

Detrimental effect of alcohol intoxication on severity of injuries in male traffic accident victims: A cross-sectional study

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The role of alcohol intoxication in traffic accidents is at present one of the main public health concerns in several countries. In Switzerland, medico-legal reports suggest that collisions in which either the driver or the pedestrian involved had a blood alcohol concentration (BAC) ≥ 0.8 g/kg (17.4 mmol/l) accounted for 12% of non-fatal injuries and 17% of fatalities in 1987¹. Two prospective emergency room studies showed that 21% of traffic crash victims had a BAC ≥ 0.8 g/kg^{2,3}. Similar values have been reported in a prospective study involving 21 French hospitals, where 24% of traffic crash victims were found to have a BAC ≥ 0.8 g/kg⁴. In the United States, alcohol has been found to be involved in 43% of fatalities and in 29% of non-fatal serious injuries resulting from motor vehicle accidents⁵.

The role of alcohol intoxication as a risk factor for the occurrence of traffic accidents is a well-accepted fact, but data on its possible relation to the type and severity of injuries have been less conclusive. Animal research has demonstrated an aggravating effect of alcohol intoxication on the outcome of trauma to the nervous system^{6,7} and to the heart⁸, as well as after experimental blood loss⁹. Human research has provided conflicting results. Several hospital studies have shown an association between alcohol intoxication and certain types of injuries, such as head injuries^{10–15}. Two large retrospective studies performed in The United States demonstrated a significant deleterious effect of alcohol intoxication on injury severity and mortality rate^{16,17}. This effect remained after adjustment for sex, age, safety belt use, type and year of vehicle, vehicular speed and crash type. In addition, several prospective studies have shown a significant aggravating effect of alcohol intoxication on the outcome for the patients, including the mortality rate of motorcycle accident victims¹⁴, and injury severity^{14,18}, as well as the rate of admission¹¹ and duration of hospital stay¹⁹. However, this potentiating effect of alcohol intoxication on injury severity has not been confirmed by other similar studies^{20,13}.

The cross-sectional emergency room study on which the present report is based was designed to assess the prevalence of alcohol intoxication among patients aged 16 to 75 years, admitted consecutively to the emergency ward of a major Swiss hospital.

This paper focuses on the relationship between alcohol intoxication and type and severity of injuries among male traffic crash victims; other data concerning the same study population have been reported elsewhere³.

Patients and Methods

The study was conducted in the emergency ward (EW) of the Centre Hospitalier Universitaire Vaudois (CHUV) in Lausanne, Switzerland, from July 7th to November 2nd, 1987. The CHUV is a 1000-bed city and university hospital whose EW provides acute care for medical and surgical emergencies 24 hours per day; it is the sole public hospital in the medium-sized city of Lausanne, and also serves the adjoining suburbs. There are several small private emergency centers in Lausanne providing ambulatory care, which may provide minor surgical treatment for some traffic accident victims.

During the 17-week study period, all accident victims aged 16 to 75 years admitted within four hours of the accident were included in the study. Patients admitted more than 4 hours after the accident were excluded to avoid inaccuracy in the estimation of blood alcohol concentration (significant decrease of BAC, alcohol consumption during the interval, etc.). Patients requiring immediate cardio-pulmonary resuscitation (CPR) and those who were dead on arrival were also excluded from the analysis for practical reasons (lack of precise anamnestic data, difficulty in obtaining a blood sample for BAC determination before the intravenous administration of fluids).

During the study period, 4043 patients were admitted to the surgical EW, of whom 1110 were excluded because of their age (> 75 or < 16 years). Of the remaining patients, 511 had been admitted within 4 hours of an accident, and 47 of these patients were excluded because of immediate CPR or death (death, $n = 7$), leaving 464 patients for inclusion in the study. Of these, 167 (36%) were victims of traffic crashes.

