were included in the study. Patients who had incomplete registered data (n = 182) or lacked information on hospital expenditure (n = 3,289) were excluded. In Taiwan, all drivers involved in traffic accidents are legally compelled to undergo testing for BAC. In trauma injuries other than traffic accidents, the physician at the ED may perform a BAC test when required or under strong suspicion. A BAC level of 50 mg/dL, which is the legal limit for drivers in Taiwan, was defined as the cut-off value. Therefore, patients with a BAC level ≥ 50 mg/dL at the time of arrival at the hospital were considered intoxicated and were included in the study as BAC (+). Patients for whom an alcohol test was not requested or who had a BAC level < 50 mg/dL at the time of arrival at the hospital were considered to be non-intoxicated and BAC (–). Of the total 11,033 adult patients, 929 (8.4%) patients with BAC (+) and 10,104 (91.6%) patients with BAC (–) were enrolled in this study for further analysis. Detailed patient information was retrieved from the Trauma Registry System of our institution, including data on age; gender; trauma mechanism; initial Glasgow Coma Scale (GCS) in the ED; Abbreviated Injury Scale (AIS) severity score for each body region; Injury Severity Score (ISS); rates of associated injures; number of operations; hospital length of stay (LOS); LOS in ICU; in-hospital mortality; and total expenditure per patient including cost of operation (operation fee and operation supply fee), cost of examination (physical examination fee, hematology testing fee, examination fee for radiography, pathological examination fee, examination fee for electrocardiography, echo, endoscopy, electromyography, cardiac catheterization, and monitoring fee for electroencephalography), cost of pharmaceuticals (medicine service fee, medicine fee, and narcotic drug fee), and other costs (registration fee, administrative fee, ward fees, nursing fee, blood/plasma test fees, hemodialysis fees, anesthesia fees, rehabilitation-treatment fee, special material costs, and personal expenses). The ISS is expressed as the median and interquartile range (IQR, Q1–Q3). Pre-existing comorbidities and chronic diseases including diabetes mellitus (DM), hypertension (HTN), coronary artery diseases (CAD), congestive heart failure (CHF), cerebrovascular accident (CVA), and end-stage renal disease (ESRD) were also identified. Odd ratios (ORs) of the associated conditions and injuries of the patients were calculated with 95% confidence intervals (CIs). The data collected were compared using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). Two-sided Fisher exact or Pearson chi-square test was used to compare categorical data. Unpaired Student's *t*-test was used to analyze normally distributed continuous data, which was reported as mean ± standard deviation. Mann–Whitney *U*-test was used to compare non-normally distributed data. To minimize confounding effects due to non-randomized assignment in the assessment of the effect of alcohol intoxication on mortality, propensity scores were calculated using a logistic regression model and the following covariates: gender, age, comorbidity, GCS, injuries based on AIS, and ISS. A 1:1 matched study group was created by the Greedy method using NCSS software (NCSS 10; NCSS Statistical software, Kaysville, Utah). After adjusting for these confounding factors, binary logistic regression was used for evaluating the effect of intervention for alcohol intoxication on mortality. In addition, to assess the effect of alcohol intoxication on cost and number of surgeries, two comparable populations of BAC (+) and BAC (–) patients were selected in a 1:4 ratio by the Greedy method using NCSS software, according to the matched propensity scores, which were calculated using a logistic regression model with gender, age, and comorbidity as covariates. P-values < 0.05 were considered statistically significant.

Results

Injury characteristics of patients with alcohol intoxication

A significant predominance in the percentage of men was noted among patients with alcohol intoxication (821 [88.4%] men and 108 [11.6%] women of total 929 patients with alcohol intoxication). The mean ages of the patients with alcohol intoxication and those without alcohol intoxication were 40.4±11.5 years and 43.0±13.6 years, respectively (Table 1). Among patients with alcohol intoxication, a greater number of patients were aged 30–39 years and 40–49 years, but fewer patients were aged between 50–59 years and 60–69 years. A greater number of patients with alcohol intoxication were younger than those without alcohol intoxication. Significantly lower incidence of pre-existing comorbidities and chronic diseases including HTN (OR: 0.7, 95% CI: 0.6–0.8; $p < 0.001$), DM (OR: 0.5, 95% CI: 0.3–0.6; $p < 0.001$), and ESRD (OR: 0.2, 95% CI: 0.1–0.7; $p = 0.009$) were found among patients with alcohol intoxication as compared to those without alcohol intoxication. On comparison with patients without alcohol intoxication, patients with alcohol intoxication and those involved in motorcycle accidents were most commonly admitted (48.5% vs. 66.0%, respectively; $p < 0.001$), followed by strike by/against objects (25.0% vs. 11.8%, respectively; $p < 0.001$), fall accidents (19.9% vs. 10.0%, respectively; $p < 0.001$), and motor vehicle accidents (2.7% vs. 7.1%, respectively; $p < 0.001$). More patients with alcohol intoxication were injured in motorcycle and motor vehicle accidents than those without alcohol intoxication. In contrast, a smaller number of patients with alcohol intoxication were injured in strike by/against objects and fall accidents.

