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Relationship between anatomical sites and severity of the lesions and use of alcohol and psychotropic substances in traumatized drivers admitted to the Emergency Department of Padua, Italy

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Abstract

Introduction. Driving under the influence of alcohol and/or psychoactive substances increases the risk of road accidents, but it is controversial whether this affects site and severity of injuries.

Material and methods. We search for alcohol, cannabinoids, cocaine, benzodiazepines, opioids, methadone, amphetamines and barbiturates in biological fluids of 1764 traumatized drivers admitted to the Emergency Department (ED) of Padua between 2010 and 2014.

Results. We note correlation between alcohol and benzodiazepines and admission in ICU and between all the intoxications and the reserved prognosis. The sites of injuries were: head (37.13%), maxillofacial (8.33%), spinal column (44.67%), thoracic (15.31%), abdominal (5%), pelvic (2.55%) and limb traumas (23.58%). We observed a correlation between head trauma ($p < 0.0001$), maxillofacial trauma ($p = 0.0418$), thoracic trauma ($p = 0.0215$), pelvic trauma ($p = 0.0008$), spinal column trauma ($p < 0.0001$) and the totality of the intoxication and an association between benzodiazepines and thoracic and pelvic trauma.

Conclusions. Alcohol and benzodiazepines intoxication increases the risk of reserved prognosis and admission in ICU; benzodiazepines intoxication correlates with thoracic and pelvic trauma.

Key words

- driving under the influence
- emergency service hospital
- accidents
- prognosis
- alcohol

INTRODUCTION

Motor Vehicle Crashes (MVCs) are a preventable cause of death and lesions. Alcohol, many illegal substances as cannabis and legal drugs like benzodiazepines reduce psychomotor skills to drive in safety thus increasing the risk of accidents [1-13]. Traumas due to MVCs are a frequent cause of admittance to Emergency Departments (ED) [14] and the presence of alcohol and drugs in the biologic fluids of traumatized drivers is well documented in the Literature [15-28]. Since 1974 the Grand Rapids Study proved convincingly that driving under the influence of alcohol is an important risk factor for road accidents [29, 30] and following studies proved surely the relation between the assumption of alcohol and/or psychotropic substances and risk of MVCs [31-34]. The relationship between the use of alcohol and psychotropic substances and the seriousness of MVCs is not so clear. The few studies on this subject

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are not comparable since they took in the consideration different populations and evaluated the seriousness of accidents in different ways: on the bases of the drivers lesions, on the necessity of hospitalization, on death of the drivers, and on damages to things. Smink's work examined the relation between the use alcohol and/or psychotropic substances and seriousness of the lesions in a group of 993 drivers. Smink considered serious accidents that led to hospitalization or death but didn't prove any association between exposure to different classes of psychotropic substances and seriousness of lesions [35]. Works on the benzodiazepines don't show any correlation between the presence/absence of benzodiazepines and the seriousness of the accidents, considering also damages to things [31, 36]. In 2008 Smink confirmed once more that there is no clear association between the use of alcohol and psychoactive substances and the seriousness of lesions suffered by drivers involved in MVCs [37, 38]. Deutch's study, which listed not only MVC traumatized but all traumatized people who entered a Danish Trauma Center in 1999-2000 proved that the presence of alcohol and all the tested psychotropic substances positively correlates with Injury Severity Score (ISS). Alcohol use dependence did not correlate with other seriousness indexes like hospitalization times and mortality [39]. Later works did not confirm relation between ISS and the use of alcohol and drugs [35-37]. Alcohol is found in about a third of MVCs resulting in serious traumas or death [2] and benzodiazepines is the drug found most frequently in the seriously traumatized population [39]. In a case-control study evaluating the association between the use of psychotropic substances and the risk of lethal MVC in the USA concluded that the drivers positive either to alcohol or drugs presented a relatively higher risk (OD 23.24 CI 95%) of being involved in lethal accidents than the drivers resulting negative [40]. In North-European countries both alcohol and psychotropic substances are very common in drivers deceased for a MVC, especially in people of the youngest age and in accidents involving just one vehicle; up to 66% of the youngest deceased drivers had used alcohol and/or drugs just before driving [41]. While the relation between haematic alcohol values and road accidents risk was clearly proved [29, 30, 34, 35], does not exist a clear correlation between haematic concentration of psychoactive substances, impairment effect (reduced driving ability) and the risk of accidents, though some studies seem to suggest it, at least for tetrahidrocannabinol (THC) [42] and benzodiazepines [31, 36, 43]. The aim of this study is the search for presence/absence of alcohol and/or psychotropic substances (opioids, buprenorfine, cocaine, cannabinoids, benzodiazepines, methadone, amphetamines, barbiturates) in the blood and/or in the urines of 1764 traumatized drivers consecutively admitted to ED of Padua Hospital from 2010 to 2014.

