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Prevalence of alcohol and other drugs in injured drivers and their association with clinical outcomes

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Abstract. – OBJECTIVE: Driving under the influence of alcohol or drugs is a risk factor for motor vehicle accidents (MVAs). This issue has become an increasing concern for the governments of many European and North American countries, thereby encouraging the adoption of preventive policies. The aim of this study was to investigate the associations between major clinical outcomes and alcohol or drug abuse among drivers involved in MVAs who were referred to an Italian Emergency Department.

PATIENTS AND METHODS: The study population consisted of consecutive injured drivers who were admitted to the Emergency Department following an MVA during a period of one year. The patients' blood alcohol concentrations (BACs) and the presence of the most common drugs of abuse [amphetamine, methamphetamine, methylenedioxymethamphetamine (MDMA), barbiturates, benzodiazepines, benzoylecgonine (cocaine main metabolite), cannabinoids, methadone, and opiates)] were determined and evaluated in association with major clinical outcomes and demographic data.

RESULTS: Overall, 347 injured drivers were enrolled. Of the 347 enrolled patients, 164 (47.3%) had a positive BAC (greater than 5 mg/dL). A subgroup of 107 injured drivers was also screened for drugs of abuse. Thirty-seven of these subjects (34.5%) were positive for at least one drug. A statistically significant association was found between BAC and triage at admission ($p<0.01$), hospitalization ($p<0.01$), and lesions of internal organs ($p=0.04$).

CONCLUSIONS: The results of this study show that a significant proportion of injured drivers had detectable levels of BAC and/or illegal drugs. Positive BACs were significantly associated with worse clinical outcomes. These findings suggest that the implementation of methods to prevent alcohol and drug abuse is of paramount importance in the effort to reduce the rates of MVAs and their dramatic consequences.

Key Words:
Alcohol, Drugs, Injured drivers, Motor vehicle accidents, Triage severity code, Internal organ lesions, Hospitalization rate.

Introduction

Driving under the influence of alcohol or drugs is a major risk factor for motor vehicle accidents (MVAs), and this danger has recently become a growing public and governmental concern in the European Union (EU) and in the United States (USA)[1,2]. In 2011, more than 30,000 people died on the roads of the EU, and for each death, an estimated 4 permanently disabling injuries, such as damage to the brain or spinal cord, 8 serious injuries, and 50 minor injuries occurred[1]. In 2014, 9,967 people were killed in alcohol-impaired driving crashes, accounting for nearly one-third (31%) of all traffic-related deaths in the USA[2]. Drugs other than alcohol (legal

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and illegal) were involved in approximately 16% of MVAs[2]. On the grounds of this unacceptable rate of mortality and the lifelong consequences of MVA injuries, the EU Commission has adopted an ambitious Road Safety Programme with the aim of decreasing road deaths in Europe between 2011 and 2020[1]. This program includes the implementation of a variety of initiatives focusing on improving vehicle safety, infrastructure safety and road users' behaviour. Regarding the behaviour of road users, several epidemiological studies have unequivocally demonstrated that the use of alcohol by drivers was associated with an increased risk of MVAs[3-5]. Relatively fewer data are available regarding the risk of driver injury associated with driving under the influence of other drugs[5-13]. Thus, the aim of the present study was to evaluate the relationship between major clinical outcomes and presence of alcohol and/or drugs among drivers involved in MVAs who were referred to an Italian Emergency Department (ED). Also, the associations between blood alcohol concentrations (BACs) and positive drugs screening results, and the demographic characteristics of injured drivers were determined.

Patients and Methods

Study Population

The study population consisted of consecutive injured drivers who were admitted to the ED of the A. Gemelli University Hospital in Rome (Italy) following an MVA from January 2010 to December 2010. All injured drivers arrived at the ED within 1 h of the MVA. The BACs of all included subjects were assessed, and a subgroup of patients was also screened for drugs. We considered patients older than 16 years old to be eligible for inclusion in the study. Deceased subjects were excluded. Demographic and clinical data for all enrolled patients at ED admission and during hospitalization were collected from electronic medical records and paper charts. The evaluated clinical outcomes were as follows: the patients' triage code at ED admission (all patients were assigned a code: green, yellow and red codes indicated no-urgent, urgent and emergent conditions, respectively); the presence of bone fractures or lesions of internal organs; and hospitalization. All data included in the study were anonymized to protect patient privacy.