Injury severity of the patients with alcohol intoxication

GCS were significantly lower (by 1 point) in patients with alcohol intoxication than in patients without alcohol intoxication (12.6 ± 3.7 vs. 14.5 ± 1.9, $p < 0.001$). A significantly larger number of patients with alcohol intoxication had a GCS of ≤8 and GCS of 9–12 and a smaller number of patients had a GCS of ≥13 compared to those without alcohol intoxication. Analysis of AIS revealed that patients with alcohol intoxication had sustained significantly higher rates of head/neck, face, thoracic, and abdomen injuries than patients without alcohol intoxication, whereas patients without alcohol intoxication had sustained significantly higher rates of extremity injury. Regarding the associated common injuries in each trauma region, a significantly higher percentage of patients with alcohol intoxication had sustained associated common major injuries of head, maxillofacial, thoracic, abdominal, and extremity trauma (Table 2). In contrast, a significantly lower percentage of patients with alcohol intoxication had sustained humeral fracture and ulnar fracture. In addition, a significantly higher ISS was found in patients with alcohol intoxication than in patients without alcohol intoxication (median [IQR: Q1–Q3], 10 [5–17] vs. 5 [4–9], $p < 0.001$) (Table 1). When stratified by ISS (<16, 16–24, or ≥25), among patients with alcohol intoxication, a larger number of patients had an ISS ≥ 25 and an ISS of 16–24 and a smaller number of patients had an ISS < 16 as compared to patients without alcohol intoxication.

Outcome of patients with alcohol intoxication

Patients with alcohol intoxication had a significantly higher mortality than those without alcohol intoxication (OR 3.0, 95% CI 2.0–4.4; $p < 0.001$). After propensity-score matching, mortality outcome was compared in the 131 well-balanced pairs of patients (Table 3). In these propensity score-matched patients, there was no significant difference in sex, age, co-morbidity (HTN, DM, and ESRD), GCS, injury region based on AIS, and ISS. The logistic regression analysis showed that alcohol intoxication did not significantly influence mortality (OR: 0.8, 95% CI: 0.5–1.4, p = 0.563), implying that the higher mortality of alcohol-intoxicated patients was attributable to the patient characteristics and associated with higher injury severity. Furthermore, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively, p < 0.001), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively, p < 0.001), and shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively, p < 0. 001).

Expenditure for patients with alcohol intoxication

To compare the expenditure for patients with and those without alcohol intoxication, 929 well-balanced pairs of patients, with a 1:4 ratio after propensity score matching of sex, age, and co-morbidity (HTN, DM, and ESRD), were used for outcome assessment (Table 4). In these propensity score-matched patients, there was no significant difference in sex, age, and co-morbidity (HTN, DM, and ESRD). On comparison with patients without alcohol intoxication, those who had alcohol intoxication spent a significantly higher total expenditure (28.3% higher), cost of operation (51.8% higher), cost of examination (71.7% higher), and cost of pharmaceuticals (63.8% higher) (Table 5). On comparing the selected well-balanced pairs of patients with and those without alcohol intoxication, who had similar personal characteristics regarding sex, age, and co-morbidities, those who had alcohol intoxication still had significantly higher total expenditure (17.4% higher), cost of operation (40.3% higher), cost of examination (52.8% higher), and cost of pharmaceuticals (38.3% higher) (Table 6).

Discussion

This study compared the clinical outcome and expenditure in a broad group of adult trauma patients comprising those with alcohol intoxication and those without alcohol intoxication hospitalized at a Level I trauma center. Patients with alcohol intoxication presented with significantly different body-injury patterns, higher injury severity, longer hospital stay, higher proportion of admission to the ICU, and higher short-term mortality than those without alcohol intoxication. In addition, patients with alcohol intoxication had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals than those without alcohol intoxication, regardless of whether the comparison was made among the total patients or among the selected propensity score-matched patients.

