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The Relation Between the Use of Psychoactive Substances and the Severity of the Injury in a Group of Crash-Involved Drivers Admitted to a Regional Trauma Center

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Objective. *There is much evidence that driving under the influence of alcohol and/or drugs of abuse is related to an increased accident risk. A remaining question is whether the use of psychoactive substances is also related to clinically more severe accidents. The aim of this study is to explore the relationship between the use of psychoactive substances and the injury severity in a group of crash-involved drivers.*

Methods. *The study group included all injured car drivers, admitted to the regional trauma center, in the period from May 2000 until August 2001. The outcome of interest was the severity of injury, measured by using the Injury Severity Score (ISS). The determinant was the presence of psychoactive substances in blood and urine samples. Psychoactive substances tested for were alcohol, amphetamines, barbiturates, benzodiazepines, cannabis, methadone, opiates, and tricyclic antidepressants in blood and urine.*

Results. *The number of injured car drivers included in this study was 106. Overall, 43% (46/106) of the drivers tested positive for at least one psychoactive substance. Comparison of the means of the log ISS suggests that there is no significant difference between drivers who tested positive for alcohol and/or drugs, compared to drivers tested negative.*

Conclusion. *The results of this study support the hypothesis that there is no clear association between use of psychoactive substances and the severity of crash-related injury.*

Keywords Alcohol; Drugs; Injury Severity Score; Traffic Accident

INTRODUCTION

There is much evidence that driving under the influence of alcohol and/or drugs of abuse is related to an increased accident risk (Kelly et al., 2004). A remaining question is whether the use of psychoactive substances is also related to clinically more severe accidents. Information concerning the influence of alcohol on the severity of the injury is controversial (Li et al., 1979; Waller et al., 2003); information about the influence of drugs is limited. The results of our prior study within a group of crash-involved drivers (Smink et al., 2005) did not show a clear association between the use of alcohol, illicit drugs, and/or medicinal drugs and the severity of an accident. Since blood sampling only took place in case of a police officer's suspicion of drug use and given the retrospective nature of the study, the findings of that study may have been biased. In the present study, all injured drivers admitted to the regional trauma center have been tested

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for the presence of alcohol and drugs, so selection bias can be excluded. An outcome measure frequently used to express the severity of an accident is the Injury Severity Score (ISS; Baker et al., 1974). The aim of the study is to study the relation between the use of psychoactive substances and injury severity, expressed as the injury severity score (ISS), within a group of crash-involved drivers admitted to a regional trauma center.

METHODS

The study group included all injured drivers who were admitted to the regional trauma center located in the St. Elisabeth Hospital in Tilburg, The Netherlands, after a motor vehicle crash in the period from May 2000 until August 2001 as described in detail elsewhere (Movig et al., 2004). This regional trauma center covers an area with approximately 350,000 inhabitants. The outcome of interest is the clinical severity of the injury measured with the Injury Severity Score (ISS). There are several scales to characterize trauma (Holmes et al., 2005). The Abbreviated Injury Scale (AIS) describes anatomical injury and classifies them into different categories: minor (1), moderate (2), serious (3), severe (4), critical (5) and fatal (6). The ISS is determined by summing the squares of the highest AIS rating (up to 5) for each of the three most severely injured body areas. As a consequence, ISS can take values between 0 and 75.

The determinant of interest was exposure to alcohol and/or other psychoactive substances at the moment of the crash, as concluded from the presence of those substances or metabolites in blood and urine samples collected directly after admission to the hospital (Movig et al., 2004). Informed consent was obtained from the patients or their relatives. Samples (43 urine and 63 blood samples) were considered positive for drugs in case of a positive test result for amphetamines, barbiturates, benzodiazepines, cannabis, cocaine, methadone, opiates, and/or tricyclic antidepressants.

Qualitative analysis was performed by using a combination of immunoassay techniques, gas chromatography-mass spectrometry (GC-MS), and high-performance liquid chromatography-diode array detection (HPLC-DAD). Screening of urine samples was performed using enzyme multiplied immunoassay technique. Applied screening cutoff concentrations by using immunoassay in urine were 50 (cannabis: THC-COOH), 150 (tricyclic antidepressants), 200 (barbiturates), 300 (cocaine: benzoylecgonine, benzodiazepines, methadone), and 1000 (amphetamine and opiates) nanograms per milliliter (ng/mL). Amphetamine- and opiate-positive screening results in urine were confirmed qualitatively by using GC-MS. Serum samples were screened for opiates and cannabis by using enzyme immuno assay (EIA). Applied screening cutoff concentrations in serum were 20 (opiates) and 5 (cannabis) ng/mL.

