Drug-facilitated crimes. Evidence by hair analysis

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Introduction

In the last few years, considerable information about drug-facilitated crimes (rape, sexual assault, robbery, sedation of persons) has accumulated. In these situations, the victims are subjected to non-consensual acts while they are incapacitated through the effects of a drug. This impairs their ability to resist or to give consent to the act. In a typical scenario, a predator (rapist, robber) surreptitiously spikes a drink of an unsuspecting person with a hypnotic drug. Victims, both women and men, usually report loss of memory during and after the event. For the perpetrator, the ideal substance is one that is readily available, is easy to administer, rapidly impairs consciousness and causes anterograde amnesia (i.e. it prevents the recall of events that occurred whilst under the influence of the drug but not general memory). Due to the low dosage of most drugs involved (benzodiazepines, hypnotics, neuroleptics, anti-histamines), a surreptitious administration into beverages such as coffee, soft drinks (cola) or alcoholic cocktails is relatively simple (1).

Two review papers have been recently published, both on the clinical (2) and toxicological (3) aspects of drug-facilitated crimes. For all compounds involved in drug-facilitated crimes, the detection times in blood and urine depend mainly on the dose and sensitivity of the method used. Prohibiting immunoassays and using only hyphenated techniques, substances can be found in blood for 6 hours to 2 days and in urine for 12 hours to 5 days. Sampling blood or urine has little interest 48 hours after the offense occurred. To address a response to this important caveat, hair was suggested as a valuable specimen. Hair sampling is a useful complement to these analyses to increase the window of detection and to permit differentiation of a single exposure from chronic use of a drug by segmentation. Moreover, due to the long delays that are frequently encountered between the event and the matter being reported to the police, hair can often be the only matrix capable of providing corroborative evidence of a committed crime.

Analytical aspects

Hair is best collected from the area at the back of the head, called the vertex posterior. Hair locks are cut as close as possible to the scalp, and the orientation root-tip is noted. Storage is achieved at ambient temperature in an aluminum foil, an envelope or a plastic tube.

Our laboratory recommends waiting for 4-5 weeks after the offense and then collecting 4 locks of about 100 hairs. One lock will be used to test for drugs of abuse, one for GHB and another one for a screening of hypnotics and sedatives. The last lock is collected for a potential counter-analysis. Assuming normal hair growth rate (range from 0.7 to 1.4 cm/month with a mean of about 1 cm/month accepted by the scientific community), it is the opinion of the authors to cut the lock into 3 segments of 2 cm in order to document any drug-facilitated case. Administration of a single dose would be confirmed by the presence of the drug in the proximal segment (root) while not detected in the other segments. If the drug is detected in only one segment, this is good supporting evidence for the occurrence of a drug-facilitated crime. If the drug is found in multiple segments, it may represent multiple doses over time. However, one cannot exclude a contribution of sweat and potential distribution along the hair shaft.

The analytical part (hair preparation, extraction, analysis by LC-MS/MS) has been extensively published during the past years by our laboratory (4-6). Key points of the analysis are summarized below. After decontamination of the hair, the lock is segmented and cut into small pieces. About 20 mg are incubated overnight in phosphate buffer (pH 7 8.4), in the presence of diazepam-d_5 used as internal standard (IS), and extracted by methylene chloride/diethylether (90/10, v/v). For separation, an XTerra MS C18 (3.5 µm, 100 x 2.1 mm i.d) was used. Detection was achieved by a tandem mass spectrometer equipped with an ionspray atmospheric pressure interface. For identification, 2 precursor ion/product ion transitions for each drug were used.

The limit of quantification for all benzodiazepines, sedatives and hypnotics range from 0.5 to 5 pg/mg using a 20-mg hair sample.

Case report 1

The white hair (3 cm) of a 81-year old woman in a nursing home was obtained after her daughter noticed marked somnolence. She was not under sedative treatment. Hair analysis revealed the presence of diphenhydramine (683 pg/mg) and doxylamine (152 pg/mg), two anti-histamine drugs with sedative properties. Police and health authority investigations demonstrated that her registered nurse admitted giving the drugs to sedate the woman and reduce her workload.