In this study, patients with alcohol intoxication were predominantly men, of younger age, and had lower incidence of pre-existing comorbidities and chronic diseases. In addition, patients with alcohol intoxication sustained significantly higher injury severity and rates of head/neck injury, face injury, thoracic injury, and abdomen injury, but lower rate of extremity injury than patients without alcohol intoxication. In addition, the mortality was 3-fold higher in patients with alcohol intoxication than that of patients without alcohol intoxication. Notably, controlled experimental and epidemiologic studies have shown that alcohol exposure can increase the severity of injury[36], and the adjustment for injury severity in their analyses of outcomes from alcohol intoxication may have obscured the association of mortality and other outcomes with BAC[37]. In this study, by analyzing the selected propensity score-matched patients with respect to sex, age, co-morbidity, GCS, and injury region based on AIS, and ISS, we found that alcohol intoxication did not significantly influence mortality; this implies that the higher mortality of these alcohol-intoxicated patients was attributable to the patient characteristics and associated higher injury severity. These results are in agreement with the results of some studies that stated that although the beneficial effects of alcohol have been controversial[38], its detrimental effects on injury outweigh its beneficial effects[23].

In this study, compared to the patients without alcohol intoxication, the patients with alcohol intoxication had significantly longer hospital LOS (9.1 days vs. 11.4 days, respectively; $p < 0.001$), higher proportion of patients admitted to the ICU (15.0% vs. 35.4%, respectively; $p < 0.001$), but shorter LOS in the ICU (9.4 days vs. 7.1 days, respectively; $p < 0.001$). Patients with alcohol intoxication had significantly higher total expenditure, cost of operation, cost of examination, and cost of pharmaceuticals than both the total patient population and the selected propensity score-matched patients with respect to sex, age, and co-morbidity. Multiple factors may have contributed to the increase in the expenditure of alcohol-intoxicated patients. In addition, more examinations[21,22,27], excess charges for laboratory testing and radiologic testing, and extra monitoring and other procedures may be conducted for patients with alcohol intoxication[28]. These alcohol-intoxicated patients were also more likely to have a delay in discharge due to alcohol withdrawal[39] and require a high level of in-hospital care such as in a coronary care unit or ICU[28]. In contrast, previous studies have reported a reduction in the hospital LOS and lower overall costs of care associated with intoxicated patients[36,40]. However, the descriptive study design prevented further analysis of the effects of additional factors (e.g., a particular treatment and the judgment of discharge from the hospital or stay in the ICU) and relied on the assumption of uniform assessment and management of patients with and without alcohol intoxication.

Our study has some limitations that should be acknowledged. First, owing to the retrospective design of the study with its inherent selection bias, it was impossible to fully account for potential confounders of important risk factors such as differentiation between alcohol-induced psychoses, alcohol dependence, and alcohol abuse [41]; between intentional and unintentional injuries; and most importantly, between patterns of drinking and alcohol consumption. Second, the lack of data regarding indication of hospitalization, type of surgery, and the associated-patient costs at the referring hospital may have led to a bias. Third, the patients declared dead on hospital arrival or at the accident scene were not included in the Trauma Registry Database, and some outcomes such as late mortality were not analyzed, which potentially led to bias in the assessment of mortality and overall cost. Further, in Taiwan, all drivers involved in traffic accidents are legally compelled to undergo BAC testing; however, a few patients may have refused to undergo an actual BAC test after alcohol consumption was confirmed using a breathalyzer. Accordingly, these patients might have been placed in an incorrect category, because the breathalyzer results were registered in the police report but not noted in the medical records. In addition, the combination of psychoactive drugs and alcohol use may have led to bias in the outcome assessment[42]. However, in our experience, such cases are rare. Lastly, considering that cognitive function may be impaired at a BAC level of <50 mg/dL[14,43] and that the BAC level that defines alcohol intoxication varies by country, an arbitrary BAC cut-off value of 50 mg/dL as the definition of alcohol intoxication may have introduced bias into this study. Moreover, the most common traumatic injuries in Taiwan involved motorcycle accidents rather than car accidents, which are more common in Western countries; this may also hinder the generalization of assessing the effect of alcohol intoxication on hospital mortality and expenditure.

Conclusion

This study of hospitalized adult trauma patients, based on the Trauma Registry System at a Level I trauma center and spanning a 6-year period, revealed that a higher mortality associated with the adult trauma patients with alcohol intoxication was completely attributable to patient characteristics and associated injury severity and not to the effects of alcohol. However, patients with alcohol intoxication incurred significantly higher expenditure than patients without alcohol intoxication, even on comparison with sex-, age-, and co-morbidity-matched patients without alcohol intoxication.

Competing interests

The authors declare that they have no competing interests.

