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New psychoactive substances: catalysing a shift in forensic science practice?

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The analysis of substances of abuse remains one of the most matured areas in forensic science with a strong scientific basis, namely analytical chemistry. The current evolving drug markets, characterized by the global emergence of new psychoactive substances (NPS) and the need for forensic scientists to identify an unprecedented and ever-increasing number of NPS, presents a unique challenge to this discipline. This article looks at the current situation with NPS at the global level, and the challenges posed to the otherwise technically robust forensic science discipline of analysis of substances of abuse. It discusses the preparedness of forensic science to deal with the current situation and identifies the need for a shift in forensic science practice, especially one which embraces research and looks beyond normal casework in order to provide the much needed data for developing effective policy responses to the NPS problem.

1. Introduction

Five years ago, the National Academy of Sciences (NAS) report on the state of forensic science in the USA, titled Strengthening Forensic Science in the USA: A Path Forward [1], stimulated discussions beyond the intended national scenario. While raising concerns about the underlying science for some forensic disciplines, the report recognized the strong scientific basis of the fields of analysis of controlled drugs, both in seizures and in biological fluids (forensic toxicology). With most analytical methods evolving from classical analytical chemistry, the reliability of forensic science in the analysis of controlled substances is widely acknowledged. The finding of the NAS in this regard was a good reflection of the state of the science in a global context.

The well-founded basis of the analysis of drugs has meant that the data derived from such analysis have served as a strong evidence base for trend analysis, and as a corollary, a valuable input into policy decisions in drug control. The robustness of forensic science particularly in the analysis of drugs has helped in answering key drug control policy questions such as on: purity of products, route of manufacture, alternative manufacturing routes, use of pre-precursors and the effectiveness of precursor control measures; impurity profiles, the role of cutting agents, market dynamics and an understanding of the flow of controlled substances from source to user markets. Most significantly, the robustness of the underlying science has meant that forensic work in this field has, by default and when practised to recognized international standards, impacted positively on accurate analysis of drug markets and fed into evidence-based policy decisions.

The analysis of drugs is, and will probably remain, one of the most robust forensic science disciplines. However, the nature of the global drug markets over the past half-decade, particularly with regard to new psychoactive substances (NPS), presents an unexpected challenge to this field.

2. The challenge of new psychoactive substances

In recent years, the number and diversity of NPS with potentially serious risks to public health has continued to increase. The first comprehensive United

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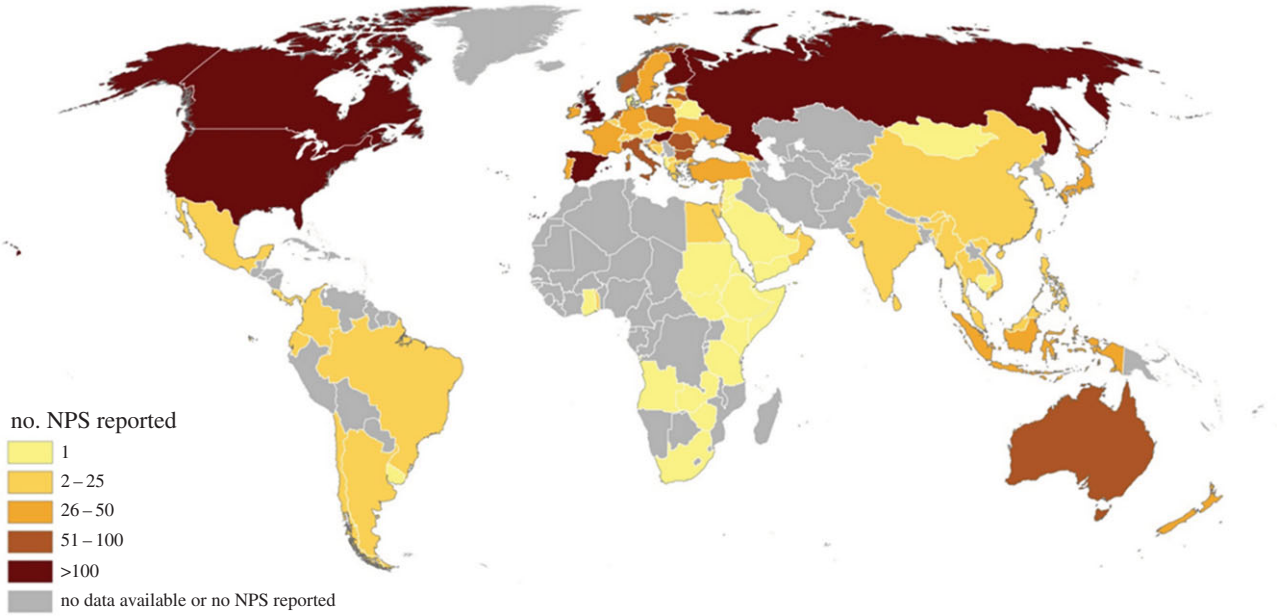

