

The consumption of alcohol and cocaine among drunk-drivers: retrospective data analysis of a protocol for driving license regranting program

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ABSTRACT

Introduction: alcohol and cocaine are frequently used together; this co-abuse compromises the physical and mental requirements included in the assessment of fitness to drive. The assessment for the issuing of the certificate of fitness to drive is released by Local Medical Commissions after clinical examination and toxicological analysis. The aim of this paper is to estimate the prevalence of cocaine use among drunk-drivers during a specific driving regranting protocol, in order to assess the usefulness of the inclusion of cocaine metabolites in hair analysis in this category of subjects.

Methods: according to the toxicological protocol at the Regional Reference toxicological laboratory of the "Liguria Levante" in Sarzana (La Spezia) at San Bartolomeo Hospital, in addition to the quantification of carbohydrate-deficient transferrin (CDT) in serum by HPLC and Ethylglucuronide (ETG) in keratin matrix, also cocaine and its metabolites, especially Coca-ethylene (CE) has been tested in hair by LC-MS/MS. The protocol has been applied on biological samples collected from 2215 drunk-drivers.

Results: the 6.6% of the 2215 hair samples analyzed were classified as non-moderate alcohol users (ETG >30 pg/mg). Among these 0.1% were cocaine users and 0.9% consumed together alcohol and cocaine, as highlighted by the presence of CE. Out of the 94.4% of the 2215 hair samples with ETG <30 pg/mg, 3.9% and 6.1% were positive for cocaine, and CE respectively.

Conclusion: This study demonstrates the importance of toxicological analysis of drugs of abuse in hair and the need to include the analysis in specific protocols for driving regranting, such as the one here adopted.

Keywords: alcohol, cocaine and metabolites, hair analysis

INTRODUCTION

Alcohol and cocaine are frequently used together (1). The use of both cocaine and alcohol has been reported in clinical samples from substance abusers in the US (2-4), in the UK (5), as well in other countries (6). Use of alcohol and cocaine has been reported in the general population (7) and among specific subjects such as those attending dance music events (8). Animal studies have also found a relationship between the self-administration of alcohol and cocaine (9).

The combination of alcohol and cocaine is popular among drug users, perhaps because of more intense feelings of "high" beyond that perceived with either drug alone, less intense feelings of alcohol-induced inebriation

and tempering of discomfort when coming down from a cocaine "high".

Cocaine consistently antagonizes the learning deficits, psychomotor performance deficits and driving deficits induced by alcohol. The combination of alcohol and cocaine tends to have greater-than-additive effects on heart rate, concomitant with up to 30% increased blood cocaine levels. Both prospective and retrospective data further reveal that co-use leads to the formation of cocaethylene (CE), which may potentiate the cardiotoxic effects of cocaine or alcohol alone. More importantly, retrospective data suggest that the combination can potentiate the tendency towards violent thoughts and threats, which may lead to an increase of violent behaviors (10).

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The Italian Traffic Code includes a specific article (article 119) to establish the “*Physical and psychic requirements for the driving license*” (11). The assessment for the issuing of the certificate of fitness to drive is released by Local Medical Commissions after clinical examination and toxicological analysis.

In most European countries, the procedures for driving license re-issuing to drivers convicted for driving under the influence of alcohol (drunk-drivers) are generally based on the assessment of alcohol use, utilising the determination of indirect biomarkers such as carbohydrate-deficient transferrin (CDT), gamma-glutamyltransferase (GGT), aspartate/alanine aminotransferase (AST/ALT), mean corpuscular volume (MCV) and/or direct biomarkers (ethanol metabolites) in blood, urine and/or hair samples (12-15). The presence of an underlying simultaneous use of illicit drugs in drunk-drivers is thus not always investigated (16,17).

The aim of this study is to estimate the prevalence of drug use in a northwest Italian population of drunk-drivers, performed during the driving license regranting process, in order to verify the usefulness of the inclusion of toxicology tests on hair samples in the regranting protocol of drunk-drivers.