Author contributions

SHP analyzed the data and wrote the manuscript; SYH collected the data and performed the statistical analyses; PJK validated and is responsible for the integrity of registered data, SCW edited the tables, YAC revised the manuscript and supervised the proceedings of the study, and CHH designed the study and contributed to the analysis and interpretation of data. All authors read and approved the final manuscript.

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DATA SHARING

No additional data are available.

REFERENCES

1. Zador PL, Krawchuk SA, Voas RB. Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. J Stud Alcohol 2000;**61**(3):387-95.

2. Taylor B, Irving HM, Kanteres F, et al. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug Alcohol Depend 2010;**110**(1-2):108-16.

3. Liu HT, Liang CC, Rau CS, et al. Alcohol-related hospitalizations of adult motorcycle riders. World journal of emergency surgery : WJES 2015;**10**(1):2.

4. Vinson DC, Maclure M, Reidinger C, et al. A population-based case-crossover and case-control study of alcohol and the risk of injury. J Stud Alcohol 2003;**64**(3):358-66.

5. Cherpitel CJ. Alcohol and injuries: a review of international emergency room studies. Addiction 1993;**88**(7):923-37.

6. Stockwell T, McLeod R, Stevens M, et al. Alcohol consumption, setting, gender and activity as predictors of injury: a population-based case-control study. J Stud Alcohol 2002;**63**(3):372-9.

7. Ye Y, Bond J, Cherpitel CJ, et al. Risk of injury due to alcohol: evaluating potential bias using the case-crossover usual-frequency method. Epidemiology 2013;**24**(2):240-3.

8. Cherpitel CJ, Ye Y, Bond J, et al. Multi-level analysis of alcohol-related injury among emergency department patients: a cross-national study. Addiction 2005;**100**(12):1840-50.

9. Alcohol and other drug use among victims of motor-vehicle crashes--West Virginia, 2004-2005. MMWR Morb Mortal Wkly Rep 2006;**55**(48):1293-6.

10. Fabbri A, Marchesini G, Morselli-Labate AM, et al. Positive blood alcohol concentration and road accidents. A prospective study in an Italian emergency department. Emerg Med J 2002;**19**(3):210-4.

11. Schwan R, Allen JP. Unhealthy alcohol use. N Engl J Med 2005;**352**(20):2139-40; author reply 39-40.

12. Guilherme Borges SM, Cheryl J. et al. Variation in alcohol-related injury by type and cause of injury. In: Cheryl J. Cherpitel GB, Norman Giesbrecht, et al., ed. Alcohol and Injuries:Emergency Department Studies in an International

Perspective geneva, switzerland: World health organization, 2009:15-25.

13. Stubig T, Petri M, Zeckey C, et al. Alcohol intoxication in road traffic accidents leads to higher impact speed difference, higher ISS and MAIS, and higher preclinical mortality. Alcohol 2012;**46**(7):681-6.

14. Phillips DP, Brewer KM. The relationship between serious injury and blood alcohol concentration (BAC) in fatal motor vehicle accidents: BAC = 0.01% is associated with significantly more dangerous accidents than BAC = 0.00%. Addiction 2011;**106**(9):1614-22.

15. McCoy GF, Johnstone RA, Nelson IW, et al. A review of fatal road accidents in Oxfordshire over a 2-year period. Injury 1989;**20**(2):65-8.

16. Tulloh BR, Collopy BT. Positive correlation between blood alcohol level and ISS in road trauma. Injury 1994;**25**(8):539-43.

17. Pories SE, Gamelli RL, Vacek P, et al. Intoxication and injury. J Trauma 1992;**32**(1):60-4.

18. Scheyerer MJ, Dutschler J, Billeter A, et al. Effect of elevated serum alcohol level on the outcome of severely injured patients. Emerg Med J 2014;**31**(10):813-7.

19. Vital signs: alcohol-impaired driving among adults--United States, 2010. MMWR Morb Mortal Wkly Rep 2011;**60**(39):1351-6.

20. WHO. Global status report on alcohol and health 2014. 2014.

21. Roudsari B, Caetano R, Field C. Alcohol intoxication/dependence, ethnicity and utilisation of health care resources in a level I trauma center. Injury 2011;**42**(1):66-71.

22. Rau CS, Liu HT, Hsu SY, et al. Alcohol-related hospitalisations of trauma patients in Southern Taiwan: a cross-sectional study based on a trauma registry system. BMJ open 2014;**4**(10):e005947.

23. Rehm J, Mathers C, Popova S, et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet 2009;**373**(9682):2223-33.

24. Kyu HH, Pinho C, Wagner JA, et al. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. JAMA pediatrics 2016;**170**(3):267-87.