Case report 2

A 87-year old man living in an old people's home was found by his family with inconsistent behavior, including totally incoherent speech. A 6 cm white hair lock was submitted to segmental analysis (3 x 2 cm section). Promazine, a neuroleptic with sedative properties, was detected at 9, 2 and 6 pg/mg. There were no data in the literature on promazine hair concentrations. In particular, it was not possible to put any quantitative interpretation on the dosage

that was administered. It is however obvious that repetitive administrations have occurred but it is not possible to determine the number of exposures. Given the length of the man's hair and assuming a growth rate of 1 cm / month, exposure to promazine should have occurred at least during the previous 6 months.

Case report 3

A 39-year old woman, in trouble with her husband, felt sleepy for 24 hours after having consumed a coffee, at home. Blood sample, collected 20 hours after absorption, revealed the presence of 51 ng/mL of bromazepam, whereas hair sampled at the same time was bromazepam-free. An other strand of hair was collected 1 month after the event and the proximal 2 cm-long segment was positive for bromazepam at 10.3 pg/mg and the other segments (2-4 and 4-6 cm) remained negative. These results are consistent with a single exposure to this drug. The analysis of the residue in the cup of coffee (positive for bromazepam) and the husband's declaration did not challenge the biological conclusions.

Case report 4

A 21-year-old woman was hospitalized for gastric disorders. One night, she was offered by a male nurse a coffee that made her unconscious. When recovering she noticed an assault, but afraid of the consequences did not report immediately to the Police. This was done after she went back from the hospital, 6 days later. As blood or urine collection was without interest, we were requested to analyse the victim's hair, sampled 15 days after the alleged offense. Zolpidem was identified in the proximal segment (root to 2 cm) at 4.4 pg/mg, while the distal segment (2 to 4.5 cm) remained negative.

Discussion

As it is the case with other applications (survey of addicts, doping control, driving license regranting...) hair testing is a valuable approach to increase the window of drug detection. Embarrassment associated with urine collection, particularly after sexual assault, can be greatly mitigated through hair analysis. It is always possible to obtain a fresh, identical hair sample if there is any trouble during analysis, claim of specimen mix-up or breach in the chain of custody. In contrast to blood or urine specimens, it is possible to collect on a later date a similar hair specimen, assuming that there has not been bleaching, straightening or shaving of the hair. The discrimination between a single exposure and long-term use can be theoretically documented by multi sections analysis. With the concept of absence of migration along the hair shaft, a single spot of exposure must be present in the segment corresponding to the period of the alleged event, using a growth rate for hair of 1 cm/month. As this growth rate can vary from 0.7 to 1.4 cm/month, the length of the hair section must be calculated

accordingly. The hair must be cut as close as possible to the scalp. Particular care is also required to ensure that the individual's hair in the lock retains the position it originally had beside one another.

To the best of our knowledge, there is no data in the literature on external contamination of hair by sedatives, irrespective of their galenic forms. Limitations of hair testing in drug-facilitated cases are common with all the described applications of this technology, including differences in hair growth rate, influence of cosmetic treatments or even normal hygienic practices, incorporation rates, color bias ...

The unique possibility to demonstrate a single drug exposure through hair analysis has some additional interests. In case of late crime declaration, positive hair findings are of paramount importance for a victim, in order to start under suitable conditions a psychological follow-up. It can also help in the discrimination of false report of assault, for example in case of revenge. These cases are often sensitive with little other forensic evidence. Tedious interpretations, in case of concomitant intake of hypnotics as a therapy for sleeping disorders, are avoided when investigations are done using hair in addition to urine.

Conclusion

It appears that the value of hair analysis for the identification of drug-facilitated crimes is steadily gaining recognition. The major practical advantage of hair testing compared to urine or blood testing for drugs is that it has a larger surveillance window (weeks to months, depending on the length of the hair shaft, against 2-4 days). For practical purposes, the two tests complement each other. Blood or urine would still remain the matrices of choice if they can be obtained within a suitable time frame. Urinalysis and blood analysis provide short-term information of an individual's drug exposure and thus can provide a more accurate reflection of the situation present within the body at the relevant time. However, long-term histories are accessible through hair analysis and thus can be useful where the window of opportunity for blood or urine has passed or where a drug has been detected in a body fluid and investigation of previous drug using history may be of value.

Hair analysis may be especially useful when a history of drug use is difficult or impossible to obtain, notably when an elder person is poisoned and the defence is one of the subject accidentally gaining access to the drug on a single occasion. The discrimination between a single exposure and long-term use can be documented by multi-sectional analysis.

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