For the detection of other substances in serum, samples were analyzed by using HPLC-DAD after solid phase extraction. Detection limits by using GC-MS or HPLC-DAD have been described in detail elsewere (Mathijssen & Houwing, 2005). If drugs were detected that had been administered during transport to the hospital or in the emergency room before sampling (e.g., morphine for pain), the specimens were considered to be negative.

A quantitative analysis was performed only for alcohol by using enzyme multiplied immunoassay technique. Information about the blood alcohol concentration was derived from the hospital files: the determination of the blood alcohol concentration was part of the standard procedure for patients admitted to the hospital. Patients were considered positive for alcohol in case of a blood ethanol concentration equal to or over 0.5 g per L. The samples used for the analysis of ethanol were not available for the analysis of drugs.

The relation between the presence of alcohol and/or drugs and injury severity was assessed in two ways. For both analyses we grouped the use of alcohol and/or drugs into four mutually exclusive categories: a) no drugs, no alcohol, b) alcohol, no drugs, c) drugs, no alcohol, d) alcohol and drugs. The category "no drugs, no alcohol" was the reference group. First, the ISS was analyzed as a continuous variable. ISS data showed positive skewness. Therefore, to compare the means, a logarithmic transformation was performed. Differences in the means of the log ISS were studied using ANOVA. Second, the ISS scores were presented in three categories related to minor injury ($ISS < 9$), moderate injury ($9 \leq ISS \leq 15$), and severe injury ($ISS > 15$) (Copes et al., 1988; Singleton et al., 2004). A chi-square test was used to assess differences in proportions of the categorized ISS.

The relation between the use of psychoactive substances and injury severity was analyzed using SPSS 12.0 statistical software.

RESULTS

In the period from May 2000 until August 2001, 110 injured car or van drivers were admitted to the emergency room of the

Table I Characteristics of the patients

Characteristics	N = 106 (%)		
Gender			
Male	78 (74%)		
Female	28 (26%)		
Age group (year)			
18–24	30 (28%)		
25–34	34 (32%)		
35–49	26 (25%)		
≥50	16 (15%)		
Blood alcohol concentration (g/L)			
<0.5	82 (77%)		
0.5–0.79	1 (1%)		
≥0.80	23 (22%)		
Drug class		Blood	Urine
Amphetamines	7 (7%)	3	4
Barbiturates	2 (2%)	1	1
Benzodiazepines	11 (10%)	3	8
Cannabis	13 (12%)	6	7
Cocaine	10 (9%)	2	8
Methadone	1 (1%)	1	0
Opiates	8 (8%)	2	6
Tricyclic antidepressants	1 (1%)	0	1

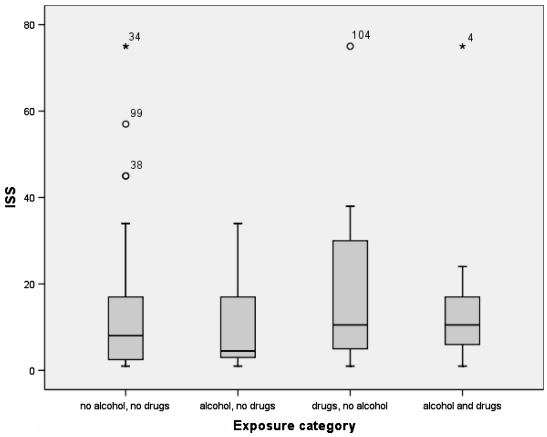

Figure 1 Figure: Box-plots for the Injury Severity Score (ISS) of the different exposure categories (0 = outlier, * = extreme).

hospital. Four patients were excluded due to missing ISS data. Therefore, the total number of patients included in this study was 106. The main characteristics of the patients are presented in Table I.

Of those patients, 74% (78/106) were male. The mean age of the drivers was 34.6 (range 18–79) years. In 23% (24/106) of the patients, the blood alcohol concentration was equal to or over the legal limit of 0.5 g per L at that time. In 30% (32/106) of the patients, blood or urine samples were positive for amphetamines (7%), barbiturates (2%), benzodiazepines (10%), cannabis (12%), cocaine (9%), methadone (1%), opiates (8%), and/or tricyclic antidepressants (1%). Overall, 43% (46/106) of the patients were positive for alcohol and/or drugs.

Figure 1 shows the box-plots for the ISS data of the different exposure categories. The outliers (o) and extremes (*), outside the range of the whiskers (the 2.5% and 97.5% values), are plotted individually, indicated by patient number.

Comparison of the means of the log ISS shows that there is no statistically significant relationship between the presence of alcohol and/or drugs on injury severity (Table II; $P > 0.05$). Table II shows the relation between the use of psychoactive substances and injury severity, expressed as the ISS.

