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Research paper

Drug analysis of residual content of used syringes: A new approach for improving knowledge of injected drugs and drug user practices

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ABSTRACT

Background: Since their inception, harm reduction services, including needle exchange programs, have aimed to improve and update knowledge about illicit drug consumption and injection practices in order to assess and regularly revise the effectiveness of preventive strategies.
Methods: In this paper we describe the development of a scientific approach to obtaining this type of information through analysis of the residual content of used syringes. This was done using a validated liquid chromatography method with mass spectrometry detection to identify different molecules. Used syringes were collected from automatic injection kit dispensers at 17 sites in Paris and the surrounding suburbs each month for one year.
Results: In total, 3489 syringes were collected. No compounds were detected in 245 syringes. Heroin was the most commonly observed compound (42%), followed by cocaine (41%), buprenorphine (29%) and 4-methylethylcathinone (23%). These analyses also showed the increased appearance of 4-methylethylcathinone between the summer and winter of 2012.
Conclusions: Despite the bias involved in this approach, the method can provide rapid data on patterns of drug consumption for specific time periods and for well-defined locations. This kind of analysis enables the detection of new substances being injected and thus enables harm reduction services to revise and adapt prevention strategies.

Introduction

Drug use is associated with numerous social and health risks. Microbiological cross-contamination risk through specific injection practices, for example, can facilitate the transmission of HIV, hepatitis B and C viruses, and bacteria and fungi inducing abscesses, endocarditis, septicemia, fungal ophthalmic mycosis (Kim, Juzych, & Eliott, 2002), tetanus (Hahné et al., 2006), botulism (Barry et al., 2009) and anthrax (Ringertz et al., 2000). Harm reduction programs have been established in many countries to reduce such health risks (Des Jarlais, 1998).

The first needle exchange programs (NEP) were opened in 1984 in The Netherlands to reduce the need for sharing and reuse of syringes by injection drug users (IDUs). By 1990, NEP were established in 15 European countries, including in France (Hedrich, Pirona, & Wiessing, 2008). Since that time, predominantly voluntary sector organisations have tried to improve their knowledge of injection practices in order to assess the effectiveness of their preventive strategies.

Evaluations of harm reduction programs mainly rely on self-reported data from program participants and this introduces an immediate bias. Many IDUs have never been in contact with support or treatment services and are considered to be a 'hidden' population (National Research Council, 2006). Methodological difficulties associated with evaluation studies include: differences between studies in the variables of interest, differences in the reporting periods for risk behaviours, operational definitions (e.g. "needle reuse"), but also the validity and reliability of data collection tools (Ksobiech, 2004) and the length of time it takes for such findings to be processed and published. These methodological problems limit the usefulness and representativeness of findings.

Likewise, it is difficult to gather up-to-date information on the qualitative composition of injected drugs in order to adapt or refine prevention recommendations for IDUs. Various substances can be

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injected: drugs bought on the illicit market, therapeutic compounds such as opiate substitutes provided with a prescription, or new psychoactive drugs purchased mainly from the Internet. In 2012, for example, more than 50 new molecules were synthesised and sold on the market (UNODC, 2013). A significant portion of these products contained insoluble compounds or unknown cutting agents that can lead to serious intravascular administration problems.

This ever-changing situation means that those working in harm reduction and prevention services need to be able to respond quickly to changes in IDU practices. This can be difficult and even targeted population surveys are unable to provide the relevant consumption information in the necessary timeframe.

The French "SAFE" association manages the biggest NEP in France through the installation and maintenance of street-based automatic injection kit dispensers (AIKD) which deliver injection kits and receive used syringes. In 2013, 185,000 of these kits were distributed from 33 AIKD in Paris and 83 in its suburbs. The AIKD deliver new kits 24 h a day, seven days a week. IDUs get a kit in return for a token, which they receive when they dispose of their used syringes in a special trash bin. Pharmacy or harm reduction services also provide tokens. The activity level of these units has risen by 8% per year since 2001. To optimise effect, the SAFE association needs up-to-date information to inform the geographic distribution of AIKD, to provide the necessary 'tools' to reduce microbial infections (e.g. filters and needles) and to give targeted prevention advice to IDUs.

We argue that a scientific approach to obtaining these data is to analyse the residual content of used syringes collected via the AIKD. This can provide more accurate and geographically sensitive information about drug compounds being used by IDUs as well as an opportunity to assess the extent of wear and tear of returned injecting equipment. In turn this information can help services to revise and refine their harm reduction advice.

Materials and methods

Sampling strategy

Seventeen AIKD were chosen from sites in Paris and its suburbs to reflect different types of location (e.g. proximity to harm reduction services, crowded area such as train stations, high- vs. low-income area, business and touristic districts).

