Cocaine and its metabolites in surface and waste water in Belgium

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Cocaine (COC) is an addictive substance that is used as a 'drug of abuse'. The use of cocaine has an immediate physiological impact, such as a stimulation of the central nervous system and modified serotonine levels. In the long term an increased lifelong risk of heart attacks, lung complications and other risks exists. The recreational use of cocaine has strongly increased in the last 25 years as a result of a higher availability. Until now the research on drug abuse is based on population inquiries, interview with users, medical reports and crime statistics. These general indicators do not always give an objective estimation of the real local use. In the human body only a small part (~ 10 %) of the cocaine is excreted in the urine as the parent compound, whereas the largest part (~ 45 %) is eliminated as benzoylecgonine (BE), the most important metabolite, which can also be used as proof of cocaine use. A new, more direct and objective approach for cocaine use has been based on the measurements of cocaine and metabolites (e.g. BE) in waste and surface water.

The COWAT project aims at measuring cocaine and its metabolites in a number of selected waste and surface waters to estimate the use of cocaine in Belgium. Samples were taken in 28 water courses and in the influent of 41 important waste water treatment plants (WWTPs). The selection of sampling sites in water courses was based on the presence of flow meters, for further calculation of the total amount of cocaïne or BE. They are mainly present at the end of a densely populated catchment, or upstream and downstream of important agglomerations in Belgium. For the WWTPs the 41 largest installations (> 10 000 inhabitants) were selected to sample wastewater originating from a large part of the Belgian population. Two sampling techniques were applied for the water courses. The traditional grab sampling, which is only momentaneous, was compared with a procedure of passive sampling, which can measure the incorporated contamination over a period of some weeks. WWTPs samples were taken with an automatic sampling device, which makes it possible to calculate loads for certain compounds. The sampling included 41 WWTPs and 43 surface water sites spread all over Belgium. Because the stability of cocaine is dependent on the temperature, sampling was done in two seasons, the summer and autumn of 2007 and the winter of 2007-2008, to detect possible differences. They were also taken on Sunday and Wednesday, the days with the largest differences in concentration. The choice of passive samplers was based on the experiments for the optimization of the analysis procedure. It was obvious that the type POCIS (Polar Organic Chemical Integrative Passive Sampler), which exists of 2 microporous membranes filled with Oasis HLB® as sorbent, gave the best results. They were exposed in the water for 3 weeks at 8 sites, selected on the results from the first campaign.

An important objective of the COWAT project was the optimization and validation of the analytical procedure, with emphasis on the suitability of solid-phase extraction for sample preparation and of liquid chromatography and tandem mass spectrometry (LC/MS-MS) for the analysis. Samples were analyzed both at the University of Antwerp and at the University of Liège. Preliminary experiments showed that COC and BE were the most useful compounds for the aims of this study. Other metabolites of cocaine, namely ecgonine methylester and ecgonine, were also examined. COC and BE remained the most stable in the freezer at pH 2 and thus samples were preserved under these conditions. There was no adsorption of COC or BE to the fixed particles observed thus the effluent could be filtered before analysis. Several sorbents were tested for the optimization of the solid phase extraction, where Oasis HLB® gave the best results. COC and BE were separated with liquid chromatography, whereupon the detection was performed with tandem mass spectrometry. Detailed analytical interlaboratory validation was performed both during the first and the second campaign to evaluate variation in the analytical procedures. Of the 20 samples analyzed in both laboratories only 1 sample exceeded the acceptable relative standard deviation of 20%.

A geographical estimate of the local cocaine use was based on the one hand on concentrations of cocaine and BE in the water and on the other hand on data concerning pharmacokinetics, metabolism and environmental destination. The model took into account (a) the metabolisation of cocaine to benzoylecgonine, which was reported as 45% in the literature, (b) the flow measured during the day of sampling, (c) the number of people which is served by the WWTP, and (d) the age partitioning of the local population. For water courses only the quantity of cocaine that passes the sampling site during a day was calculated. It was clear that the quantity of cocaine strongly fluctuated between the sampling days. This was probably due to the sampling technique. In low populated areas, such as the southern part of Belgium, no traces of COC and BE were observed in the water courses. This was probably caused by the low population density. In the Zenne, Dijle and Demer, however, a clear trend of COC and BE input was observed going downstream. The results of this study were comparable to those found in other, smaller studies in the European Union. From the analyses of the passive sampling no conclusions could be drawn to COC or BE quantities in the water. Until now this technique can be applied only for qualitative aims, but in the long term it has the potential to give a precise picture of contaminants in the water course.

COC and BE was measurable in the influents of all sampled WWTPs. Using the results of the analyses and additional information it was possible to make an estimate of the quantity of cocaine (in g/day) used by 1000 inhabitants for the examined regions. As expected the highest concentrations were measured in the larger cities such as Antwerp, Brussels and Charleroi and especially over the weekend. The results were similar to those of other studies in Italy, Spain and the United Kingdom. In the cities of medium size the quantities found were slightly higher in comparison with similar cities from the Italian study. In Antwerp we found the highest value ever measured (1,8 g/day per 1000 inhabitants). In total an average of approximately 3,7 million inhabitants were sampled during each campaign. These results were extrapolated to the total Belgian population and the several regions. The cocaine abuse for people between 15 and 45 years old was also calculated. According to the applied model an average of 1,41 g per day is consumed per 1000 inhabitants between 15 and 45 year over the weekend, and 1,03 g per day during the week. This brings us to a total of 1,75 tons used in Belgium during the year of research. From the three regions in Belgium, the Brussels capital district showed a usage of 1,83 g per 1000 inhabitants between 15 and 45 year on a day over the weekend and 1,29 g per day during the week. Two WWTPs, namely Brussel-Noord and Deurne, were followed on a daily basis during a week. A clear trend was observed where the usage was highest over the weekend. From 7 WWTPs additional to the influent, effluent samples were taken. Only at one WWTP traces of cocaine were found in the effluent. Also in other studies COC and BE were mainly purified from the effluent. Other drugs are not removed as efficiently and can therefore be a problem. We measured quite high concentrations of COC and BE in surface water, which may have ecotoxicological implications.

It is clear that one can get a precise picture of the drug consumption within a geographical region with the methodology that was used. It is possible to indicate regions with high consumption or to observe possible increases rapidly (within several days). This can form a basis for additional sociological and epidemiological studies or evaluation of prevention campaigns. With this information policy makers and organizations can get more support at indicating problem regions and setting priorities for a good drug policy.