Injury severity of 50% (53/106) of all drivers admitted to the hospital was classified as minor (ISS < 9), 19% (20/106) was classified as moderate ($9 \leq ISS \leq 15$), and 31% (33/106) was classified as severe (ISS >15). Within the categories of injury severity (minor, moderate, severe), the patients were almost equally divided between the drivers of the reference category (no alcohol, no drugs) and the drivers of the category either alcohol or drugs. Differences in proportions were not significantly different ($P > 0.05$).

DISCUSSION

Within a group of 106 crash-involved drivers (with and without responsibility for the accident), we found no relation between the use of psychoactive substances (alcohol, drugs) and the severity of the injury expressed as the ISS. The results of this study support the findings of our prior study (Smink et al., 2005)

Table II The relation between the use of psychoactive substances and injury severity

	No alcohol, no drugs n = 60	Alcohol, no drugs n = 14	Drugs, no alcohol n = 22	Alcohol and drugs n = 10
ISS, median (range)	8 (1–75)	4.5 (1–34)	10.5 (1–75)	10.5 (1–75)
Log ISS, mean	0.83	0.72	0.99	1.02
Minor severity (ISS < 9; n)	31	10	9	3
Moderate severity (ISS 9 – 15; n)	12	0	4	4
Severe (ISS > 15; n)	17	4	9	3

in which, given a crash, the use of alcohol or drugs showed no clear association with the severity of an accident.

The accident data used in the prior study classified the severity of the accident as property damage only, non-serious injury, hospital admission, or fatality. An accident was considered to be severe in cases of injury with admission to the hospital or death. The major limitation of that study was the potential for selection bias, due to the fact that not all crash-involved drivers were tested for the use of alcohol and drugs. In this study, all crash-involved drivers admitted to the hospital were included, so the present findings were not influenced by selection bias. The percentage of drug-negative drivers with a blood alcohol concentration lower than 0.5 g/L in the prior study (15%) was less than the percentage of drug-negative drivers in the present study (57%), likely due to the fact that in the prior study sampling only took place in cases of a suspicion of alcohol or drug use. In the present study, all drivers were tested. Another influencing factor in the prior study could have been the time interval between accident and sampling. In this study, blood and urine sampling took place immediately after admittance to the hospital. As a consequence, elimination of alcohol or drugs due to time course is limited.

A limitation of the present study might be that in 40% of the cases screening for other substances than alcohol was performed in urine (Movig et al., 2004). Positive test results in urine are not always an indication for recent drug use. For example, after cannabis use, the metabolite THC-COOH may be present in urine for several weeks after the last intake, depending on the pattern of use. If recent drug use is related to more severe injury, the use of urine samples in this study might cover up this relationship. If recent drug use is related to less severe injury, the use of urine samples would have produced higher ISS values than the use of only blood samples. This implies that in that case, the use of blood samples only would also confirm the hypothesis that there is no significant difference between drivers who tested positive for alcohol and/or drugs, compared to drivers tested negative.

In this study, the number of patients was not large enough to be able to study the relation between the different classes of drugs and the injury severity expressed as the ISS. Regarding the injury severity, the present study did not control for characteristics like age, gender, time of day, day of week, type of car, speed at time of crash, and seat belt use. Another limitation of this study might

be that only the injured drivers were included and, e.g., drivers responsible for the crash, but not injured, were not tested.

Deutch et al. described drug and alcohol use in a population of victims of major trauma admitted to a regional Danish trauma center (Deutch et al., 2004). They found that both drug and alcohol presence correlates positively with the ISS within a group of patients (n = 417). Their results showed that the mean ISS was statistically higher among drug-positive patients (9 versus 7, P = 0.025) by using the Mann-Whitney test with the Monte Carlo correction. In our opinion, the remaining question is whether the difference in ISS that Deutch et al. found is clinically relevant or not.

Differences in findings between the study of Deutch et al. and our present study may be related to differences in intake criteria of the subjects (injured drivers in our study versus all patients admitted to a trauma center), differences in statistical analysis (parametric in our study versus non-parametric methods), or other methodological issues. There are some limitations by using the ISS as an outcome measure (Champion, 2002). In literature, ISS is treated as a continuous, normally distributed variable as well as categorical variable and there is no consistency in the number of categories used or the severity cut off points (Stevenson et al., 2001). The ISS is not linearly related to mortality (O'Neill et al., 1979) and other outcomes, is positively skewed, and accounts for only one injury in each body region (Moore et al., 2006). However, despite the limitations it is still widely used for injury severity scoring.

In conclusion, the results of this study support our prior findings (Smink et al., 2005) that alcohol and/or drug use is not associated with increased crash severity. More research is needed and blood sampling of all crash-involved drivers is recommended to confirm the results and to be able to study the relation between the different classes of drugs and injury severity.

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