Upon admission, information was gathered from the patient (or relatives) regarding the patient's sex and age, as well as the circumstances of the accident: time of occurrence, vehicle type (automobile, mo-

torcycle, moped, bicycle), single or multi-vehicle crash, occupant status (driver or passenger). Injured pedestrians were included as traffic crash victims when a vehicle was involved in the accident. A venous blood sample was drawn and the BAC was measured by gas chromatography²¹.

At the end of hospitalization, the mortality rate and duration of hospital stay (classified as outpatient care for stays < 24 hours and inpatient care for stays \geq 24 hours) were recorded. All identified injuries and medical diagnoses listed in the medical records were also documented using the 9th revision of the International Classification of Diseases (ICD 9).

Injuries, diagnoses and patients were classified by one investigator (DW), who had no knowledge of the BAC, into the following categories:

- a) "Alcoholic diagnoses": alcoholic psychosis, alcoholic liver diseases, alcoholic gastritis, alcoholic polyneuropathy and alcoholic cardiomyopathy (ICD 9 codes 291, 571.0–571.3, 535.3, 357.5 and 425.5).

- b) Type of injuries:

Head injury: presence of any of the following: skull or spinal column fracture, intracranial trauma with or without fracture, cephalic wound, head or neck blood vessel damage, superficial head contusions, head crushing, head or neck foreign body, and cranial or spinal nerve damage (ICD 9 codes 800–806, 850–854, 870–873, 900, 910, 920, 925, 930–932 and 950–952).
Internal injuries: any intrathoracic or intraabdominal visceral lesion, any major vascular injury, or cranial trauma with neurologic symptoms.

- c) Severity of injuries.

All patients were also classified into one of four categories of injury severity (in decreasing order of severity):

Patients with severe injuries included all patients suffering from an internal injury, neurologic damage or a traumatic amputation, and those who died during hospitalization.

Patients with moderate injuries included patients with bone fractures who were not already classified among patients with severe injuries.

Patients with light injuries included patients with a dislocation or sprain and who were not already classified under patients with severe or moderate injuries.

Patients with minor injuries (superficial closed or open wounds, and contusions) included all remaining patients.

The analysis focused on the comparison of type and severity of injuries between intoxicated and non-intoxicated patients. Alcohol intoxication refers to BAC \geq 0.8 g/kg (\geq 17.4 mmol/l), which constitutes the legal limit of alcohol intoxication for motor vehicle drivers in Switzerland. The BAC actually measured was used for the analysis, and no attempt

was made to make retrospective estimates of the BAC at the time of the accident. Statistical analysis included Student's t-test and the Chi-square test with continuity correction when appropriate.

Patients from whom a blood sample was drawn uniquely for this study were asked for informed consent for the BAC test; patients for whom blood samples were required for purposes other than this study did not provide informed consent. All BAC test results were reported to and kept in strictest confidence by the principal investigator (BY); they were used exclusively for the purpose of this study and were not disclosed to the patient, the treating physician, or any third party. The study protocol was submitted to and accepted by the ethical committee of the hospital.

Results

Among our study cohort of 167 traffic crash victims, of whom 118 (71%) were male and 49 (29%) female, 35 patients (21% of the population studied) had a BAC \geq 0.8 g/kg. Thirty-four of these 35 intoxicated patients were men (accounting for 29% of all male traffic accident victims), among whom nine (8% of the male study population) presented a BAC \geq 2.0 g/kg. As only one woman in our study population presented a BAC \geq 0.8 g/kg, only the male population (n = 118) was analysed. The total in-hospital mortality for males and females was 4% (7/167), and the rate of inpatient care (stay \geq 24 hours) 58% (96/167).

The characteristics of male patients with respect to BAC are presented in Table 1. No significant differences were found between the BAC < 0.8 g/kg and BAC \geq 0.8 g/kg cohorts with respect to age, type of vehicle involved or occupant status. Sober patients were more likely to be involved in multi-vehicle crashes than were the intoxicated accident victims (62% versus 47%, respectively), although this difference was not significant. Two patients in the intoxicated group (6%) had a diagnosis of an alcohol-related disease.