The intention was to collect syringe samples once a month for a year from SAFE staff who managed the maintenance of AIKD. Due to logistical problems, however, this was not always possible. The number of samples collected per site is presented in Table 1.

In order to ensure the safety of SAFE staff and to avoid the degradation of compounds during storage, the syringes were collected with safety gloves in medical waste disposals boxes (MWD) that were kept cold (+4 °C) until analysis. If samples could not be prepared within 48 hours, the MWDs were kept frozen at −20 °C.

Chemicals and materials

In order to analyse for 23 different compounds, we obtained standard solutions of morphine (MOR), 6-monoacetylmorphine (6-MAM), heroin (HER), buprenorphine (BUP), methadone (MET), naltrexone (NALTREX), dextropropoxyphene (DEXTRO), fentanyl (FENT), cocaine (COC), benzoylecgonine (BZE), ecgonine methyl ester (EME), levamisole (LEV), amphetamine (AMP), 3,4-methylene-dioxy-N-methylamphetamine (MDMA), methylethylcathinone (4-MEC), methylphenidate (MePH), alprazolam (ALPRA), clonazepam (CLONA), diazepam (DIAZEP), flunitrazepam (FLUNI), zolpidem (ZOL), ketamine (KETA) and trihexyphenidyle (THP) from LGC Standards (Molsheim, France).

Table 1
Number of samples per site.

Sampling sites	Number of sampling	Number of syringes analysed
75 – Bastille	7	195
75 – Chevaleret	8	217
75 – Colonel Fabien	6	156
75 – Lyon Train Station	6	160
75 – Montparnasse Train Station	8	229
75 – Nord Train Station	11	510
75 – Bichat Hospital	5	148
75 – Les Halles	10	229
75 – RER Kennedy Subway Station	11	236
75 – St Lazare Train Station	8	194
75 – RER Javel Subway Station	9	207
77 – Melun – Marc Jacquet Hospital	8	199
78 – Mantes la Jolie – Train Station	6	148
92 – Colombes – Louis Mourier Hospital	6	163
93 – Saint Denis – de La Fontaine Hospital	7	195
93 – Aulnay-sous-Bois – Robert Ballanger Hospital	8	161
95 – Cergy – St Christophe	7	142
Total	131	3489

Methanol (MeOH) and acetonitrile (ACN) LC-MS Grade were purchased from Fisher Scientific (Illkirch, France), formic acid (FA) (Normapur) and ammonium formate (AF) (Normapur) from VWR (Fontenay-sous-Bois, France) and bleach from Paredes (Goussainville, France). Ultra-pure water was produced using successive Milli-RO reverse-osmosis filtration and Milli-Q Plus water purification (Milli-Q Direct 8, Millipore SAS, Molsheim, France).

New disposable syringes 1 mL Omnifix® and needles 0.80 × 40 mm, 21G × 1.5 Sterican® were purchased from BRAUN (ROTH, Lauterbourg, France), and wheel filters (PTFE, 15 mm, 0.45 μm) Phenex from PHENOMENEX (Le Pecq, France). 1.5 mL vials with Silicone/PTFE caps were purchased from VWR (Strasbourg, France).

Analyses were carried out on a ThermoFisher UPLC-MS/MS system (Accela pump, Accela autosampler, Quantum Access Max mass spectrometer, Xcalibur software from ThermoFisher Scientific, Courtaboeuf, France) equipped with an Acquity UPLC® BEH Phenyl column (1.7 μm, 2.1 × 100 mm).

Sample preparation

The syringe preparation consisted of an inside rinsing out with MeOH: 1 mL of MeOH was pumped with the used syringe to dilute the compounds and thrown back in a clean test tube. The recovered methanolic solution was then filtered before UPLC-MS/MS analysis (Fig. 1).

Analytical method

Chromatographic separation was performed at 40 °C with a mobile phase composed of A: AF buffer, 5 mM, pH 4 and B: ACN, eluted at a flow rate of 0.4 mL/min with the following gradient program: 0–1 min, 98% solvent A; 1–7 min, decrease to 2% solvent A; 7–10 min, 2% solvent A; 10–12 min increase to 98% solvent A; 12–13.2 min, 98% solvent A.

Mass spectrometry was carried out in positive and negative electrospray ionisation (ESI) mode with the following conditions: capillary/spray voltage: 3 kV (ESI+) and −2.5 kV (ESI−); source and capillary temperatures: 300 °C; desolvation/vaporizer temperature: 300 °C and desolvation gas flow rate: 20 L/h.

Qualitative analyses were conducted in the selected multiple reaction (SMR) monitoring mode according to European requirement 2002/657/CE, with two transitions for each compound.