Research paper

Increases in synthetic cannabinoids-related harms: Results from a longitudinal web-based content analysis

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A B S T R A C T

Background: Synthetic Cannabinoid Receptor Agonists (SCRA), also known as "K2" or "Spice," have drawn considerable attention due to their potential of abuse and harmful consequences. More research is needed to understand user experiences of SCRA-related effects. We use semi-automated information processing techniques through eDrugTrends platform to examine SCRA-related effects and their variations through a longitudinal content analysis of web-forum data.

Method: English language posts from three drug-focused web-forums were extracted and analyzed between January 1st 2008 and September 30th 2015. Search terms are based on the Drug Use Ontology (DAO) created for this study (189 SCRA-related and 501 effect-related terms). EDrugTrends NLP-based text processing tools were used to extract posts mentioning SCRA and their effects. Generalized linear regression was used to fit restricted cubic spline functions of time to test whether the proportion of drug-related posts that mention SCRA (and no other drug) and the proportion of these "SCRA-only" posts that mention SCRA effects have changed over time, with an adjustment for multiple testing.

Results: 19,052 SCRA-related posts (Bluelight (n = 2782), Forum A (n = 3882), and Forum B (n = 12,388)) posted by 2543 international users were extracted. The most frequently mentioned effects were "getting high" (44.0%), "hallucinations" (10.8%), and "anxiety" (10.2%). The frequency of SCRA-only posts declined steadily over the study period. The proportions of SCRA-only posts mentioning positive effects (e.g., "High" and "Euphoria") steadily decreased, while the proportions of SCRA-only posts mentioning negative effects (e.g., "Anxiety," 'Nausea," "Overdose") increased over the same period.

Conclusion: This study's findings indicate that the proportion of negative effects mentioned in web forum posts and linked to SCRA has increased over time, suggesting that recent generations of SCRA generate more harms. This is also one of the first studies to conduct automated content analysis of web forum data related to illicit drug use.

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Introduction

Synthetic cannabinoids are a large family of chemical substances designed to reproduce specific therapeutic/psychotropic properties of cannabis. Among these compounds, the Synthetic Cannabinoid Receptor Agonists (SCRA) mimicking Δ-9-tetrahydrocannabinol (THC) have attracted substantial attention due to

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their potential for abuse, their numerous emergency department presentations and increasing number of overdose-related cases reported in the US and in Europe (AAPCC, 2016; Bush & Woodwell, 2014; Cohen, Morrison, Greenberg, & Saidinejad, 2012; European Monitoring Centre for Drugs and Drug Addiction, 2013; Forrester, 2012; Riederer, 2016; Trecki, Gerona, & Schwartz, 2015). These substances belong to the Novel Psychoactive Substances (NPS) category, a heterogeneous group of substances temporarily not regulated by international legislation (Papaseit, Farré, Schifano, & Torrens, 2014; Zawilska, 2011; Zawilska & Andrzejczak, 2015). SCRA products have been available for purchase in "head shops" and through online websites since 2004 (Schifano et al., 2009). SCRA were initially dissolved and sprayed onto inert vegetal material to be sold as "herbal incense", "potpourri" or "legal high" labeled as "not for human consumption" under various marketing names (e.g., "Black Mamba", "Ultimate Warrior", "Mad Hatter"). SCRA were also commercialized directly in their powder form under their chemical designation (e.g., JWH-018, MAM-CHMI-NACA, UR-144).

Unlike natural cannabis products (e.g., floral cannabis, hashish, marijuana concentrates), SCRA are full agonists of the endocannabinoid CB_1 and CB_2 receptors inducing a stronger neuronal response (Brents & Prather, 2014; Huffman & Padgett, 2005). This enhanced neurological response is one of the main factors contributing to a large spectrum of observed adverse effects such as increased risk of psychosis (Every-Palmer, 2011; van Amsterdam, Brunt, & van den Brink, 2015), seizures and convulsions (Schneir, Cullen, & Ly, 2011), dependence (Zimmermann, et al., 2009), and kidney failure (Bhanushali, Jain, Fatima, Leisch, & Thornley-Brown, 2013; Centers for Disease Control Prevention (CDC), 2013a, 2013b; Kazory & Aiyer, 2013).

Despite legislative efforts to regulate new cannabinoids as soon as they reach the market (e.g., the U.S. government has scheduled various SCRA molecules five times in the last five years), banned SCRA are rapidly replaced by molecules presenting chemical variation(s) to bypass current legal interdictions (Cohen, 2014; Lindigkeit, et al., 2009). For example, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) has reported the emergence of 134 SCRA from the end of 2008 until end of 2014 (EMCDDA, 2015). Reported emergency department cases linked to SCRA have increased in the U.S. over the past three years (Riederer, et al., 2016). According to the American Association of Poison Control Centers (AAPCC), 7,779 calls for of synthetic cannabinoid exposures were reported in 2015 exceeding both annual cases reported in 2013 (2668) and 2014 (3682) (AAPCC, 2016).

