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Investigating the correlation between wastewater analysis and roadside drug testing in South Australia

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ABSTRACT

Background: The societal impact of drug use is well known. An example is when drug-intoxicated drivers increase the burden on policing and healthcare services.
Methods: This work presents the correlation of wastewater analysis (using UHPLC–MS/MS) and positive roadside drug testing results for methamphetamine, 3,4-methylenedioxymethamphetamine (MDMA) and cannabis from December 2011–December 2016 in South Australia.
Results: Methamphetamine and MDMA showed similar trends between the data sources with matching increases and decreases, respectively. Cannabis was relatively steady based on wastewater analysis, but the roadside drug testing data started to diverge in the final part of the measurement period.
Conclusions: The ability to triangulate data as shown here validates both wastewater analysis and roadside drug testing. This suggests that changes in overall population drug use revealed by WWA is consistent and proportional with changes in drug-driving behaviours. The results show that, at higher levels of drug use as measured by wastewater analysis, there is an increase in drug driving in the community and therefore more strain on health services and police.

1. Introduction

Wastewater analysis (WWA) has become a standard means of assessing population-scale use of illicit drugs and other substances of interest (European Monitoring Centre for Drugs and Drug Addiction, 2016). In Australia, the approach has been applied to estimate drug use in several regions over a period of six years (Irvine et al., 2011; Lai et al., 2013, 2011; Tscharke et al., 2016) and, more recently, has been applied nationally (Australian Criminal Intelligence Commission, 2017). Although WWA can reflect the relative scale of drug use in a community, it cannot distinguish between heavy use by a small number of habitual users from occasional use by a large number of drug takers. Consequently, if the scale of drug use changes over time in an area, as measured by WWA, it is not possible to determine whether the change is due to a shift in users in the community, a change in frequency of use, or changes in the purity of available drugs or the amount of pure drug consumed.

Increases in the use of an illicit drug in a population are associated with a number of adverse consequences. In general, the precise consequences depend on the nature of the drug but may include increased harm and increased criminality associated with intoxicated behaviour (Walters, 2014). One consequence that is associated with use of all illicit drugs is impairment of driving. For a range of drugs, there are a number of epidemiological and experimental studies showing driving impairment as a result of use of the drugs at the doses normally consumed, and the epidemiological evidence shows that this impairment results in an increase of both fatal and non-fatal crashes (Elvik, 2013).

Based on this evidence, roadside driver testing (RDT) for a limited range of drugs has been implemented in a number of countries, including Australia. After the compulsory oral swab tests are conducted, confirmatory analyses in a forensic laboratory are performed on oral fluid to establish whether or not the driver had consumed drugs and was driving under the influence. In Australia, tests are only carried out for methamphetamine, MDMA and cannabis (alongside alcohol).

If drug use increases in a population, and particularly if that increase in total use is due in part to an increase in number of users, then

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Table 1
Annual comparison of number of positive RDT detections for each drug and drug combination from 2010/11–2014/15.

Year	Screened	THC[a]	Meth[b]	MDMA	Meth[b]/THC[a]	Meth[b]/MDMA	THC[a]/MDMA	All	Total
2010/11	43838	605	636	0	469	2	0	1	1713
2011/12	42312	527	1286	21	841	45	18	40	2778
2012/13	50409	619	1541	25	959	66	21	31	3262
2013/14	49865	969	1868	22	1131	41	22	29	4082
2014/15	52939	1123	2499	13	1177	48	8	23	4891

Meth/THC, Meth/MDMA, THC/MDMA and All indicate the situations where the drugs were simultaneously detected.
[a] THC = cannabis.
[b] Meth = methamphetamine.

this may be reflected in the rate of positive detections in RDT for that drug. It would therefore be expected that for each drug, rates of use measured by WWA would correlate with RDT detections. However, a limitation of RDT is that targeted policing captures drug ‘hotspots’, creating the risk of sampling bias, although the number of drug tests and sites covered over a year provides a sample that is close to random. In Finland, driving under the influence of drugs and drug seizure information was compared to results from WWA from 2008 to 2015, and there were relatively good correlations for the drugs investigated (Kankaanpää et al., 2016). In Norway, methamphetamine and amphetamine use were compared across drug seizures, RDT, WWA, forensic autopsies, and urine from prisoners with similar trends observed in all data sources (Bramness et al., 2015).