METHODS

The retrospective study was conducted on 2 215 drunk-drivers examined by the Local Medical Commission of North-West Tuscany from 2017-2019 using a protocol that included the quantification of Ethyl-glucuronide (ETG) and Cocaine and its metabolites (CE) on keratin matrix and CDT on serum samples.

The analysis were performed at the Regional Reference Toxicological Laboratory of the “LiguriaLevante” located in Sarzana (La Spezia) at San Bartolomeo Hospital.

The quantification of ETG and Cocaine on keratin matrix was performed by liquid chromatography associated with tandem mass spectrometry (Agilent infinity 1260 QQQ 6470 LC/MS-MS) while CDT was evaluated by High Pressure Liquid Chromatography (HPLC Thermofisher Ultimate 3000).

Keratin matrix sampling was obtained on 3-6 cm hair segments taken from the neck area; alternatively the chest hair or limbs were sampled according to the indications of the Society of Hair Testing Consensus (SOHT, 2019) (18,19).

For the reporting of the obtained values, the cut-offs suggested by the guidelines of the Italian Istituto Superiore di Sanità (ISS) (20,21), forensic toxicologists (22,23) and SOHT were adopted.

RESULTS

A total of 2 215 samples of drunk-drivers were examined; Table 1 summarizes the number of examined samples according to the results obtained for tested analytes.

4.6% show excessive alcohol consumption (ETG >30 pg/mg) and among these 1% are also cocaine

users. 84.3% of the samples show an ETG value <30 pg/mg (moderate consumption of alcohol or abstem), but, 10% of these subjects are cocaine consumers (Figure 1). In particular, among cocaine users (total 11.0%), the presence of the active metabolite cocaethylene (CE), an indicator of concomitant alcohol consumption, is found in 7% of samples (Figure 2).

Furthermore, the data of cocaine users among drunk-drivers is confirmed over the years, around 10% (Figure 3).

DISCUSSION

Overconsumption of alcohol and impaired driving represent a major public health issue worldwide, and alcohol is the most prevalent psychoactive substance found in the driving population, with a great variation between different countries (highest prevalence in the southern and western countries of Europe) (24-26). In 1995, the International Council on Alcohol, Drugs & Traffic Safety proposed a protocol for the regranting of driving license in drunk-drivers, providing an accurate methodology based on medical examination and alcohol-specific biomarkers determination for the detection of alcohol abuse. Up to now, the regranting procedure has not been revised at international level, and the phenomenon of polydrug use is not diffusely included in the protocols of driving license regranting process on drunk-drivers. Presently, in the majority of the European countries, after the period of the driving license retrieval, drunk-drivers undergo alcohol use investigation, while the toxicological analysis on hair and urine is systematically performed only on subjects convicted for driving under the influence of drugs.

It is well known that hair analysis, providing information on long-term use of illicit drugs, allows the identification of drug use on a greater number of subjects than urine analysis does and may thus represent a better tool to check for drug abstinence as required by the law (27,28).

Compared to other matrixes and keratinized materials, the most important advantage of hair analysis is the possibility for retrospective monitoring of an accurate specific time period (29), which could be well defined through the hair growth rate/cycle (in forensic investigations an average value of 1 cm/month is

Table 1
Number of positive and negative samples

| N | ETG+ | ETG- | ETG+ | ETG- | ETG+ | ETG- | |
|-------|-------|-------|---------------|--------------|--------------|--------------|-----|
| | COCA- | COCA- | COCA + CE- | COCA+ CE- | COCA+ CE+ | COCA+ CE+ | |
| 2017 | 674 | 27 | 571 | 1 | 16 | 8 | 51 |
| 2018 | 748 | 37 | 622 | 1 | 33 | 8 | 47 |
| 2019 | 793 | 38 | 675 | 1 | 38 | 3 | 38 |
| Total | 2215 | 102 | 1868 | 3 | 87 | 19 | 136 |
| % | | 4.6 | 84.3 | 0.1 | 3.9 | 0.8 | 6.1 |

ETG+, positive to Ethyl-glucuronide (>30 pg/mg); COCA-, negative to Cocaine; ETG-, negative to Ethyl-glucuronide (<30 pg/mg); COCA+, positive to Cocaine; CE+, positive to Cocaethylene; CE-, negative to Cocaethylene.

