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Novel psychoactive substances: An investigation of temporal trends in social media and electronic health records

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ABSTRACT

Background: Public health monitoring is commonly undertaken in social media but has never been combined with data analysis from electronic health records. This study aimed to investigate the relationship between the emergence of novel psychoactive substances (NPS) in social media and their appearance in a large mental health database.
Methods: Insufficient numbers of mentions of other NPS in case records meant that the study focused on mephedrone. Data were extracted on the number of mephedrone (i) references in the clinical record at the South London and Maudsley NHS Trust, London, UK, (ii) mentions in Twitter, (iii) related searches in Google and (iv) visits in Wikipedia. The characteristics of current mephedrone users in the clinical record were also established.
Results: Increased activity related to mephedrone searches in Google and visits in Wikipedia preceded a peak in mephedrone-related references in the clinical record followed by a spike in the other 3 data sources in early 2010, when mephedrone was assigned a 'class B' status. Features of current mephedrone users widely matched those from community studies.
Conclusions: Combined analysis of information from social media and data from mental health records may assist public health and clinical surveillance for certain substance-related events of interest. There exists potential for early warning systems for health-care practitioners.

1. Introduction

The need to interpret and act upon information from large-volume media such as Twitter is well recognised in business and politics, and increasingly appreciated in health research. For example, interactions on social media have enabled researchers to study health-related attitudes and behaviours in relation to tobacco smoking in Twitter [1] and Facebook [2], as well as identifying user social circles with common medical experiences [3], medical malpractice [4], HIV prevention [5] and pharmaco-vigilance [6] in Twitter. Wikipedia usage has also been utilised to estimate the prevalence of influenza-like illness in the United States in near real-time [7]. Similarly, the size, coverage and longitudinal nature of electronic health records (EHR), as well as their potential for data linkage offer unprecedented opportunities for big data analytics. Healthcare is thus emerging as part of a worldwide network of developing technologies [8] and with the arrival of Web 2.0, the relationship between patients and healthcare providers is rapidly changing. Web 2.0 [9] is a term popularised in 2004 and marks the beginning of a new wave of online activity–one that moves away from passive viewing of content and emphasizes interaction between users as creators of the very content that is being accessed. Communication now transcend geographical, cultural and language barriers to allow the exchange of information before it reaches the clinical room and a suspected flu outbreak could be trending on Twitter within hours, long before specialists have had an opportunity to properly examine it [10].

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The number of novel psychoactive substances (NPS), commonly referred to as 'Legal highs*', has been growing steadily in the last couple of decades with 100 not-previously-reported substances identified, in Europe, in 2015 [11]. The Internet is a primary source of information about NPS and the rapid rate with which they appear, as well as the uncertainty over the actual 'branding' and composition of these substances, pose substantial challenges for healthcare providers. Online user-generated content is increasingly becoming essential to providing an informed and up-to-minute portrayal of positive and negative effects, subjective experiences and availability of NPS [12]. As part of the PHEME project (www.pheme.eu), whose wider aim is to explore social media veracity and rumours, we investigated the temporal relationship between the emergence of NPS in social media and their appearance in a large mental health EHR covering an inner urban catchment area.

2. Method

2.1. Electronic health record data resource

Mental healthcare data were collected using the South London and Maudsley (SLaM) Biomedical Research Centre (BRC) Case Register [13]. The SLaM NHS Foundation Trust provides comprehensive mental health services to a geographic catchment area of over 1.2 million residents in four south London boroughs, making it one of the largest mental healthcare organisations in Europe. A single electronic health record has been used by all SLaM teams since April 2006. The Clinical Record Interactive Search (CRIS) application, developed in 2007–2008, extracts anonymised data from structured fields as well as unstructured free text from case notes and correspondence [13], which are particularly valuable in mental health research. The free text fields are used by health-care professionals to record clinical information over the course of care ranging from diagnoses and mental state examinations to daily nursing entries and treatment plans. CRIS contains over 250,000 de-identified patient records, including over 20 million text documents (growing at a rate of 170,000 per month) and has supported a number of studies [14–19]. The SLaM Case Register has ethical approval as a database for secondary analysis (Oxford REC C, reference 08/H0606/71 + 5) and a service-user led oversight committee provides governance for projects utilising these data [20].