The relationship between presence or absence of intoxication and type and severity of injuries of these male traffic crash victims is shown in Table 2. The proportion of patients with injuries requiring inpatient hospital care was similar among intoxicated patients and the sober group (65% versus 60%, respectively). However, the duration of hospital stay of inpatients with a BAC \geq 0.8 g/kg was significantly longer than that of the non-intoxicated accident victims requiring inpatient care (36 days versus 20 days, respectively). In addition, a greater percentage of intoxicated patients suffered head injuries (76%) and internal injuries (59%) than did the BAC < 0.8 g/kg group (46% and 40%, respectively). The intoxicated group also had a higher rate of severe injuries than did the sober group.

Tab. 1. Characteristics of male traffic crash victims in relation to blood alcohol concentration (BAC).

	BAC < 0.8 g/kg (n = 84)	BAC ≥ 0.8 g/kg (n = 34)	p ^a
Age (x ± SD)	30 ± 13	34 ± 13	n. s.
Mode of transportation: % (n)			
automobile	26 (22)	32 (11)	n. s.
motorcycle/moped	62 (52)	53 (18)	
bicycle	4 (3)	—	
pedestrian ^b	8 (7)	15 (5)	
Occupant status: % (n)			
driver	83 (70)	82 (28)	n. s.
passenger	8 (7)	3 (1)	
pedestrian ^b	8 (7)	15 (5)	
Multi-vehicle crash: % (n)	62 (52)	47 (16)	n. s.
Alcohol-rel. dis. ^c : % (n)	1 (1)	6 (2)	n. s.

Notes:^a Chi-square test or t-test – level of significance p < 0.05.^b Pedestrian victims were considered as traffic crash victims when a vehicle was involved (accidental falls excluded).^c Alcohol-related disease represents the number of patients with diagnoses suggestive of chronic alcohol abuse.

Tab. 2. Type and severity of injuries in male traffic crash victims in relation to blood alcohol concentration (BAC).

	BAC < 0.8 g/kg (n = 84)	BAC ≥ 0.8 g/kg (n = 34)	p ^a
Rate of inpatient hospital care ^b : % (n)	60 (50)	65 (22)	n. s.
Duration of stay			
outpatients (x ± SD hours)	3.6 ± 3.5	3.2 ± 2.5	n. s.
inpatients (x ± SD days)	20.2 ± 25.7	36.4 ± 37.4	< 0.05
Type of injuries % (n) of patients with:			
head injuries	46 (39)	76 (36)	< 0.005
internal injuries	40 (34)	59 (20)	n. s.
fractures	58 (49)	53 (18)	n. s.
fractures low. ext.	26 (22)	21 (7)	n. s.
Injury severity ^c % (n) of patients with:			
severe injuries	40 (34)	59 (20)	n. s.
moderate injuries	35 (29)	24 (8)	
light injuries	7 (6)	—	
minor injuries	18 (15)	17 (6)	

Notes:^a Chi-square test or t-test – level of significance p < 0.05.^b Inpatient care was defined as a stay ≥ 24 hours, outpatient care as a stay < 24 hours.^c In decreasing order of severity. See text for details.**Discussion**

An examination of male traffic crash victims aged 16 to 75 years admitted consecutively to an emergency room showed a deleterious effect of acute alcohol intoxication on injury severity. Despite a similar rate of inpatient care of the intoxicated and sober group, (65% versus 60%, respectively), intoxicated victims required a hospitalization nearly twice the length of that of the non-intoxicated inpatients (36 days versus 20 days, respectively). This fact may be partly explained by the higher

prevalence of certain injuries in the intoxicated group, such as head injuries and internal injuries, accounting for the higher rate of severe injuries (Table 2). Indeed, as no important differences were found between the two groups in variables such as age, type of vehicle, or occupant status, our data suggests that alcohol intoxication at the time of crash was a major contributing factor to the severity of injuries in the BAC ≥ 0.8 g/kg cohort. The mechanism(s) by which alcohol intoxication may have led to more serious injuries in the patients studied remains unclear. A difference in vehicular