25. O'Keeffe T, Shafi S, Sperry JL, et al. The implications of alcohol intoxication and the Uniform Policy Provision Law on trauma centers; a national trauma data bank analysis of minimally injured patients. J Trauma 2009;**66**(2):495-8.

26. Rivara FP, Koepsell TD, Jurkovich GJ, et al. The effects of alcohol abuse on readmission for trauma. JAMA 1993;**270**(16):1962-4.

27. Moore EE. Alcohol and trauma: the perfect storm. J Trauma 2005;**59**(3 Suppl):S53-6; discussion S67-75.

28. O'Keeffe T, Rhee P, Shafi S, et al. Alcohol use increases diagnostic testing, procedures, charges, and the risk of hospital admission: a population-based study of injured patients in the emergency department. Am J Surg 2013;**206**(1):16-22.

29. Guo R, Ren J. Alcohol and acetaldehyde in public health: from marvel to menace. Int J Environ Res Public Health 2010;**7**(4):1285-301.

30. Berry C, Salim A, Alban R, et al. Serum ethanol levels in patients with moderate to severe traumatic brain injury influence outcomes: a surprising finding. Am Surg 2010;**76**(10):1067-70.

31. Salim A, Teixeira P, Ley EJ, et al. Serum ethanol levels: predictor of survival after severe traumatic brain injury. J Trauma 2009;**67**(4):697-703.

32. Salim A, Ley EJ, Cryer HG, et al. Positive serum ethanol level and mortality in moderate to severe traumatic brain injury. Arch Surg 2009;**144**(9):865-71.

33. Hadjibashi AA, Berry C, Ley EJ, et al. Alcohol is associated with a lower pneumonia rate after traumatic brain injury. J Surg Res 2012;**173**(2):212-5.

34. Ruiz M, Ewig S, Torres A, et al. Severe community-acquired pneumonia. Risk factors and follow-up epidemiology. Am J Respir Crit Care Med

1999;**160**(3):923-9.

35. Afshar M, Smith GS, Terrin ML, et al. Blood alcohol content, injury severity, and adult respiratory distress syndrome. The journal of trauma and acute care surgery 2014;**76**(6):1447-55.

36. Jurkovich GJ, Rivara FP, Gurney JG, et al. The effect of acute alcohol intoxication and chronic alcohol abuse on outcome from trauma. JAMA 1993;**270**(1):51-6.

37. VanderWeele TJ. On the relative nature of overadjustment and unnecessary adjustment. Epidemiology 2009;**20**(4):496-9.

38. Fuchs FD, Chambless LE. Is the cardioprotective effect of alcohol real? Alcohol 2007;**41**(6):399-402.

39. Williams RJ, Hittinger R, Glazer G. Resource implications of head injuries on an acute surgical unit. J R Soc Med 1994;**87**(2):83-6.

40. Fuller MG. Alcohol use and injury severity in trauma patients. J Addict Dis 1995;**14**(1):47-54.

41. Murray CJ, Lopez AD. Quantifying disability: data, methods and results. Bull World Health Organ 1994;**72**(3):481-94.

42. Watt K, Purdie DM, Roche AM, et al. Risk of injury from acute alcohol consumption and the influence of confounders. Addiction 2004;**99**(10):1262-73.

43. Breitmeier D, Seeland-Schulze I, Hecker H, et al. The influence of blood alcohol concentrations of around 0.03% on neuropsychological functions--a double-blind, placebo-controlled investigation. Addict Biol 2007;**12**(2):183-9.

Tables

Table 1. Demographics and injury characteristics of the adult trauma patients with and without alcohol intoxication.

