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Digital era drug surveillance—Quo vadis, Australia?

RUNNING TITLE: Digital era drug surveillance

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Since patterns of drug use evolve constantly [1–4], they require constant monitoring. Two recent developments illustrate this need. First, the development of New Psychoactive Substances (NPS) necessitates careful monitoring—in December 2017, 111 countries reported 779 different NPS to the United Nations Office on Drugs and Crime [5], with about 100 NPS appearing annually [6]. Second, prescription medication misuse (e.g., opioids, stimulants, sedatives and tranquilizers) [1,7,8], has risen sharply—exemplified by some academics labelling opioid misuse as a growing “epidemic” [9–12] (tellingly, Google Scholar returned ≈ 3500 exact phrase matches to “opioid epidemic” from 2017 to April 2018 alone).

However, change is not limited to drug use. Globally, societies en bloc face radical change. Two of the biggest drivers of recent societal change are internet access (especially, in the last decade, through smartphones), and social media. Despite having 20th century roots, smartphones and social media are properly 21st century phenomena. Modern societies have near-ubiquitous smartphone- and internet access. Australia is no exception, with 88% smartphone penetration [13], and social media usage (especially Facebook) at $\approx 80\%$ [14,15], mostly on smartphones [14]. Internet searching and social media can no longer responsibly be excluded as research data sources, especially in behavioural medicine, although web surveillance cannot supplant, but should complement, traditional surveillance [16].

Accordingly, drug surveillance has taken to the internet. Early attempts included the US National Institute of Health and National Institute on Drug Abuse (NIH/NIDA)-funded Real Drugs in a Virtual World studies [17], the European-funded Psychonaut web mapping project [18,19] and the more recent I-Trend [20] project. These studies involved mapping drug-discussion web forums and employing manual thematic analysis.

The NIH/NIDA more recently funded the Center for Interventions, Treatment, and Addictions Research to monitor publicly accessible Twitter feeds and web forums: The National Early Warning System Network (iN3) [21], aims to combine these data with data from key sentinel toxicologists to identify emerging psychoactive drug use, and the eDrugTrends study [22] aims to establish a platform

for the semi-automated monitoring of these data for information on cannabis usage (building on a similar study monitoring buprenorphine [23]).

The European Monitoring Centre for Drugs and Drug Addiction has also more recently funded the Computer Assisted Solutions for Studying the Availability aNd DistRibution of novel psychoActive substances (CASSANDRA) project, combining manual mapping with automated Twitter/Facebook data scraping to understand the supply and diffusion of NPS [24–26]. Both eDrugTrends and CASSANDRA make use of machine learning techniques to semi-automate surveillance efforts.

When discussing the internet in the drug research context, one must distinguish between the “surface web” and the “darknet.” The former consists of all content available through a standard search engine, whereas darknet content and -markets must be accessed through a specialised encrypted browser [27]. The NIH/NIDA funded eDarkTrends project monitors the emergence of NPS through darknet markets, using machine learning and automated web scraping [28]. The National Drug and Alcohol Research Centre’s Drugs and New Technologies programme monitors the darknet for substance availability [29]. The CASSANDRA project also monitors darknet markets to track the availability of NPS. Apart from these projects aiming to monitor new drug trends through the tracking and analysis of internet data, several one-off studies have used social media data to describe illicit drug trends. A recent systematic review identified 14 such studies which typically utilised Twitter, YouTube, web forums and Facebook data [30], and another identified 22 studies using social media for pharmacovigilance [31].

Are these early forays into the world of drug research and monitoring on the internet sufficient, or are there as yet untouched avenues? We believe that internet-related drug use and surveillance research needs to embrace four important concepts if it is to establish itself as an effective methodology capable of delivering translational impacts.