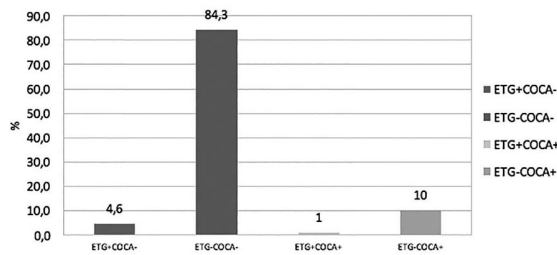


Figure 1
Percentages of positive and negative samples to alcohol and cocaine

ETG+, positive to Ethyl-glucuronide (>30 pg/mg); ETG-, negative to Ethyl-glucuronide (<30 pg/mg); COCA+, positive to cocaine; COCA-, negative to cocaine.

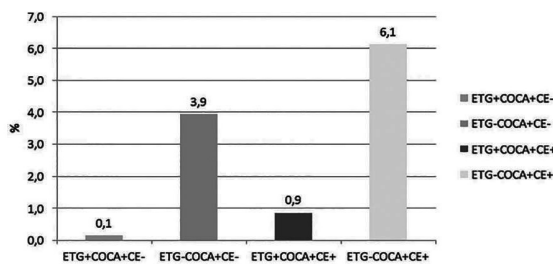


Figure 2
Percentages of positive and negative samples to Cocaethylene

ETG+, Ethyl-glucuronide >30 pg/mg; ETG-, Ethyl-glucuronide <30 pg/mg; COCA+, positive to cocaine; COCA-, negative to cocaine; CE+, positive to cocaethylene; CE-, negative to cocaethylene.

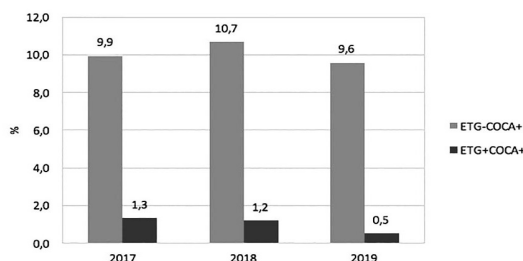


Figure 3
Summary of the cocaine positive samples during the years

ETG+, Ethyl-glucuronide >30 pg/mg; ETG-, Ethyl-glucuronide <30 pg/mg; COCA+, positive to cocaine; COCA-, negative to cocaine.

commonly applied). Therefore, a time-selecting filter can be set with the investigation of a hair specimen of a certain length, which defines the monitoring time frame, according to the purpose of forensic investigation.

Hair analysis is widely accepted and applied in different fields (i.e drug fatalities, workplace drug testing, drug-facilitated crimes). The main goal of these applications is the long-term monitoring of misuse of drugs, pharmaceuticals and alcohol or the documentation of the subject's abstinence (30).

A particular picture emerged from our study, illustrating how in the population of subjects monitored by the Legal Medical Commissions from year 2017 to 2019 for driving under the influence of alcohol, as many as 11% are also cocaine users.

Moreover, the highest percentage of cocaine users can be found into the moderate drinker category with an ETG value <30 pg/mg; this result is rather important for the driving license regranting program.

The data obtained confirm that the toxicological screening in drunk subjects is mandatory in this category of subjects.

CONCLUSION

The present study proves that the increasing phenomenon of drug use should be taken into consideration in the population of drunk-drivers license regranting program.

Concurrent abuse of alcohol and cocaine represents a dangerous psycho-behavioral pattern, with a high frequency in the studied population. The absence of a toxicological analysis in hair could compromise the preventive efficacy of the regranting system itself.

The results of hair testing in large population groups could indicate that exposure to drugs or xenobiotics should be investigated in epidemiological studies (31) and reveal new trends in drug markets. Therefore, the objective of applying these forensic or clinical tests could be profitably used, as predicted by Baumgartner MR (30), to determine a positive impact in the behavior of drivers.