These were submitted to toxicological controls ex artt. 186 and 187 of the Codice della Strada [44] to evaluate the possible correlations between seriousness and site of the trauma and the presence/absence in blood and urine of the most common substances.

MATERIALS AND METHODS

We studied retrospectively (reviewing the data contained in the clinical records in the aftermath) 1764 traumatized drivers admitted to ED of Padua Hospital from 2010 to 2014. We tested blood and urine samples drawn within three hours from the trauma looking for alcohol (cut-off 0,5g/l), opioids, buprenorphine, cocaine, cannabinoids, benzodiazepines, methadone, amphetamines, barbiturates, single or in association, using Liquid Chromatography-High Resolution Mass Spectrography (HPLC-HRMS) [45]. We considered positive for a specific substance all the intoxicated subjects (that is positive in the blood) and/or those exposed to the toxic substance (that is positive in the urine). The results of the tests on biological fluids were reported in an Excell Database, protected by a password, together with demographical features, date and hour of admittance, type of vehicle involved in the accident, how the driver arrived to ED, color code assigned at triage, possible pharmacological therapies given by Emergency Medical Service before the collection of blood and urine samples, value of Revised Trauma Score (RTS) [46-48] and site of the trauma and outcome -hospitalization, admission in Intensive Care Unit (ICU), dismissal, death – and prognosis – reserved or not. The biological fluid samples were marked with a serial number for each patient and the test results were inserted in a different database from the one of ED; this means they can no more be connected the identity of the tested subjects. In this way we put into mutual relation severity and site of the trauma with the presence/absence in the blood and/or urine of the tested substances. We considered negative those patients who received in ED midazolam or fentanest before the collection of the samples and who resulted positive only to these drugs.

As severity indexes we used RTS (between 0-8 in decreasing severity order), hospitalization in ICU, reserved prognosis. The sites of trauma that we considered are head, face, spinal column, chest, abdomen, pelvis and serious traumas to limbs (fractures, dislocations, amputations, deep wounds).

RTS is a score system estimated on a linear combination of three physiological indicators: Glasgow Coma Scales (GCS), Systolic Blood Pressure (SBP) and Respiratory Rate (RR). Though very simple, RTS proved accurate in predicting mortality [47, 78]. When entering in ED all patients were submitted to triage and were assigned a colour code indicating the treatment priority. If the vital functions are compromised the patient receive a red colour code, and have the highest priority; when the patient is stable but the site of lesion is a risk priority, or the trauma presents a major dynamic, or the patient is fragile due to pathophysiological factors, receives a yellow colour code; otherwise he receives a green or white colour code [49]. The criteria to define lesions' severity derive from Advanced Trauma Life Support (ATLS) guidelines, the gold standard in the treatment of major trauma patients [50].

Statistical analysis was carried on through τ-test of Student, χ^2test, Fischer test, univariate and multivariate regression logistics.

RESULTS

The sample consisted of 1764 subjects mainly males (73.75%) ranging in age between 15 and 93 years; the average age was 40.04 (40.04 ± 16.20) years median 37.50 years. Most of the subjects were Italian citizens (77.72%). The vehicles involved in accidents were car/van (55.20%), motorcycle (29.37%), bike (10.00 %), truck (2.06%), bus (0.06%), not indicated (3.31%). Most of the wounded people (95.52%) were taken in ED by ambulance.

The colour codes assigned at triage were in majority yellow (74.38%), 14.12% white, 5.84% green and 5.67% red. *Figure 1* shows positivity distribution of the different substances, alcohol being by far the most frequently found substance (17.23%). Blood samples positive to alcohol were 346 with an average blood alcohol of 1.51 ± 0.90 g/L (minimum 0.05 g/L - maximum 4.28 g/L). In the youngest age (15-18 years) the most frequent intoxication was from cannabis (10.96%), while alcohol intoxication was absolutely the most common in any other range of age considered, both for males and females, independently from nationality and from type of the vehicle *(Figure 2)*. As seen, the peak was in the age range between 25 and 34 years, where blood alcohol was higher than the legal limit (0.5g/L) in 21.16% of cases. Alcohol intoxication was the most frequent in all colour codes, and its frequency increased with the increment of the severity shown by the colour code: the percentage of people intoxicated by alcohol represented the 12.05% of white colour codes and up to 26% of red codes.