First, the obvious importance of the darknet for drug-related research does not obviate the need to continually monitor surface web information—findings from the 2017 Ecstasy and Related Drugs Reporting System [32] suggested that only 16% of respondents had purchased drugs from the darknet,

while 20% had purchased from the surface web. It is not unusual for darknet retailers to maintain surface web front ends or entry portals to their darknet sites, or to have surface web shops that sell psychoactive substances under the guise of selling nootropics, herbal supplements or “incense.” Since these web shops are on the surface web, users are searching for information on drugs using conventional search engines, and since people use their smartphones to access the internet when they are on the go (typically not via Tor browsers), researchers could use the Application Programming Interfaces (APIs) made available by various search portals (e.g., Google Trends) to gauge trends in interest for a number of substances. Prescription medication misuse can also be tracked using social media [33]. This illustrates the potential of surface web data for drug monitoring. The same argument concerning cryptomarkets must be applied to drug trading via smartphone apps—since the data are inaccessible, this is best studied through surveys, but it still does not negate the necessity of studying surface web data.

Second, we may need to rethink our methodologies and toolsets with replicability in mind. All the aforementioned studies monitoring social media or the darknet use their own proprietary systems, developed as part of their work. If these tools are not shared, they are time-consuming and costly to replicate. Even if they are shared, they may be so custom-designed that adapting them for a new context may match redeveloping new tools in difficulty. Replicability is thus a big concern with current research [31]. To address this challenge, researchers could consider using commercial, “off-the-shelf” solutions. There may often be costs associated with these tools, but these costs can be negotiated and may compare very favourably with the resource-intensive process of developing custom tools. Several tools exist for commercial brand management on social media (so-called “social listening”), and these can easily be used for other topics such as drug use. The publicly available search portal APIs (mentioned above) that provide access to internet search data may also be useful. Another solution to increasing replicability is the sharing of curated datasets. This approach was taken by Carnegie Mellon University to support their research into darknet markets [34]. A variety of ethical and legal issues must be worked through to better support data sharing of this kind [35,36].

Third, researchers need to rethink their research questions when it comes to the internet. Researchers in the drugs field have turned to the internet for data, but we argue that many researchers are not thinking deeply enough about the internet as a source of data [37]. For many, the internet is seen (not incorrectly) as a tool enabling access to larger numbers of respondents for conventional surveys or to hidden populations not otherwise accessible [38]. The real value of internet data, however, may not be that it gives access to respondents, nor that it allows researchers to overcome the small-sample limitations of their studies, but rather that it provides access to new modes of human interaction, new data that cannot be obtained by surveys [36,39]. We feel that researchers in the drugs field are only just beginning to explore these avenues in the depth required. This effort should also extend to the question of how the analysis of internet data can meaningfully supplement (not supplant) survey data [40], which is, in terms of implementation, far from a trivial methodological question. This question may be fruitfully explored using internet data for the contemporaneous forecasting of new drugs and drug use patterns which are confirmed and validated in due course through conventional survey and other surveillance methods (e.g., wastewater analysis).

Finally, while cross-sectional or one-off studies are useful for demonstrating possibilities, to make full use of internet data for drug trend monitoring, studies should be designed to detect trends over long time-periods and funded accordingly. It is regrettable that there is currently no Australian drug trend monitoring system that systematically includes monitoring of both surface and darknet internet data. Ideally, given the global nature of most social media platforms, global multi-disciplinary consortiums would share in systematic extraction methodologies, creating replicability datasets for research and monitoring purposes [30].

In closing, it should be remembered that, even apart from the question of suitability to context, all research is imperfect. Drug surveillance using internet data has advantages compared to conventional methodologies, such as lower cost and the immediacy with which data are obtained and updated. But research using internet data also has liabilities; it can address some conventional forms of bias, but introduces biases of its own. The acquisition and analysis of internet data also requires additional skillsets beyond the conventional training of researchers in the drugs field, with the additional

requirement of continual retraining to keep on top of developments in internet data. Despite these challenges, we argue that studying internet data to monitor new drug trends is no longer an optional choice for researchers. The question, instead, is how best to approach these data to derive the maximum impact.

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Declaration of interests

There are no relevant interests to declare.

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