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Driving under the effect of drugs: Hair analysis in order to evaluate recidivism

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ABSTRACT

Under Italian law drug addiction and regular drug abuse are incompatible with driving ability. One important problem with the enforcement of the impaired driving law is the large number of people that re-offend. To regain their license, offenders must be drug-free for the duration of an observation period, according to the judgement of a medical commission. The exclusion of illicit drug use is determined by toxicological analysis. A few studies exist that have used a hair matrix to monitor recidivism. Hair is an attractive matrix for monitoring drug recidivism, due to the large time window for drug detection, and to the non-alterability of this matrix. We report the results of several years of experience at our forensic toxicology laboratory in the use of hair analysis for the assessment of past exposure to drugs in persons suspected of driving under the influence of drugs. 5592 subjects were analyzed for opiates, cocaine and delta-9-tetrahydrocannabinol (Δ^9-THC) using a GC/MS method. 1062 (19.0%) subjects resulted positive. From this group, the individuals that resulted positive at least at the second control were considered recidivists (243, 22.9%). 79.7% of recidivist subjects were positive for cocaine and metabolites, 14.9% for morphine and metabolites, 5.4% for Δ^9-THC. We also studied the time frame of the abuse, as well as gender and age distribution of recidivist subjects. Furthermore, we analyzed risk factors associated with recidivist behaviour. Our results show that cocaine consumption was the only factor that showed significance with regard to increased likelihood of being a recidivist.

1. Introduction

Driving under the effect of drugs presents a serious concern for general traffic safety. Many of the accidents and deaths that occur on Italian roads are caused by drivers whose performance is impaired by the use of psychoactive substances [1,2]. Under Italian law (art. 187 of the Highway Code [3]) drug addiction and regular drug abuse are incompatible with driving ability (zero tolerance law). They constitute valid reasons for disqualification from driving, or revocation of the offender's driving license. Persons whose license has been revoked or suspended due to driving under the influence of drugs, and persons addicted to psychoactive drugs can obtain, or re-obtain their driving license according to the judgment of a medical commission (Local Medical Commission (CML) art. 119 Highway Code, DPR 495/92 [4]).

One of the physical requirements involved is the exclusion of illicit drug use by means of toxicological analysis, mainly of urine or hair matrices. Urinalysis informs us of recent or current exposure, while hair analysis provides information on long-term use of illicit drugs. Moreover, hair analysis allows us to identify drug use more often than urinalysis, and may represent a better means of monitoring drug abstinence as required by law [5–7]. So hair analysis is a relevant part of the procedure for granting or re-granting a driver's license.

According to most CML procedures, in the presence of positive hair and/or urine data, the offender's driving license is suspended for a 1–2 year period. During this period, the person is recalled for toxicological analysis monitoring generally every 6 months.

One important problem with enforcement of the impaired driving law is the large number of people that re-offend [8,9]. Repeat offenders are more likely to be involved in fatal motor vehicle accidents or hit-and-run collisions with pedestrian fatalities [10]. Under Italian law, a repeated offense leads to permanent withdrawal of the offender's license [3]. The license withdrawal sanction and zero-tolerance laws could be considered

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a general deterrent that aims to discourage people from committing the same crime. According to some authors, the risk of penalties, such as fines and incarceration, has non-deterrent effects on hardcore alcohol offenders, while a combination of license suspension and rehabilitative programs can reduce recidivism [11].

Until now, literature has concentrated mainly on relapse or recidivism among drunken drivers. Much less is known about re-arrest rates for driving under the effects of other drugs of abuse [8,12]. Furthermore, to our knowledge there are few studies that have used a hair matrix to detect drug intake and recidivism. Hair has a number of characteristics that make it an attractive matrix for monitoring drug recidivism, due to the large time window for drug detection, and to the non-alterability of this matrix [13,14]. Most studies on the prevalence of driving under the influence of drugs have examined drivers who were involved in accidents, while little research has been conducted into the growing phenomenon of recidivism in the general driving population. To enhance traffic safety, it is important to minimize the risk of recidivism. According to some authors, there are certain characteristics that constitute risk factors for drinking recidivism: mainly gender and age [8,15,16]. In fact, drivers aged below 36 years showed higher re-arrest rates than older drivers [8]. As regards drug users, drivers with multi-drug detection showed a higher re-arrest rate than those for whom only one drug was detected [8].

We report the results of a study that analyzed recidivism-related behavior by using hair samples taken from people who had had their licenses suspended for driving under the influence of drugs. Furthermore, we analyze the role of license suspension as a deterrent for this behavior. The procedure adopted by the CML described above allows the subject to be monitored for a long time period (two or more years), and it involved the forensic toxicology laboratory of the University of Macerata for hair analysis together with clinical and laboratory tests.