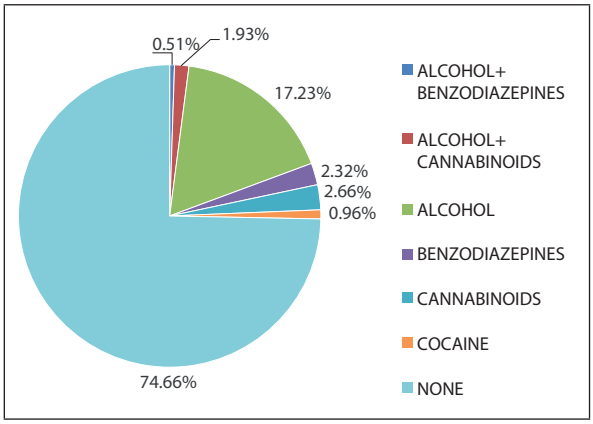

Figure 1
Positivity distribution of the different substances.

The most frequent traumas were those to the spinal column and head; the percentage distribution of different trauma sites was: spinal column trauma 44.67%, head trauma 37.13%, maxillofacial trauma 8.33%, thoracic trauma 15.31%, abdominal trauma 5%, pelvis trauma 2.55% and severe limb trauma 23.58%. *Table1* shows the distribution of frequency of each trauma site for any tested substances.

The majority of traumatized patients was discharged from the hospital (59.25%), 11.45% stayed under observation in ED for less 24 hours, 3.68% left the hospital against medical advice, 25.62% was admitted in hospital. The admission wards were mainly surgical wards (21.43%), less frequently ICU (3.40%) and rarely medical wards (1.19%). No patient died in the ED, but 14 patients (0.793%) died in hospital in the first hours.

We investigated the presence/absence in the blood and urine of the substances (alone or in associations) with the seriousness indexes (RTS, admission in ICU and reserved prognosis). Regarding the indexes of severity considered, the medium RTS was 7.86 ± 0.64, the median 8. Although small differences were recognized in the medium RTS values, for each substance the median was constantly 8, making any statistic correlation not clinically significant. On the contrary, alcohol

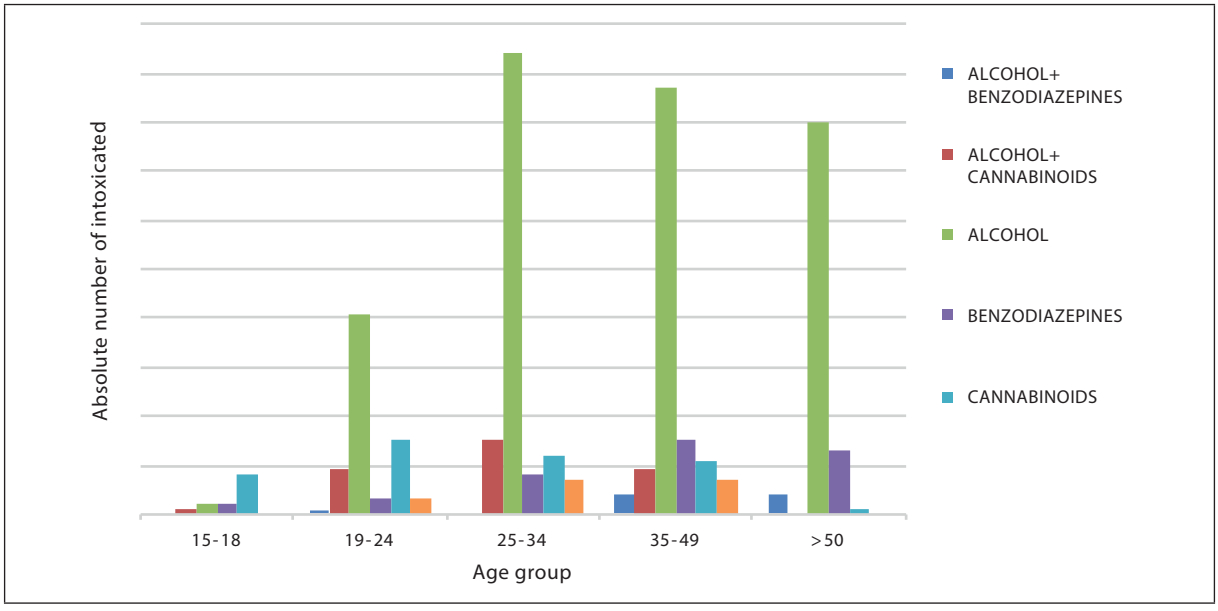

Figure 2
Positivity distribution of the different substances in different age groups.