BAC Detection

Blood samples were collected from injured drivers after the venipuncture site was cleaned with an alcohol-free disinfectant solution and stored in 5 mL tubes containing 1% fluoride/oxalate, which served as a preservative and anti-coagulant. The samples were analyzed for the presence of ethanol at the Clinical Chemistry Laboratory of Catholic University of Rome using the enzymatic method Ethanol Gen. 2 kit (Roche Diagnostics International Ltd, Rotkreuz, Switzerland) in the Cobas 8000 auto-analyzer (Roche Diagnostics International Ltd, Rotkreuz, Switzerland). Subjects were considered to have a positive (+) BAC if their BAC was greater than 5 mg/dl.

Drugs Testing

A subgroup of injured drivers also provided urine samples. The toxicological analysis was performed by the Public Health Institute, Section of Legal Medicine of the Catholic University of Rome. All urine samples were analyzed using an immunochemical technique Tox/See system (Bio-Rad Laboratories, Hercules, CA, USA) for rapid identification of the most common drugs of abuse [amphetamine (cut-off, 1000 ng/ml), methamphetamine (cut-off, 1000 ng/ml), methylenedioxymethamphetamine (MDMA) (cut-off, 500 ng/ml), barbiturates (cut-off, 300 ng/ml), benzodiazepines (cut-off, 300 ng/ml), benzoylecgonine (cocaine main metabolite) (cut-off, 300 ng/ml), cannabinoids (cut-off, 50 ng/ml), methadone (cut-off, 300 ng/ml), and opiates (cut-off, 300 ng/ml)].

Statistical Analysis

The X^2 test with Fischer's correction, when appropriate, was used to determine the associations between BAC and non-parametric factors. Parametric variables were assessed using *t*-tests for unpaired data. Data are expressed as absolute values and percentages or means ± standard deviations, as appropriate. A p-value ≤ 0.05 was regarded as significant.

Results

General Data

Overall, 347 consecutive injured drivers were included in the present study. Samples from the 3 drivers who died as a result of their MVA were not included in the statistical analysis.

The mean age of the included subjects was 33.4 years (ranging from 16 to 87 years). The majority of the participants were male (n=290, 83.6%).

Table I. Gender distribution.

Blood Alcohol Concentration	Female N (%)	Male N (%)	Total N (%)
< 5 mg/dl	30 (52.6 %)	153 (52.7%)	183 (52.7%)
5-50 mg/dl	14 (24.6%)	47 (16.2%)	61 (17.6%)
50-100 mg/dl	2 (3.5%)	8 (2.8%)	10 (2.9%)
100-150 mg/dl	5 (8.8%)	20 (6.9%)	25 (7.2%)
150-200 mg/dl	2 (3.5%)	17 (5.9%)	19 (5.5%)
> 200 mg/dl	4 (7.0%)	45 (15.5%)	49 (14.1%)

Rate of BAC Positivity and Associations Between BAC and Demographic Features

In total, 164 subjects (47.3%) had a (+) BAC. They were further classified according to their BAC as follows: (1) patients with a BAC ranging from 5 to 50 mg/dl; (2) patients with a BAC ranging from 50 to 100 mg/dl; (3) patients with a BAC ranging from 100 mg/dl to 150 mg/dl; (4) patients with a BAC ranging from 150 to 200 mg/dl; and (5) patients with a BAC ≥ 200 mg/dl. The BAC results are summarized in Table I. The majority of patients with a (+) BAC were in the 22 to 40-year-old age range (48.8% of all positive subjects), while 28% of patients were 41-60 years old; 13.4% of patients were younger than 21 years old, and 9.8% of patients were older than 60 years old (Table II). A BAC higher than 50 mg/dl, which is the legal limit in Italy for people older than 21 years and for who have been licensed driver for more than three years, was identified in 103 cases (29.7% of the total studied population) and most frequently observed in males (87.0%). With regards to age, a BAC higher than 50 mg/dl was identified in 50.5% of 22 to 40-year-old patients, 28.2% of 41 to 60-years-old patients, 8.7% of patients over 60 years old, and 12.6% of patients younger than 21 years old (Table II). No significant association was observed between BAC and the age at which the accident occurred (p=0.22).