Variables	BAC(+) N=929	BAC(-) N=10104	*Odds Ratio (95%CI)*	*p*
Sex				
Male	821 (88.4)	6113 (60.5)	5.0 (4.0-6.1)	<0.001
Female	108 (11.6)	3991 (39.5)	0.2 (0.2-0.2)	<0.001
Age	40.4±11.5	43.0±13.6	—	<0.001
20-29 years	197 (21.2)	2302 (22.8)	0.9 (0.8-1.1)	0.287
30-39 years	242 (26.0)	1847 (18.3)	1.6 (1.3-1.8)	<0.001
40-49 years	262 (28.2)	1986 (19.7)	1.6 (1.4-1.9)	<0.001
50-59 years	181 (19.5)	2656 (26.3)	0.7 (0.6-0.8)	<0.001
60-64 years	47 (5.1)	1313 (13.0)	0.4 (0.3-0.5)	<0.001
Co-morbidity				
DM	41 (4.4)	923 (9.1)	0.5 (0.3-0.6)	<0.001
HTN	102 (11.0)	1546 (15.3)	0.7 (0.6-0.8)	<0.001
CAD	6 (0.6)	124 (1.2)	0.5 (0.2-1.2)	0.150
CHF	2 (0.2)	27 (0.3)	0.8 (0.2-3.4)	1.000
CVA	5 (0.5)	127 (1.3)	0.4 (0.2-1.0)	0.057
ESRD	3 (0.3)	138 (1.4)	0.2 (0.1-0.7)	0.009
Alcohol Level (mg/dL)	191.1±74.6	15.5±15.0	—	—
Mechanism				
Motor vehicle	66 (7.1)	269 (2.7)	2.8 (2.1-3.7)	<0.001
Motorcycle	613 (66.0)	4900 (48.5)	2.1 (1.8-2.4)	<0.001
Bicycle	29 (3.1)	260 (2.6)	1.2 (0.8-1.8)	0.333
Pedestrian	18 (1.9)	135 (1.3)	1.5 (0.9-2.4)	0.141
Fall	93 (10.0)	2010 (19.9)	0.4 (0.4-0.6)	<0.001
Strike by/against	110 (11.8)	2530 (25.0)	0.4 (0.3-0.5)	<0.001
GCS	12.6±3.7	14.5±1.9	—	<0.001
≤8	158 (17.0)	337 (3.3)	5.9 (4.9-7.3)	<0.001
9-12	122 (13.1)	248 (2.5)	6.0 (4.8-7.5)	<0.001
≥13	649 (69.9)	9519 (94.2)	0.1 (0.1-0.2)	<0.001
AIS				
Head/Neck	485 (52.2)	2184 (21.6)	4.0 (3.5-4.5)	<0.001
Face	373 (40.2)	1646 (16.3)	3.4 (3.0-4.0)	<0.001
Thorax	184 (19.8)	1183 (11.7)	1.9 (1.6-2.2)	<0.001
Abdomen	117 (12.6)	642 (6.4)	2.1 (1.7-2.6)	<0.001

Extremity	538(57.9)	7430(73.5)	0.5(0.4-0.6)	<0.001
ISS (median, IQR)	10(5-17)	5(4-9)	—	<0.001
<16	626(67.4)	8905(88.1)	0.3(0.2-0.3)	<0.001
16-24	209(22.5)	822(8.1)	3.3(2.8-3.9)	<0.001
≥25	94(10.1)	377(3.7)	2.9(2.3-3.7)	<0.001
Mortality	33(3.6)	124(1.2)	3.0(2.0-4.4)	<0.001
LOS in Hospital (days)	11.4±11.2	9.1±10.0	—	<0.001
ICU admission, n (%)	329(35.4)	1517(15.0)	3.1(2.7-3.6)	<0.001
LOS in ICU (days)	7.1±8.5	9.4±12.1	—	<0.001

AIS = Abbreviated Injury Scale; BAC= blood alcohol concentration; CAD = coronary artery disease; CHF = congestive heart failure; CI = confidence interval; CVA = cerebral vascular accident; DM = diabetes mellitus; ESRD = end-stage renal disease; GCS = Glasgow Coma Scale; HTN = hypertension; ICU = intensive care unit; IQR = interquartile range; ISS = injury severity score; LOS = length of stay; OR = odds ratio.

Table 2. Significant associated injuries among the adult trauma patients with and without alcohol intoxication.

Variables	BAC(+) N=929	BAC(-) N=10104	*Odds Ratio (95%CI)*	*p*
Head trauma, n (%)				
Neurologic deficit	35(3.8)	181(1.8)	2.1(1.5-3.1)	<0.001
Cranial fracture	150(16.1)	482(4.8)	3.8(3.2-4.7)	<0.001
Epidural hematoma (EDH)	98(10.5)	298(2.9)	3.9(3.1-4.9)	<0.001
Subdural hematoma (SDH)	180(19.4)	630(6.2)	3.6(3.0-4.3)	<0.001
Subarachnoid hemorrhage (SAH)	186(20.0)	716(7.1)	3.3(2.7-3.9)	<0.001
Intracerebral hematoma (ICH)	43(4.6)	150(1.5)	3.2(2.3-4.6)	<0.001
Cerebral contusion	89(9.6)	407(4.0)	2.5(2.0-3.2)	<0.001
Maxillofacial trauma, n (%)				
Orbital fracture	53(5.7)	173(1.7)	3.5(2.5-4.8)	<0.001
Nasal fracture	25(2.7)	101(1.0)	2.7(1.8-4.3)	<0.001