In the future, in order to identify the underlying patterns of substance use in drunk-drivers, assessment procedures could and should be improved, with the aim to maximize specificity and efficacy of prevention and treatment approaches.

A commission has been recently set up at the Italian Ministry of Health in collaboration with the main scientific societies in field. In December 2021 the document "Guidelines for the assessment of the eligibility to drive in subjects with the use/abuse of alcoholic beverages", has been issued (32); it provides on the matter that could be used presently by national institutions and translated into legal regulations in the future.

CONFLICT OF INTEREST

None.

REFERENCES

- Cateano R, Weisner C. The association between DSM-III-R alcohol dependence, psychological distress and drug use. *Addiction* 1995;90:351-9.
- Craddock S, Rounds-Bryant J, Flynn P, et al. Characteristics and pretreatment behaviors of clients entering drug abuse treatment: 1969 to 1993. *Am J Drug Alcohol Abuse* 1997;23:43-59.
- Brooner RK, King VL, Kidorf M, et al. Psychiatric and substance use comorbidity among treatment-seeking opioid abusers. *Arch Gen Psychiatry* 1997;54:71-80.
- Chutuape MA, Silverman K, Stitzer ML. Use of methadone take-home contingencies with persistent opiate and cocaine abusers. *J Subst Abuse Treat* 1999;16:23-30.
- Gossop M, Marsden J, Stewart D, et al. Substance use, health and social problems of clients at 54 drug treatment agencies: intake data from the National Treatment Outcome Research Study (NTORS). *Br J Psychiatry* 1998;173:166-71.
- M, Ferri. Primary prevention for alcohol misuse in young people: a Cochrane Systematic Review. *Ann Ist Super Sanita* 2004;40:47-53.
- Grant BF, Harford TC. Concurrent and simultaneous use of alcohol with cocaine: Results of national survey. *Drug Alcohol Depend* 1990;25:97-104.
- Sumnall HR, Wagstaff GF, Cole JC. Self-reported psychopathology in polydrug users. *Journal of Psychopharmacology* 2004;18:75-82.
- Mierzejewski P, Rogowski A, Stefanski R, et al. Ethanol-reinforced behaviour predicts acquisition but not extinction of cocaine self-administration in the rat. *Alcohol Alcohol* 2003;38:543-9.
- Pennings JM, Leccese AP, Wolff FA. Effect of concurrent use of alcohol and cocaine. *Addiction* 2002;97:773-83.
- Requisiti fisici e psichici per il conseguimento della patente di guida. *Nuovo Codice della Strada*. D.L. 30 aprile 1992, n.285. *Gazzetta Ufficiale* n.114 del 18-5-1992 - Suppl. Ordinario n. 74. Titolo IV: Guida dei veicoli e conduzione degli animali. https://www.gazzettaufficiale.it/dettaglio/codici/strada/104_0_1 (Last access: May 2022).
- Bortolotti F, Tagliaro F, Cittadini F, et al. Determination of CDT, a marker of chronic alcohol abuse, for driving license issuing: immunoassay versus capillary electrophoresis. *Forensic Sci Int* 2002;128:53-8.
- Appenzeller MRB, Schneider S, Yegles M, et al. Drugs and chronic alcohol abuse in drivers. *Forensic Sci Int* 2005;155:83-90.
- Kronstrand R, Brinkhagen L, Nystrom FH. Ethyl glucuronide in human hair after daily consumption of 16 or 32 g of ethanol for 3 months. *Forensic Sci* 2012;215:51-5.
- Maenhout TM, Baten G, De Buyzere ML, et al. Carbohydrate deficient transferrin in a driver's license regranting program. *Alcohol Alcohol* 2012;47:253-60.
- Nickel WR. Medical screening and medical-psychological assessment as prerequisites for re-granting of licenses: summary of recommendations. *Alcohol Alcohol* 1996;31:605-7.