Associations Between BAC and Clinical Outcomes

The patients' BACs were significantly associated with the assignment of a more severe triage code at ED admission (p<0.01) (Figure 1). Specifically, of the subjects with a (+) BAC, 13 (7.9%) were assigned a green code, 34 (20.7%) were assigned a yellow code, and 117 (71.3%) were assigned a red code. In addition, patients with a (+) BAC more frequently were diagnosed with bone fractures than those with a (-) BAC (52.8% vs. 39.3%, respectively, p=0.06) (Figure 2) and had a significantly higher rate of internal organ lesions, with 32.9% of subjects with (+) BAC and 19.7% in those with a (-) BAC being diagnosed with internal organ lesions (p=0.04) (Table III). Finally, patients with a (+) BAC had a significantly higher rate of hospitalization than those with a (-) BAC (67.8% *vs*. 44.3%, respectively, p<0.01).

Drugs Detection Rate

Of the 107 drivers involved in MVAs, who were also screened for drugs of abuse, 37 (34.5%) were positive for at least one drug. Specifically, 16 of these 37 patients (43.2%) tested positive for more than a drug; in one case, 3 different drugs were detected, and in another case, 4 different drugs were detected. Opiates were the most frequently detected drug (n=20). Cannabis was identified in 19 cases, often in association with opiates (4 cases) or cocaine (4 cases). Overall, cocaine was detected in 11 cases. Benzodiazepines, methadone, and methamphetamine were always identified in association with other drugs. A statistical evaluation of the associations between drug detection and clinical outcomes was not performed due to the low number of patients in this group.

Table II. Age distribution.

	Age Group (years)				
Blood Alcohol Concentration	< 18 N (%)	18-21 N (%)	22-40 N (%)	41-60 N (%)	>60 N (%)
< 5 mg/dl	10 (66.6%)	28 (62.3%)	86 (51.8%)	44 (48.9%)	15 (48.3%)
5-50 mg/dl	3 (20.0%)	6 (13.3%)	28 (16.9%)	17 (18.9%)	7 (22.6%)
50-100 mg/dl	0 (0%)	0 (0%)	6 (3.6%)	2 (2.2%)	2 (6.5%)
100-150 mg/dl	1 (6.7%)	6 (13.3%)	12 (7.2%)	5 (5.6%)	1 (3.2%)
150-200 mg/dl	1 (6.7%)	3 (6.7%)	12 (7.2%)	3 (3.3%)	0 (0%)
> 200 mg/dl	0 (0%)	2 (4.4%)	22 (13.3%)	19 (21.1%)	6 (19.4%)

Table III. Correlation between blood alcohol concentration (Bac) and internal organ lesions.

BAC	No internal organ lesions	One or more internal organ lesions
Positive (≥ 5 mg/dL)	49 (80.3%)	12 (19.7%)
Negative (< 5 mg/dL)	192 (67.1%)	94 (32.9%)
Total cases	241 (69.5%)	106 (30.5%)

p=0.04.

Association Between BAC and Drug Detection Results

Of the 107 patients screened for drugs, 48.6% had a (-) BAC identified in association with negative drugs screening results (52 out of 107), whereas the remaining subjects were positive for alcohol and/or drugs. In detail, test results indicating a (+) BAC and the presence of at least one drug of abuse were observed in 9.3% of cases, while 15.9% of patients had a (+) BAC and negative drug screening results, and 26.2% of patients had a (-) BAC and positive drug screening results.