Except for a small number of epidemiological surveys describing SCRA use (Barratt, Cakic, & Lenton, 2013; Castellanos, Singh, Thornton, Avila, & Moreno, 2011; Caviness, Tzilos, Anderson, & Stein, 2015; Hu, Primack, Barnett, & Cook, 2011; Johnson, Johnson, & Portier, 2013; Vandrey, Dunn, Fry, & Girling, 2012; Winstock & Barratt, 2013a, 2013b), most of this literature informs either the neuropharmacology and neurophysiology of these products (Grigoryev et al., 2011; Kavanagh, Grigoryev, Savchuk, Mikhura, & Formanovsky, 2013) or the adverse effects observed on emergency department patients (Besli, Ikiz, Yildirim, & Saltik, 2015; Bonar, Ashrafioun, & Ilgen, 2014; Johnson et al., 2013; Tait, Caldicott, Mountain, Hill, & Lenton, 2016). Collecting information regarding SCRA patterns of use and related effects remains challenging because SCRA users are sometimes difficult to reach through conventional epidemiological surveillance methods. Furthermore, not all SCRA users who have experienced negative effects require or seek medical attention, nor were those who did receive medical attention necessarily assessed for SCRA-related symptoms (Tait et al., 2016).

To overcome the challenges of identifying and recruiting SCRA users, we analyzed posts from web-forums dedicated to drug

discussions. The last few years have seen an increased interest in the use of large-scale internet-based data as a source of information on evolving public health problems and emerging trends (Butler et al., 2007; Daniulaityte, Nahhas et al., 2015; Eysenbach 2011; Lamy et al., 2016; Lazer et al., 2009; Miller & Sonderlund, 2010). Recent research has also demonstrated that social media analysis provides valuable information regarding new drug trends, such as the use of loperamide by opiate users to ease opiate withdrawal (Daniulaityte et al., 2013), or changes in attitudes and behaviors of a population of synthetic cannabinoid users in Norway (Bilgrei, 2016).

In contrast to other social media platforms (such as Twitter or Instagram), Web forums allow their users to post extensive comments about their drug use, share experiences or ask questions regarding new products and trends. These websites also favour dialogue between users, who can share their thoughts, advice, and techniques on similar topics. Analysis of such data can provide valuable information regarding effects, patterns of use, and opinions directly from the user's perspective (Miller & Sønderlund, 2010; Schifano et al., 2006). Nevertheless, harnessing data on drug forums is a significant challenge due to the large amount of data displayed on Web forums. We used an advanced software platform, eDrugTrends (Daniulaityte, Nahhas et al., 2015; eDrugTrends, 2015), to collect and analyze forum posts related to SCRA and their effects, and conducted a longitudinal analysis of drug-focused web-forum posts. The key aims of this study are to: (1) identify the most common SCRA-related effects discussed on Web forums; and (2) analyze how frequencies of SCRA and their effects mentioned in Web forum discussions changed from January 2008 through September 2015.

Methods

The eDrugTrends system is a semi-automated comprehensive platform resulting from collaboration between social scientists in the Center for Interventions, Treatment and Addictions Research (CITAR) and computer scientists in the Ohio Center of Excellence in Knowledge-enabled Computing (Kno.e.sis Center) (eDrugTrends, 2015). This platform is designed to extract, process, and analyze social Web data, with the current application directed towards understanding cannabis and synthetic cannabinoid-related trends from Twitter and selected Web forums.

Data collection

Data were collected from three publicly available web-based sources: Bluelight, Forum A, and Forum B. Web forum posts were retrieved using a combination of source specific custom Web Crawlers for Forums A and B, and through direct data transfer from Bluelight. Only publicly available/viewable information was collected and stored in the eDrugTrends platform. We have collected data from the opening of the Web forums until September 30, 2015. Since synthetic cannabinoids emerged in 2008, for this analysis we used Web forum data posted between the January 1, 2008 and September 30, 2015.

Ethical considerations

The study was approved by the Wright State University IRB under exemption 4 (i.e., Exempt Human Subjects Research) as collected data are publically available. One of the three forums used in this study, Bluelight.org, has a research portal accessible from the front page of the website, which asserts Bluelight's ownership of the forum content and instructs researchers to contact Bluelight administrators to discuss proposals for research, including archival analyses. The researchers contacted Bluelight to