- Jones AW, Holmgren A. What non-alcohol drugs are used by drinking drivers in Sweden? Toxicological results from ten years of forensic blood samples. *J Safety Res* 2012;43:151-6.
- SoHT. Consensus for the use of alcohol markers in hair for supporting the assessment of abstinence and chronic alcohol consumption. 2019. https://www.soht.org/images/pdf/Revision_2019_Alcoholmarkers.pdf (Last access: May 2022).
- SoHT. Consensus on drugs of abuse (DOA) testing in hair. 2021. https://www.soht.org/images/pdf/Consensus_DoA_2021.pdf (Last access: May 2022).
- Pichini S, Pacifici R. Linee guida per la determinazione delle sostanze d'abuso nella matrice pilifera. 2013. https://www.iss.it/droga/-/asser_publisher/CjKTPUEurcwM/content/-linee-guida-per-la-determinazione-delle-sostanze-dabuso-nella-matrice-pilifera (Last access: May 2022).
- Pichini S, Bucchioni P, Pellegrini M, et al. Procedure operative per la determinazione delle sostanze d'abuso su sangue. <https://www.iss.it/documents/20126/0/PROCEDURE-OPERATIVE%20sangue.pdf/7d0a5216-ded9-7e23-6609-1deed0df14e1?t=1576346208583> (Last access: May 2022).
- GTFI 2017 (Gruppo Tossicologi Forensi Italiani). Linee guida per le strutture dotate di laboratori per gli accertamenti di sostanze d'abuso con finalità tossicologico-forensi su campioni biologici prelevati da vivente. Revisione n. 5 del 29 maggio 2017 a cura della Commissione Qualità dell'Associazione Scientifica "Gruppo Tossicologi Forensi Italiani" (GTFI) https://www.gtfi.it/wp-content/uploads/2017/06/LG_biologico_revisione_2017_29_05.pdf (Last access: May 2022).
- Favretto D, Pichini S, Bucchioni P, et al. Consensus document of the Study Group on Clinical Pharmacotoxicology and Doping of Italian Society of Clinical Biochemistry and Italian Forensic Toxicologists Group (GTFI) – for laboratories involved in the determination of substances of abuse. *Biochim Clin* 2019;43:449-52.
- Bernhoft IM, Hels T, Lyckegaard A, et al. Prevalence and Risk of Injury in Europe by Driving with Alcohol, Illicit Drugs and Medicines. *Procedia Social and Behavioral Sciences* 2012;48:2907-16.
- Leporati M, Salvo RA, Pirro V, et al. Driving under the influence of alcohol. A 5-year overview in Piedmont, Italy. *J Forensic Legal Med* 2015;34:104-8.
- Jamt REG, Gjerde H, Normann PT, et al. Roadside survey on alcohol and drug use among drivers in the Arctic county of Finnmark (Norway). *Traffic Inj Prev* 2017;18:681-7.
- Kronstrand R, Nystrom I, Forsman M, et al. Hair analysis for drugs in driver's license regranting. A Swedish pilot study. *Forensic Sci Int* 2010;196:55-8.
- Tassoni G, Mirtella D, Zampi M, et al. Hair analysis in order to evaluate drug abuse in driver's license regranting procedures. *Forensic Sci Int* 2014;244:16-9.
- Wille SMR, Baumgartner MR, Di Fazio V, et al. Trends in drug testing in oral fluid and hair as alternative matrices. *Bioanalysis* 2014;6:2193-209.
- Baumgartner, MR. Single hair analysis. monitoring concept for P4 implementation. In: Ferrara, SD, ed. *P5 Medicine and Justice*. Berlin: Springer, 2017;500-11.
- Rust KY, Baumgartner MR, Dally AM, et al. Prevalence of new psychoactive substances: a retrospective study in hair. *Drug Test Anal* 2012;4:402-8.
- COMLAS. Documento linee di indirizzo sulla valutazione dell'idoneità alla guida in soggetti con uso/abuso di bevande alcoliche. 3 December 2021. <https://www.quotidianosanita.it/allegati/allegato3816299.pdf> (Last access: May 2022).