Discussion

Approximately 25% of all road fatalities in the EU and nearly one-third of road fatalities in the USA were found to be alcohol-related according to the most recently available data[1,2]. On the other hand, from a public health perspective, relatively little is known about the contribution of drugs other than alcohol to traffic crashes. In particular, data obtained from studies performed in Italy that have focused on the prevalence of alcohol and drugs among injured drivers involved in an MVA are limited[14-16]. Recent epidemiological data extrapolated from CARE (the EU road accidents database) indicated a decrease of 18% in road fatalities in Italy from 2010 to 2014[17]. However in 2014, more than 3,300 fatal MVAs and more than 250,000 injuries MVAs occurred in Italy[1]. The findings of the present study confirm the role of driving under the influence of alcohol and/or drugs of abuse in severe traffic injuries in Italy, indicating the presence of a positive association between the presence of a (+) BAC and major clinical outcomes. In this regard, we need to remember that the Italian legislation concerning driving under the influence of drugs and alcohol is outlined in the Highway Code and the Legislative Decree of April 30, 1992, n. 285. This legislation includes article 186, 186-bis (added in 2010), and 187, which specifically regulate the use of alcohol and drugs while driving. At present, the legal BAC limit is 0.5 g/L (50 mg/dL), as defined in the article 186. However, in 2010, the 186-bis article lowered the legal BAC level to 0 g/L for dri-

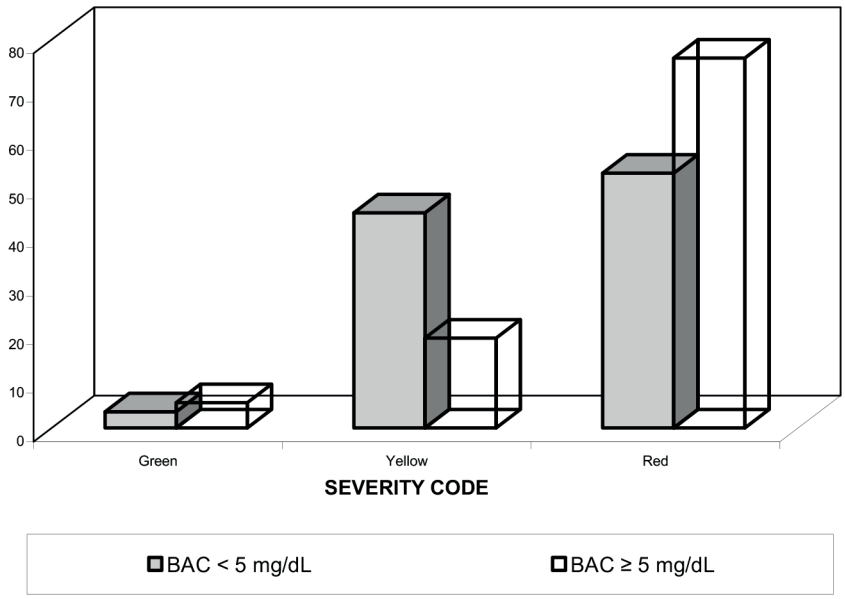

Figure 1. Association between (+) BAC (≥5 mg/dL) and triage severity code (p<0.01).

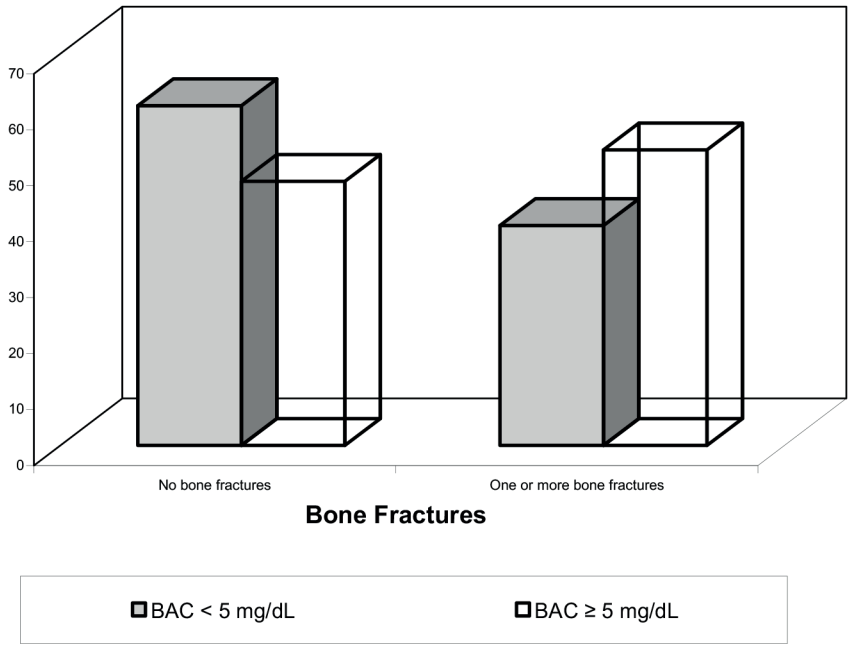

Figure 2. Association between (+) BAC (≥5 mg/dL) and bone fractures (p=0.06).