Table 1
Distribution of frequency of trauma anatomical sites by substances

Substances	Head trauma		Maxillofacial trauma		Spinal column trauma		Thoracic trauma		Abdominal trauma		Pelvis trauma		Limbs trauma	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Alcohol + benzodiazepines	7 77.78%	2 22.22%	9 100 %	0 0.00%	4 44.44 %	5 55.56%	7 77.78 %	2 22.22%	8 88.89%	1 11.11%	8 88.89 %	1 11.11%	7 77.78 %	2 22.22%
Alcohol + cannabinoids	14 41.18%	20 58.82%	27 79.41%	7 20.59%	23 67.65%	11 32.35%	29 85.29%	5 14.71%	32 94.12%	2 5.88%	33 97.06%	1 2.94%	23 67.65%	11 32.35%
Alcohol	134 44.08%	170 55.92%	270 88.82%	34 11.18%	151 49.67%	153 50.33%	246 80.92%	58 19.08%	283 93.09%	21 6.91%	287 94.41%	17 5.59%	233 76.64%	70 23.03%
Benzodiazepines	17 41.46%	24 58.54%	38 92.68%	3 7.32%	14 34.15%	27 65.85%	29 70.73%	12 29.27%	36 87.80%	5 12.20%	38 92.68%	3 7.32%	28 68.29%	13 31.71%
Cannabinoids	24 51.06%	23 48.94%	42 89.36%	5 10.64%	20 42.55%	27 57.45%	45 95.74%	2 4.26%	47 100%	0 0%	45 95.74%	2 4.26%	32 68.09%	15 31.91%
Cocaine	11 64.71%	6 35.29%	15 88.24%	2 11.76%	1 5.88%	16 94.12%	16 94.12%	1 5.88%	17 100%	0 0%	17 100%	0 0.00%	16 94.12%	1 5.88%
None	902 68.75%	410 31.25%	1216 92.68%	96 7.32%	763 58.16%	549 41.84%	1122 85.52%	190 14.48%	1254 95.58%	58 4.42%	1291 98.40%	21 1.60%	1008 76.83%	304 23.17%
Total	1109	655	1617	147	976	788	1494	270	1677	87	1719	45	1354	416

and benzodiazepine intoxication correlated positively with admission to ICU ($p < 0.0001$). All intoxications (considered together) correlated with the reserved prognosis; particularly benzodiazepines intoxication exposes to relative risk 6.272 times higher of receiving a reserved prognosis *(Table 2)*. Head trauma ($p < 0.0001$) maxillofacial trauma ($p = 0.0418$), thoracic trauma ($p = 0.0215$), pelvic trauma ($p = 0.0008$) and column trauma ($p < 0.0001$) correlated with the intoxications (considered all together). In particular the benzodiazepines intoxication correlated with chest trauma and pelvic trauma, while intoxication from cocaine correlated with the risk of spinal column trauma *(Table 3)*. None of the considered substances correlated positively with abdominal and limb trauma.

DISCUSSION

To increase safety on the road is important not only to prevent MVCs but also to understand which factors determinate mortality and morbidity. Our work investigates the role of alcohol and psychotropic substances in determining the seriousness of road accidents. Alcohol can be detected in breath while other psychotropic substances must be dosed in biological fluids and toxicology laboratory equipped with sophisticated tools in method together with qualified personnel, for this reason drug effects on driving are less investigated than those of alcohol. Our work integrates the technical skills of toxicologist and the clinical skills of emergency physician, allowing a multidimensional approach to the problem of alcohol and drug intoxication in traumatized drivers. Laboratories of clinical pathology are usually not equipped with refined techniques to determine the presence of psychotropic substances in biological fluids; on the other hand toxicologists specialist do not have clinic experience, so normally a sharing of information between doctors of emergency and toxicologists is not realized.

Table 2
Odds Ratio (OD) for reserved prognosis for each substance

Substances	OD	CI 95%	
Alcohol + benzodiazepines *vs* none	4.724	0.964	23.158
alcohol + cannabinoids *vs* none	1.225	0.286	3.081
Alcohol vs none	**1.968**	**1.258**	**3.081**
Benzodiazepines vs none	**6.272**	**3.010**	**13.070**
Cannabinoids *vs* none	0.787	0.187	3.319
Cocaine *vs* none	1.102	0.144	8.464

Toxicological investigations on blood and urine of all the traumatized drivers involved in this study are not performed on the basis of a clinical suspicion, but collected only to Police request [44]. It does not mean that the accidents are the most serious; in fact the Police is often called in a lot of trifling incidents because of insurance reasons. This avoided a selection bias.