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Dashed lines represent undetermined boundaries. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. The final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

Figure 1. Illustration of the number of individual NPS reported to the United Nations Office on Drugs and Crime by Member States and territories over the period 2008 to October 2014. (Online version in colour.)

Nations Office on Drugs and Crime (UNODC) report on NPS, titled 'The Challenge of New Psychoactive Substances', provided for the first time global data on the emergence of these substances, identifying 251 NPS (up to July 2012) in a total of 70 countries and territories [2].

In 2013, the UNODC established an Early Warning Advisory (EWA) to monitor the emergence of NPS, analyse the markets trends associated with these substances, tailor support to drug analysis laboratories and support the formulation of effective measures to mitigate this problem at the international level. Figure 1 shows the number of NPS reported by Member States over the period 2008–2014 to the UNODC EWA. By October 2014, over 388 NPS had been reported by a total of 98 countries and territories (figure 1). Disaggregation of the substances reported by country indicates substantial heterogeneity in the NPS problem, both in terms of the numbers of substances reported and the nature of these substances. In addition, only a handful of countries report the emergence of most of the NPS encountered worldwide. Anecdotal data suggest that a number of countries that have not reported the emergence of NPS officially may indeed have these substances on their markets. The failure or inability to report is subsequently attributed in part to the inability of their forensic laboratories to identify such substances, and to the absence of a legislative framework that supports law enforcement seizures of NPS.

The challenges presented by the unanticipated phenomenon of NPS to the forensic science community include: the number and diversity of substances; the geographical heterogeneity of the emergence of these substances; the transient and often short-lived nature of some substances on the drug markets; and the evolution of sequences of closely related substances which are often manufactured to circumvent control measures.

Practical considerations for forensic science, such the availability of reference standards and validated methods of analysis, have at best not matched the rapid increase in the number of NPS reported by laboratories over the same period. Reference standards for NPS have been characterized more by their unavailability due to the inability of commercial suppliers to keep pace with the rapid emergence, or the exorbitant costs in cases where they are available. As a consequence of the latter, programmes such as the UNODC international quality assurance programme for drug testing laboratories have been able to support laboratories with only limited quantities of the most commonly found NPS worldwide, such as mephedrone and benzylpiperazine. Forensic science faces the prospect of having to find reliable options for unambiguous identification of substances, without comparison to authentic standards, examples of which include comparisons with reference spectra or interpretation of spectra from non-traditional methods such as nuclear magnetic resonance spectroscopy.

While techniques and methods for the identification and analysis of traditional substances of abuse such as heroin and cocaine are readily available, the forensic community faces a challenge in gaining access to methods for the analysis of NPS. The UNODC Scientific and Forensic programme has supported the community with recommended methods of analysis of the synthetic cannabinoid receptor agonists [3] and the piperazines [4], while bodies such as SWGDRUG have made very important strides in providing the community with spectra of the substances to aid in their identification. There remains, however, the need for a huge body of research to allow the forensic community to acquire the necessary tools for the identification of the chemically diverse NPS.

3. Forensic science and research

Beyond the routine contributions to solving forensic casework, the discipline of analysis of drugs provides data and

information which enriches trend analysis, and contributes to a better understanding of the drug situation and to more effective policy decisions. For example, forensic data provide insight into the route of synthesis of drug substances, effectiveness of precursor control measures and price–purity analysis, and thus enable a better understanding of the dynamics of drug markets. With regard to the emergence of new substances, forensic data are important in identification to facilitate effective law enforcement and health interventions for the problem. Research on the new substances subsequently plays a pivotal role in raising awareness of and providing the basis for development of methods and tools for identifying NPS.