vers younger than 21 years of age, newly licensed drivers, i.e., individuals who have been licensed for less than three years, and those who transport persons or property as part of their profession. Data from our cohort of injured drivers showed that alcohol and drug abuse remain common since a third of the evaluated population (103/364) had a BAC over the limit imposed by applicable laws (≥50 mg/dL), and a third of those tested were also positive for drugs. However, the finding that 61 out of 167 (37%) injured drivers with positive BAC (≥5 mg/dL) had a value below the legal limit of 50 mg/dL may be even more important to emphasize. This finding could indicate that lowering the legal limit to 0 mg/dL for all drivers (as in Italy for drivers younger than 21 years old or professional drivers) could reduce the number of MVAs and, in turn, save lives and prevent serious injuries. Similar conclusions were also reached by an epidemiological study performed in the USA in which data extracted from the fatality analysis reporting system were analyzed[18]. The authors found that the severity of life-threatening MVAs increased significantly at BACs levels far lower than the current USA limit of 0.08% and that accident severity increased significantly even if the driver was merely buzzed[18]. In fact, a major finding of our study was the association between the presence of a (+) BAC and the occurrence of more severe clinical outcomes when compared to injured drivers with a (-) BAC. In particular, we found significant associations between the patients' BACs and triage severity codes at ED admission, prevalence rates of internal organ lesions and rates of hospitalization and a positive trend for the association between BAC and the number of bone fractures. It has been well established that alcohol consumption impairs driving skills, affects mood-cognition and psychomotor functioning, reduces alertness, and can directly or indirectly impair driving ability, all of which may result in worse clinical outcomes[4,18,19].

The effects of other drugs on driving are considerably more complicated than that of alcohol impairment. These complications stem from the fact that there are many potentially impairing drugs, not all of which are easily measurable; moreover, the relationship between dosage levels and driving impairment is complex and uncertain in many cases. In our study, approximately one-third of the evaluated injured drivers tested positive for at least one drug. Cannabis and cocaine were the most frequently detected drugs, and polyabuse was identified in 43% of positive samples. These data confirm the findings of other studies carried out with the aim of assessing the prevalence of drug abuse (other than alcohol) in impaired drivers from several European countries and the USA[8-13]. To limit the problems associated with driving under the influence of alcohol and drugs, the Italian

Parliament recently approved a new law (No. 41 of March 23th, 2016) making vehicular homicide and road traffic injuries a criminal offense, both of which are punishable as criminal negligence. As a result of the implementation of this new law in Italy, the punishment for offenses committed by people driving under the influence of alcohol or psychotropic drugs will increase[20].

Conclusions

The results of our study indicated that a significant proportion of injured drivers admitted to the ED of one of the bigger university hospitals in Italy were positive for alcohol or drugs that could impair driving. Moreover, the presence of a (+) BAC was significantly associated with worse clinical outcomes. Thus, more studies are urgently needed to gauge the magnitude of the problems associated with drug and alcohol use in the normal flow of traffic, as drug and alcohol use can result in inappropriate driving behaviours among drivers and resultant hazards to third parties. Also, we believe that a "zero tolerance" model for the consumption of alcohol or drugs before driving should be pursued to reduce the rates of MVAs and their dramatic consequences. Lastly, our study has some limitations. Firstly, the number of injured drivers tested for drugs was limited; therefore, a complete statistical analysis of the associations between drug use and clinical outcomes was not possible. Secondly, the prevalence of opiates could have been overestimated due to the use of opioid compounds in emergency room for patient sedation and the treatment of pain.

Conflict of interest

The authors declare no conflicts of interest.

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