The presence of alcohol and drug in the biologic fluids of traumatized drivers is well documented in the Literature [15-28]. In line with the Literature the most common psychoactive substances detected in blood and/or urine in all age groups (excluding the group from 15 to 17 years) is alcohol, the second most common is cannabis alone or in association with alcohol, followed by benzodiazepines especially in middle-aged and elderly males. In the youngest age group (15-17 years) the 10.6% of intoxicated people are positive to cannabis. In the case of multiple intoxications almost every time one of the present substances was alcohol. This study refers to a local population that could not be representative of the entire Italian population; however our sample is comparable for demographic characteristic, type and frequency of many detected substances to the Italian sample of DRUID Study. In our sample alcohol is the psychoactive substance most commonly detected, although less frequently than in the DRUID

Table 3
Correlation between the anatomical sites of trauma and substances

Substances	Head trauma			Maxillofacial trauma			Thoracic trauma			Pelvis trauma			Spinal column trauma		
	OD	CI 95%		OD	CI 95%		OD	CI 95%		OD	CI 95%		OD	CI 95%	
Alcohol + benzodiazepines *vs* none	0.630	0.130	3.042	0.664	0.033	13.388	1.687	0.348	8.183	10.611	1.622	69.405	1.737	0.464	6.499
Alcohol + cannabinoids *vs* none	3.142	1.572	6.283	3.435	1.475	7.999	1.018	0.389	2.663	2.690	0.458	14.924	0.665	0.321	1.375
Alcohol *vs* none	2.791	2.163	3.600	1.608	1.066	2.425	1.392	1.006	1.927	3.656	1.919	6.966	1.408	1.097	1.808
Benzodiazepines *vs* none	3.105	1.650	5.843	1.146	0.371	3.536	2.444	1.226	4.872	5.460	1.666	17.890	2.680	1.393	5.159
Cannabinoids *vs* none	2.108	1.176	3.779	1.631	0.649	4.099	0.262	0.063	1.091	3.301	0.851	12.801	1.876	1.042	3.380
Cocaine *vs* none	1.200	0.441	3.267	0.664	0.033	13.388	0.369	0.049	2.799	1.716	0.092	31.945	22.225	2.940	168.008

study (17.23% *vs* 23.1%), while benzodiazepines are much more represented (0.7% in DRUID vs 2.50%), probably because in our laboratory many more active substances of the benzodiazepine class were assayed than in DRUID. It remains to explain the high frequency of opioid intoxication detected in the Italian arm of DRUID study, compared with our (2.1% illegal opiates and 3.7% opioid-medicines *vs* 0.82%), but in our sample we did not consider patients who received opioids in the ambulance or in ED.

Our data derive from testing procedures on blood and/or on urine to determine both intoxication and exposure to psychotropic substances in injured drivers. We looked for correlations between presence/absence in blood and urine of the tested substances and some indexes of severity (RTS, admission in ICU, reserved prognosis). The choice of RTS as severity score of trauma was determined by the calculation simplicity, the possibility of finding a reliable value of RTS trough a post-hoc analysis of the medical records, by the well documented correlation between RTS value and mortality, by the extensive score validation as well as its use in ATLS protocols [50]. As already said, the median of RTS value is constantly 8, making any statistical correlation not clinically significant. However our results while not conclusive suggest that alcohol and benzodiazepines intoxication increase the risk for traumatized drivers of receiving a reserved prognosis and of being hospitalized in ICU. Our study also investigated on which no data exist in Literature: exposition to alcohol and psychoactive substances and specific anatomical sites of trauma. Some elements of this study could make us assume a correlation between benzodiazepines intoxication and thoracic and pelvic traumas.

CONCLUSIONS

Our study, according to the Literature, does not show univocal data on the correlation between the exposure to the psychoactive substances and the severity of the trauma, but suggests that driving under the influence of alcohol and benzodiazepines correlates with reserved prognosis, admission to ICU and maybe trauma in some specific anatomical sites. Further prospective studies are needed to understand the role of psychoactive substances in determining the severity of MVCs and thus establish educational programs for drivers in order to improve public safety.

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Conflict of interest statement

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

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