Currently, there is limited data showing positive correlations between driver test positive numbers and WWA trends (Bramness et al., 2015; Kankaanpää et al., 2016, 2014; Reid et al., 2012). These included a significantly lower number of tests compared to the present study and were limited to comparisons between data of different time scales; one or two-week periods of WWA were compared to the overall positive-test rate in each year. This paper, to the best of the authors’ knowledge, is the first to investigate the potential complementarity of WWA and RDT outside Europe. The correlation between the temporal trends for these two measures of drug use was evaluated for methamphetamine, cannabis, and MDMA in bimonthly sampling from December 2011 − December 2016.

2. Materials and methods

2.1. Wastewater analyses

Wastewater samples from four wastewater treatment plants in Adelaide, Australia were collected and analysed for methamphetamine, MDMA, and cannabis. Seven consecutive days of wastewater samples were collected every two months during the first week of the month (or the second week to avoid public holidays) from December 2011 to December 2016. All information regarding sample preparation and analysis is described elsewhere (Irvine et al., 2011; Tscharke et al., 2016).

2.2. Roadside drug testing

The manner of roadside drug testing is similar to that of roadside testing for alcohol, and the two can be conducted simultaneously. A police road block is set up on arterial roads with cars randomly selected for testing. After the initial presumptive roadside test, all oral swabs are sent to the laboratory for confirmatory testing regardless of the result. Confirmed positive tests are recorded for the month of the oral screening. The specific sites of police testing and the reasons for site selection were not divulged. Overall, the roadside drug testing results covered the same Adelaide metropolitan area as the four wastewater catchments under study. These data were provided by South Australia Police and did not require ethical approval. Tests covering the same month as the WW collections were selected to capture the same populations. To compare proportional change between datasets, the WWA and confirmatory RDT measures were converted to percentage change from the initial period. WWA data are weekly totals, while RDT are monthly totals. Offenders caught with RDT were not necessarily excreting drug residues in the catchment areas under investigation.

3. Results and discussion

3.1. Results of wastewater analysis

Bimonthly analysis of four wastewater treatment plants of Adelaide has been carried out since 2011. In the period up to the end of 2016 clear trends have been observed: methamphetamine use has increased significantly, MDMA has steadily declined, and cannabis has remained relatively stable, albeit with seasonal fluctuations each year coinciding with the growing/harvesting seasons (Tscharke et al., 2016).

3.2. Roadside drug testing

All data pertaining to the roadside drug tests are presented in Table S1. The number of RDTs carried out between December 2011 − December 2016 has been relatively constant with an average of 4000/month. In terms of the positive detections, methamphetamine is by far the most commonly detected drug, almost double that of cannabis, while there are much lower detections for MDMA. When looking at the percentage change over the months analysed, methamphetamine increased, cannabis showed similar fluctuations to WWA, and MDMA decreased. Considering that the number of monthly tests remained largely constant, the increase in methamphetamine and cannabis detections would appear to suggest increasing numbers of people using these drugs.

Some individuals tested positive for more than one drug, with annual data (from 2010/11–2014/15) shown in Table 1. Although it was most common for users to be found with one drug in their system as shown in Table S1, the combination of methamphetamine and cannabis seemed to be on the increase, while co-consumption with MDMA was less common.

3.3. Comparison between WWA and RDT

To make for a more coherent and direct comparison between WWA and RDT, only the months that coincided with WWA were included in this section. The comparison between all RDT data and WWA is presented in Fig. S1. Since RDT and WWA data were expressed in different units, both were transformed to the units of percentage change from the initial reading to compare the datasets (mass loads per week per 1000 people for WWA and percentage test-positive rate for RDT). This maintained the scale of change between months within each dataset while also allowing a direct comparison of proportional changes between datasets. The trends for methamphetamine, MDMA, and cannabis use via WWA and the percentage test positive rate via RDT are shown in Fig. 1. Spearman’s Rank Correlation analysis was performed using Microsoft Excel to determine the statistical significance of the