The long period of controls (2 years as a minimum) and the homogeneity of hair data collected at our toxicology laboratory allowed us to study the phenomena of recidivism in driving under the influence of drugs.

All cases of impaired driving were evaluated in relation to the drug of abuse involved, age and gender. An analysis was also made regarding whether these could be factors of risk to recidivist behavior.

2. Materials and methods

2.1. Chemicals and reagents

Nalorphine, proadifen (SKF-525A) (internal standards for opiates and cocaine respectively) were purchased from Sigma, while Δ^9THC-D_3 (internal standard for THC), cocaine, benzoylecgonine, morphine were purchased from LCG standards. *N*-methyl, *N*-trimethylsilyl trifluoroacetamide (MSTFA) and *N*,*O*-bis[trimethylsilyltrifluoroacetamide]w/1%trimethylchlorosilane (BSTFA + 1% TMS) were purchased from Sigma. Methanol, dichloromethane, prop-2-ol, ammonium hydroxide, hexane, ethylacetate and cyclohexane (purchased by Panreac) were reagent grade. Isolute HCX cartridges (10 mL capacity, 130 mg) were obtained from International Sorbent Technology.

2.2. Sample preparation

All persons registered as permanent residents were given a unique 16-digit identification number. These numbers, along with age, gender and the substances detected in case of positivity were entered into a laboratory database containing the results of toxicological analysis of a hair sample. All cases registered from 2005 to 2014 were used to select the positive subjects. The recidivist subjects were selected by matching the unique 16-digit number and the number of occurrence in the database.

The hair samples were collected from the posterior vertex of individuals being tested for use of drugs, and after washing they were manually cut into small fragments (50 mg minimum) for drug detection.

The samples were incubated overnight in 2 mL of 0.1 N HCl solution at 50 °C and internal standard (SKF for cocaine, nalorphine for opiates) was added for the detection of cocaine, opiates and their metabolites. The resulting mixtures were cooled at room temperature, neutralized with 2 mL of phosphate buffer solution pH 6 and 130 μL of NaOH 2 M at pH 6–7 was added, extracted by means of a SPE technique. The columns were conditioned sequentially with a methanol (2 mL) and phosphate buffer, pH 6 (2 mL). The samples were then slowly drawn through the columns under a low vacuum for at least 2 min. Then the columns were rinsed sequentially with water (2 mL), 0.1 N HCl (3 mL) and methanol (3 mL). After the columns were completely dried (5 min under full vacuum), the analytes were eluted with 2 mL of a dichloromethane/isopropyl alcohol solution (8:2) with 2% ammonium hydroxide. The eluate was completely evaporated and then derivatized with 50 μL of MSTFA at 60 °C for 20 min. One microliter of the derivatized eluate was injected in GC/MS.

The residual hair samples used in the previous analyses were used for Δ^9-THC detention. The samples, to which internal standard (Δ^9-THC-D_3) was added, were subjected to basic hydrolysis (NaOH 1 N solution, at 95 °C for 15 min), cooled at room temperature and subjected to a liquid-liquid extraction method. 3 mL of an extraction solution of hexane/ethyl acetate (9:1) was added to the samples which were shaken for at least 15 min. The organic phases were separated. The eluates were completely evaporated, and then derivatized with 50 μL of BSTFA + 1%TMS at 60 °C for 20 min. One microliter of the derivatized eluate was injected in GC/MS.

2.3. GC/MS instrumental and analytical conditions

All analyses were carried out by the gas chromatography–mass spectrometry method previously described [17]. Drug concentrations in analyzed hair higher than the cut-off values [18,19] were considered to be positive data.

2.4. Statistical methods

The results were compared using the Mantel–Haenszel statistics to estimate odds ratio (OR), confidence intervals (CI) for the assessment of risk and χ^2 test for statistical significance.

3. Results

Hair results from 5592 subjects were analyzed, 1062 subjects resulted positive for at least one substance, corresponding to 19.0% of the subjects checked. Almost all the individuals who resulted positive were recalled for a subsequent toxicological control. A great many of these subjects resulted negative at the subsequent controls (77.1%). We defined these subjects as the non-recidivists group (NRG), and qualified them as the control group. The individuals who resulted positive at least at the second control were considered recidivists (22.9%, RG). The analysis made of these subjects over the years shows a progressive decrease in positivity at subsequent controls, with a few subjects who were highly recidivist (16.5%, 4.5%, 1.5%, 0.3%, 0.1%, respectively 2–6 times).

When we analyzed the data for gender, positive data corresponded mainly to male individuals for both groups (Table 1).