Maxillary fracture	147(15.8)	557(5.5)	3.2(2.6-3.9)	<0.001
Mandibular fracture	47(5.1)	217(2.1)	2.4(1.8-3.4)	<0.001
Thoracic trauma, n (%)				
Rib fracture	122(13.1)	825(8.2)	1.7(1.4-2.1)	<0.001
Hemothorax	27(2.9)	158(1.6)	1.9(1.2-2.9)	0.004
Pneumothorax	23(2.5)	154(1.5)	1.6(1.1-2.6)	0.030
Hemopneumothorax	21(2.3)	140(1.4)	1.6(1.0-2.6)	0.044
Lung contusion	20(2.2)	107(1.1)	2.1(1.3-3.3)	0.005
Abdominal trauma, n (%)				
Intra-abdominal injury	35(3.8)	163(1.6)	2.4(1.6-3.5)	<0.001
Hepatic injury	55(5.9)	166(1.6)	3.8(2.8-5.2)	<0.001
Splenic injury	20(2.2)	96(1.0)	2.3(1.4-3.7)	0.002
Renal injury	10(1.1)	47(0.5)	2.3(1.2-4.6)	0.019
Extremity trauma, n (%)				
Scapular fracture	26(2.8)	156(1.5)	1.8(1.2-2.8)	0.006
Clavicle fracture	106(11.4)	839(8.3)	1.4(1.1-1.8)	0.001
Humeral fracture	21(2.3)	482(4.8)	0.5(0.3-0.7)	0.001
Ulnar fracture	34(3.7)	525(5.2)	0.7(0.5-1.0)	0.042
Pelvic fracture	38(4.1)	276(2.7)	1.5(1.1-2.1)	0.019
Tibial fracture	72(7.8)	497(4.9)	1.6(1.3-2.1)	<0.001

Table 3. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:1 greedy propensity score matching for mortality assessment.

Mortality (OR: 0.81, 95% CI: 0.46-1.432, p= 0.470)

	Before				After			
	Death n=157	Survival n=10876	*OR(95%CI)*	*P*	Death n=131	Survival n=131	*OR(95%CI)*	*P*
Sex								
Male	122(77.7)	6812(62.6)	2.1(1.4-3.0)	<0.001	111(84.7)	111(84.7)	1.0(0.5-2.0)	1.000
Female	35(22.3)	4064(37.4)	0.5(0.3-0.7)	<0.001	20(15.3)	20(15.3)	1.0(0.5-2.0)	1.000
Age	46.7±13.5	42.7±13.5	—	<0.001	45.8±13.5	44.8±12.3	—	0.560
Co-Morbidity								
HTN	23(14.6)	1625(14.9)	1.0(0.6-1.5)	1.000	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
DM	16(10.2)	948(8.7)	1.2(0.7-2.0)	0.568	10(7.6)	10(7.6)	1.0(0.4-2.5)	1.000
ESRD	9(5.7)	132(1.2)	5.0(2.5-9.9)	<0.001	4(3.1)	4(3.1)	1.0(0.2-4.1)	1.000
GCS	7.2±4.8	14.5±1.9	—	<0.001	7.5±4.8	8.0±4.8	—	0.418
AIS,n(%)								
Head/Neck	128(81.5)	2541(23.4)	14.5(9.7-21.7)	<0.001	105(80.2)	105(80.2)	1.0(0.5-1.8)	1.000
Face	22(14.0)	1997(18.4)	0.7(0.5-1.1)	0.177	19(14.5)	19(14.5)	1.0(0.5-2.0)	1.000
Thorax	54(34.4)	1313(12.1)	3.8(2.7-5.3)	<0.001	46(35.1)	46(35.1)	1.0(0.6-1.7)	1.000
Abdomen	26(16.6)	733(6.7)	2.7(1.8-4.2)	<0.001	22(16.8)	22(16.8)	1.0(0.5-1.9)	1.000

Extremity	47 (29.9)	7921 (72.8)	0.2 (0.1-0.2)	<0.001	38 (29.0)	38 (29.0)	1.0 (0.6-1.7)	1.000
ISS	30.8±17.8	7.7±6.5	—	<0.001	27.0±13.3	25.0±13.4	—	0.247
BAC(+)	33 (21.0)	896 (8.2)	3.0 (2.0-4.4)	<0.001	29 (22.1)	34 (26.0)	0.8 (0.5-1.4)	0.563

Table 4. Covariates of the adult trauma patients with and without alcohol intoxication adjusted for 1:4 greedy propensity score matching for cost assessment.