In its report of 2009, the NAS recognized the need for research as a key element to promoting rigour and quality in forensic science. However, forensic science practice in general, including the area of analysis of drugs, is globally plagued by a number of issues, such as the perennial backlog of case work worldwide, inadequate infrastructure of laboratories in a number of regions; lack of a research culture; financial and human resource limitations; and availability of chemical reference material. Notwithstanding these challenges, the discipline of drug analysis faces a definitive challenge in handling NPS, which would be best served through research, directly or otherwise, to increase the preparedness of laboratories to deal with the issue. While the NAS report recognized the importance of research in forensic science, it is unfortunate that the percentage of publicly funded forensic crime laboratories in the USA with resources dedicated to research fell from 12% in 2002 to 7% in 2009 [5]. This is not an isolated situation as many laboratories in less-developed economies are even less likely to devote scarce human and financial resources towards research. The aforementioned challenges to increasing research in forensic science are unlikely to be addressed in the short term. However, practical ways such as facilitating the dissemination of the research findings from the few institutions involved in such activity and promoting participation in international collaborative exercises (ICE) need to be encouraged.

4. New psychoactive substances and the preparedness of laboratories

In a recent survey [6] on the impact of UNODC technical assistance to drug testing laboratories, respondents (157 institutions in 48 countries) identified specific challenges in the analysis of NPS. These included difficulties in acquiring NPS reference standards, and in determining which reference materials are required to enable the identification of unknown NPS, as reported by 70% of respondents. About 40% of respondents faced challenges due to a lack of expertise in the identification of NPS particularly in the interpretation of mass spectral fragmentation patterns, while 32% of respondents reported that they did not have access to validated analytical methods for a wide range of NPS.

That the robustness of the science underlying the analysis of drugs allows it to respond to the aforementioned challenges when the necessary tools, such as reference standards and well-validated methods, are available is illustrated by recent results from the UNODC ICE for drug testing laboratories. These exercises aim to assist drug analysis laboratories worldwide in assessing their own performance and taking corrective actions, when appropriate. The programme currently supports over 180 laboratories in 60 countries. In two successive rounds of the exercises in 2013 and 2014, participants were presented with test samples containing the NPS *m*CPP (1-(3-chlorophenyl)piperazine), after they had received the relevant recommended methods of analysis of substituted piperazines and a panel of reference standards including *m*CPP. Ninety-four per cent of participants (121 out of 131 laboratories) correctly identified the *m*CPP in the test sample in the 2013 round [7]. For laboratories who performed quantitation, 76% (29 out of 37 laboratories) obtained acceptable *z*-scores (a statistical parameter used to measure accuracy of quantitation) with an average score of 1.98. When *m*CPP was used as a test sample in the subsequent round of ICE in 2014 [8], 93% (141 out of 151 laboratories) correctly identified the substance with 96% (46 out of 48 laboratories) of those who carried out quantitation obtaining acceptable *z*-scores with an improved average score of 0.94.

The positive outcome illustrates the ability of the discipline of analysis of drugs, with its strong underlying science of analytical chemistry, to respond appropriately to the NPS challenge when the necessary tools such as well-validated methods and reference standards are available. Unfortunately, with the diversity and increasing number of NPS, it is impractical to provide methods of analysis for all candidate substances and ensure preparedness of laboratories only through collaborative exercises, such as the UNODC ICE.

5. The way forward

The number and diversity of NPS continue to increase, and there are no signs of this slowing down in the immediate future. Legislative measures put in place by some governments, such as generic measures of control, have meant that the discipline of analysis of drugs faces an exponential growth in the number of controlled substances and a dilemma in even defining which substances are controlled. Notwithstanding the challenges faced by forensic science with regard to NPS, it still has a key role to play in improving our understanding of this emerging phenomenon and in assessing the effectiveness of legislative interventions at both the national and international levels. Research is needed to understand the scope of the problem, and to develop and harmonize methods of analysis that would aid interoperability and international cooperation. From the health perspective, research is required to improve our understanding of the drug-metabolite profile in forensic toxicology and the disposition of some of these substances, which may be harmful to man. As the authors have noted in this article, a radical shift towards research, while urgently needed to address the NPS issue, may not be feasible in the short term due to the number of challenges outlined previously. However, forensic science would need to evolve and adapt in a timely manner to these challenges to be able to continue providing the accurate evidence base that is essential in designing effective policy interventions.

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