speed may have partially contributed to the differing injury severity of our two groups. Although we did not know the vehicle speed at time of crash, we observed that a greater number of intoxicated patients were injured in single-vehicle crashes, which may have been influenced by a higher vehicle speed. It is not known whether the use of seat belts was different within the groups, but the higher rate of head injuries observed in the intoxicated cohort suggests that safety belts may have been used less frequently in this group of victims. Furthermore, alcohol has been shown to impair psychomotor reflexes, which may also have been a contributing factor in injury severity in the $BAC \geq 0.8$ g/kg group. Any of these cited factors may have contributed to the difference in injury severity between the two groups of traffic crash victims studied.

Whatever the mechanism(s) involved, alcohol intoxication appears to be clearly linked to a greater severity of injuries in traffic accident victims. Furthermore, our results may underestimate this potentiating effect of alcohol intoxication, since we defined intoxication as a $BAC \geq 0.8$ g/kg, the legal limit in Switzerland. It is, however, generally accepted that blood alcohol levels ≥ 0.5 g/kg can cause impairment while driving, so that our results may not reflect the true magnitude of the influence of alcohol on injury severity. Apart from this postulated aggravating effect of acute alcohol intoxication on injury severity, it may also be hypothesized that our results for the duration of hospital stay can be explained in part by the presence of an unusually high proportion of disabled people (i.e. chronic alcoholics) among the $BAC \geq 0.8$ g/kg group. Indeed, 26% of the intoxicated group had a $BAC \geq 0.2$ g/kg, a concentration suggestive of alcohol tolerance (22), and therefore of alcohol dependence. However, the prevalence of clinically evident alcohol-related diseases in the intoxicated group was only 6%. This apparent discrepancy is most probably to be explained by the young average age of our patients (34 years). It is therefore difficult to determine whether alcohol-related comorbidities played an important role in the duration of hospital stay. From published observations showing a relation between alcohol intoxication and injury severity in humans, it is unclear whether the increased risk of severe morbidities in intoxicated victims is related to acute alcohol intoxication or rather to the subgroup of chronic alcoholic patients who are more likely to be found in the group of intoxicated accident victims.

Animal research has shown that acute alcohol intoxication in itself has a deleterious effect on the outcome after different types of trauma^{6–9}. Delayed protective reflexes due to alcohol-related psychomotor disturbances may also be among the possible explanatory mechanisms. Furthermore, chronic alcohol abuse is frequently associated with biological abnormalities such as blood coagulation

defects²³, bone fragility²⁴ and cardiomyopathy²⁵ which could also account for poor injury outcomes for chronic alcohol abusers injured while under the influence of alcohol.

Possible biases in the study should be considered. The exclusion of patients requiring immediate CPR may have reduced the magnitude of the observed differences in type and severity of injuries. In fact, it has been frequently observed that fatal traffic accidents are more likely to be associated with alcohol intoxication than non-fatal accidents^{1,5}. However, our patient sample, despite its relatively small size, included a large proportion of seriously injured patients, as reflected by the rate of inpatient care (> 50%), as well as by the mean duration of stay of these inpatients (> 20 days). It is thus unlikely that the exclusion of the more seriously injured patients could have biased our results so as to produce an artificial difference between the groups. The exclusion of patients admitted more than four hours after the crash should not have biased our results to a significant degree, whereas their inclusion could have caused bias in the results, due to the inaccuracy of late BAC determinations, the likelihood of alcohol consumption during the interval before admission, and the probable high number of minor injuries in this patient population. Lastly, as our study was conducted only during the summer and fall months, we were unable to assess a possible seasonal variation in drinking behavior, and corresponding variations in alcohol-related accidents.