	Before				**After**			
	BAC(+) n=929	BAC(-) n=10104	*OR(95%CI)*	*P*	BAC(+) n=929	BAC(-) n=3716	*OR(95%CI)*	*P*
Sex								
Male	821 (88.4)	6113 (60.5)	5.0 (4.0-6.1)	<0.001	821 (88.4)	3284 (88.4)	1.0 (0.8-1.3)	1.000
Female	108 (11.6)	3991 (39.5)	0.2 (0.2-0.2)	<0.001	108 (11.6)	432 (11.6)	1.0 (0.8-1.3)	1.000
Age	40.4±11.5	43.0±13.6	—	<0.001	40.4±11.5	40.4±11.5	—	0.989
Co-Morbidity								
HTN	102 (11.0)	1546 (15.3)	0.7 (0.6-0.8)	<0.001	102 (11.0)	408 (11.0)	1.0 (0.8-1.3)	1.000
DM	41 (4.4)	923 (9.1)	0.5 (0.3-0.6)	<0.001	41 (4.4)	164 (4.4)	1.0 (0.7-1.4)	1.000
ESRD	3 (0.3)	138 (1.4)	0.2 (0.1-0.7)	0.009	3 (0.3)	12 (0.3)	1.0 (0.3-3.6)	1.000

Table 5. The cost during the hospitalization of the adult trauma patients with and without alcohol intoxication.

	BAC(+)	BAC(-)	Difference	*p*
Total expenditure	(n=929)	(n=10104)		
(US$)	3656±5104	2850±4355	28.3%↑	<0.001
Cost of operation	(n=601)	(n=7558)		
(US$)	958±864	631±706	51.8%↑	<0.001
Cost of examination	(n=791)	(n=8474)		
(US$)	249±353	145±289	71.7%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=10103)		
(US$)	285±773	174±859	63.8%↑	<0.001

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

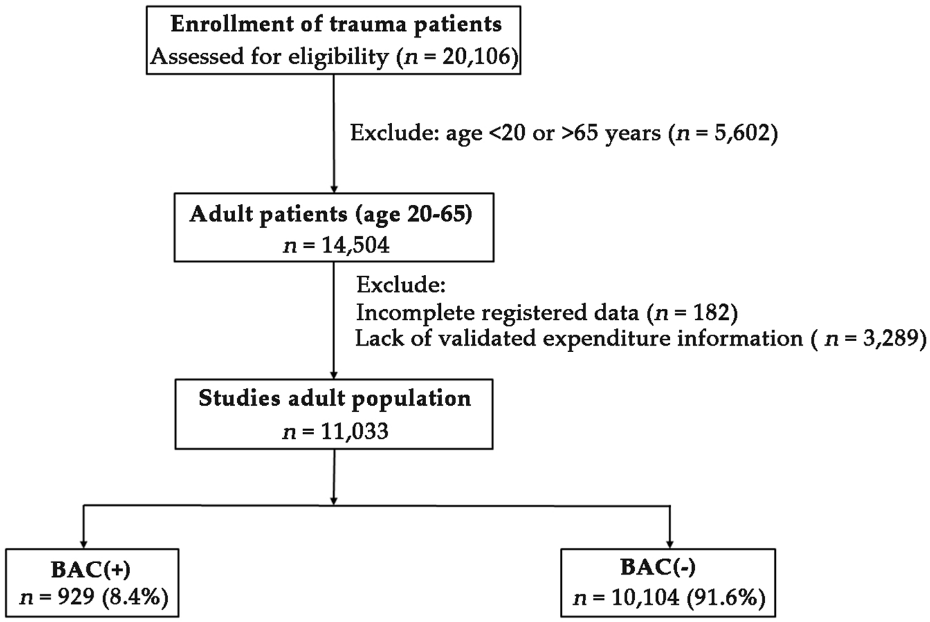
Table 6. The cost during the hospitalization of the selected propensity score-matched adult trauma patients with and without alcohol intoxication.

	BAC(+)	BAC(-)	Difference	*p*
Total expenditure	(n=929)	(n=3716)		
(US$)	3656±5104	3113±5278	17.4%↑	0.004
Cost of operation	(n=601)	(n=2758)		
(US$)	958±864	683±860	40.3%↑	<0.001
Cost of examination	(n=791)	(n=3037)		
(US$)	249±353	163±336	52.8%↑	<0.001
Cost of pharmaceutical	(n=929)	(n=3715)		
(US$)	285±773	206±706	38.3%↑	0.005

Under the calculation of 33 New Taiwan Dollar (NTD) per US dollar.

Figure Legends

Fig. 1 Flow chart of the studied adult trauma patients



Flow chart of the studied adult trauma patients

122x84mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-12
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-12
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	-
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	-
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.