To ascertain references to NPS in the clinical records, we searched case note, correspondence and discharge summary text fields for the following keywords: spice, methoxetamine, AMT, Benzo Fury, Piperazines (BZP, TFMPP, DBZP and mCPP), mephedrone, 2-DPMP, Salvia divinorum, morning glory, 2C-B, MDAI, MDPV, bromodragonfly, kanna, 4-Acetoxy-Met, naphyrone and 'Legal high*'. A list of the related terms commonly associated with these substances was also produced for searches. Table 1 shows the full list of search terms together with the number of retrieved documents containing the search term, the number of retrieved documents checked for actual mention of NPS and the number of true references (mentions truly related to the term of interest; e.g., kitty cat as referred to mephedrone and not to the animal) within the checked documents. Due to the low frequency at which NPS were mentioned in the clinical record, it was considered impractical to explore all associations with social media mentions and subsequent analyses focused solely on mephedrone, the most commonly referenced agent. Mephedrone [4methylmethcathinone, or 1-(4-methylphenyl)-2-methylaminopropan-1-one] is a phenethylamine and cathinone derivative, which typically mimics stimulant effects produced by amphetamines such as cocaine. It is widely available to purchase over the Internet usually in the form of white crystalline powder and is most commonly ingested intranasally or orally [21].

2.2. Twitter data resource

Twitter is a micro-blogging platform, which as of the second quarter of 2015, averaged 304 million monthly active users [22]. With 500 million tweets on a typical day (5700 per second) and a wealth of text, graph, image and video interaction, Twitter is one of the largest social media sources [23]. For our study, we accessed tweets archived from a Twitter feed licensed to the University of Sheffield from July 2009 to September 2014 inclusive. These comprise a random 10% sample of all tweets [24] and are kept in hourly or daily files. The sample was searched for terms related to mephedrone by using Aho-Corasick [25] search first to

Table 1
Search list for 'Legal highs*' and related terms in the clinical record.

Keywords	Related terms	Documents retrieved/ documents checked	True references
Legal high*	Plant food, mdat, eric 3, dimethocaine, bath salts	173/173	143
Spice	Spice silver, spice gold, spice diamond, bliss, blaze, genie, zohai, jwh-018, jwh-073, jwh-250, yucatan fire, moon rocks, k2, red x dawn, fake weed, x, tai high hawaiian haze, spice, mary joy, exodus damnation, ecsess, devil's weed, clockwork orange, bombay blue extreme, blue cheese, black mamba, annihilation, amsterdam gold	639/300	12
Mephedrone	Subcoca-1, 4-mmc, kitty cat, miaow miaow, meow meow, m-smack, m-cat	491/250	213
Methoxetamine	M-ket, mex, kmax, special m, ma, legal ketamine, minx, jipper, kwasqik, hypnotic, panoramix, magic, lotus, roflcoptr, rhino ket, mxe, moxy, mket, mexy, mexxy	27/27	2
AMT	2-(1h-indol-3-yl)-1-methyl-ethylamine, indopan, amt freebase, alpha-methyltryptamine	1/1	1
Benzo Fury	White pearl, benzo fury, 6-apdb, 6-apb, 5-apdb, 5-apb, apb	17/17	12
Piperazines (BZP, TFMPP, DBZP and mCPP)	The good stuff, smileys, silver bullet, rapture, pep twisted, pep stoned, pep love, pep, party pills, nemesis, legal x, legal e, happy pills, frenzy, fast lane, exodus, euphoria, esp, cosmic kelly, bzp, bolts extra strength, blast, benzylpiperazine, a2	49/49	3
2-DPMP	Vanilla sky, purple wave, ivory wave, desoxypipradrol, d2pm, 2-diphenylmethylpyrrolidine	0/0	0
Salvia divinorum	Mexican magic mint, holy sage, eclipse, salvinorin a	86/40	15
Morning glory	Pearly gates	27/27	2
2C-B, 2C-T-7	Nexus	23/23	1
MDAI	–	0/0	0
MDPV	–	5/5	5
Bromodragonfly	–	0/0	0
Kanna	Sceletium tortuosum, mesembrine	0/0	0
4-AcO-Met	4-acetoxy-met, metacetin	0/0	0
Naphyrone	Nrg	38/38	8