In conclusion, our cross-sectional study of consecutive traffic crash victims supports and emphasizes the aggravating effect of acute alcohol intoxication on injury severity. Moreover, if we consider the increased risk of traffic crashes when drivers are alcohol-intoxicated, our observations indicate a need for further legal and public health measures to prevent alcohol-related traffic accidents which, in addition to causing many injuries and deaths, are an important determinant of high hospital costs.

Summary

A cross-sectional emergency room study was performed among traffic accident victims aged 16 to 75 years in order to investigate the prevalence of alcohol intoxication (blood alcohol concentration ($BAC \geq 0.8$ g/kg) and its potential detrimental effect on injury severity. A $BAC \geq 0.8$ g/kg was present in 29% of the male patients. Intoxicated patients had a similar propensity to require inpatient hospital care (65 versus 60%) but had significantly longer hospital stays than the non-intoxicated patients (36 versus 20 days; $p < 0.05$), observations which may be explained by the higher prevalence of serious injuries (head and internal injuries) among the intoxicated cohort. This study supports

and emphasizes the detrimental effect of alcohol intoxication on the severity of injuries in traffic accident victims, and reinforces the need for further legal and public health measures in preventing alcohol-related traffic accidents.

Résumé

Effets de l'intoxication alcoolique aiguë sur la gravité des accidents de la route chez les hommes
Une étude transversale fut réalisée dans une station d'urgence d'un grand hôpital, dans le but de mesurer la fréquence d'une intoxication alcoolique aiguë parmi les accidentés de la route âgés de 20 à 75 ans, et d'investiguer l'effet aggravant éventuel de l'intoxication alcoolique sur le type et la sévérité des blessures. Une alcoolémie ≥ 0.8 g/kg fut trouvée chez 29% des patients de sexe masculin. Ces patients eurent un taux d'hospitalisation similaire aux patients non intoxiqués (65 versus 60%), mais une durée d'hospitalisation considérablement plus longue (36 versus 20 jours; $p < 0.05$). Cette différence pourrait être expliquée par une fréquence plus élevée de blessures de la tête et de blessures graves rencontrées chez les patients intoxiqués. Ces données suggèrent un rôle aggravant de l'intoxication alcoolique lors d'accident de la circulation et renforcent la nécessité d'une prévention plus efficace des accidents produits par l'alcool.

Zusammenfassung

Schädliche Auswirkung von Alkoholvergiftungen auf den Schweregrad der Verletzungen von männlichen Verkehrsunfallopfern: Eine Querschnittstudie
In der Notfallstation eines grossen Spitals wurde eine Querschnittstudie durchgeführt. Deren Ziel bestand einerseits darin, die Häufigkeit akuter Alkoholintoxikation unter den 16–75jährigen, auf der Strasse Verunglückten festzustellen, zum anderen sollte der potentielle Effekt der Alkoholintoxikation (Blutalkoholkonzentration $\geq 0,8$ g/kg) auf Art und Schweregrad einer erlittenen Verletzung festgestellt werden. Bei 29% der männlichen Patienten wurde eine Alkoholämie $\geq 0,8$ g/kg gefunden. Letztere wiesen eine Hospitalisationsrate auf, welche der von Nicht-Intoxikierten (65% versus 60%) gleichkam. Die Dauer der Hospitalisation jedoch, erwies sich als signifikant länger (36 versus 20 Tage; $p < 0,05$). Die Tatsache, dass Alkoholintoxizierte, nicht nur schwerwiegendere Verletzungen, sondern auch häufiger Kopfverletzungen aufweisen, vermag diesen Unterschied zu erklären. Somit zeigt die durchgeführte Studie folgendes auf: den potentiellen Effekt einer Alkoholintoxikation während eines Strassenverkehrsunfalls und die unbedingte Forderung nach einer besseren, erfolgsversprechenderen Prävention in Bezug auf Strassen-

verkehrsunfälle, deren Ursache in Zusammenhang mit Alkoholkonsum steht.

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