

Increases in Online Posts About Synthetic Opioids Preceding Increases in Synthetic Opioid Death Rates: a Retrospective Observational Study



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INTRODUCTION

Opioid overdose deaths have increased more than fivefold from 1999 to 2016, accounting for 42,249 deaths in 2016.¹ One particularly challenging aspect of the opioid epidemic is that it has been marked by a rapid transition from prescription opioids to heroin to synthetic opioids. This third wave involving synthetic opioids has largely been driven by illicitly manufactured fentanyl and its analogs.²

To address challenges of quickly identifying newly emerging synthetic opioids, novel data sources such as web or social media data may serve as potential early warning systems. Prior work has mainly focused on automated identification of messages indicating misuse,³ detection of online illicit pharmacies, evaluating opinions around certain compounds,⁴ understanding spread of norms, and comparing online findings to survey data.⁵ However, there is particularly limited work examining fentanyl and fentanyl analogs (now the leading cause of overdose deaths) and limited work that directly compares findings from these novel approaches to death data to describe how much lead time an early warning system based on online data could potentially provide. Thus, this retrospective analysis sought to assess the degree to which such an early warning system could have provided early insights about the rise in synthetic opioids deaths.

METHODS

We conducted a retrospective observational study of all publicly available posts from drug-related message boards on the largest forum messaging site, Reddit, estimated to be the third most visited site in the USA. On the site, users create interest groups and post anonymous messages. We identified 103 substance-related interest groups available at the time (<https://www.reddit.com/r/Drugs/wiki/subreddits>) and analyzed all publicly available posts and comments from January

1, 2010, through December 31, 2017, which were queried from a public repository of such data (<https://pushshift.io/>) using the site's Application Programming Interface.

Our primary objective was to assess trends in posts about synthetic opioids, primarily fentanyl and fentanyl analogs. Identification of such messages is challenging as multiple fentanyl-related compounds exist and the presence of drug misspellings and vernacular is prevalent. Consequently, we used two open-source algorithms that cluster words based on semantic similarity, word2vec and fastText, released by researchers at Google and Facebook, respectively. Such algorithms can be used to detect misspellings of a word (e.g., fentanyl and fentanil) as well as words that are similar in meaning (e.g., syringe and needle). We used these algorithms to identify a list of 34 keywords (Fig. 1) that captured the leading terms in synthetic opioid posts and plotted volume of synthetic opioid posts over time. Our examination of anonymous, publicly available posts was granted IRB exemption.

RESULTS

A total of 27,210,148 messages (posts or comments) were assessed. Figure 1 reveals that the rate of online posts about synthetic opioids increased approximately 1–2 years earlier than unintentional synthetic opioid deaths, increasing 347.4% from 2011 to 2012. Figure 2 plots messages about specific fentanyl analogs. Carfentanil posts began rapidly increasing by 2016. Sensitivity analyses comparing the rate of change in synthetic opioids posts to posts about other leading non-synthetic opioids (i.e., oxycodone) showed a similar pattern of early, rapid growth.

DISCUSSION

Examination of online data reveals that posts about synthetic opioids increased markedly before increases in synthetic opioid deaths. Additionally, we identified increases in discussions about the newest, emerging fentanyl analogs. Online postings about carfentanil were noted before the first identifiable carfentanil outbreak.⁶ Limited surveillance from 10 states reveals that carfentanil has contributed to the most deaths among all analogs.²

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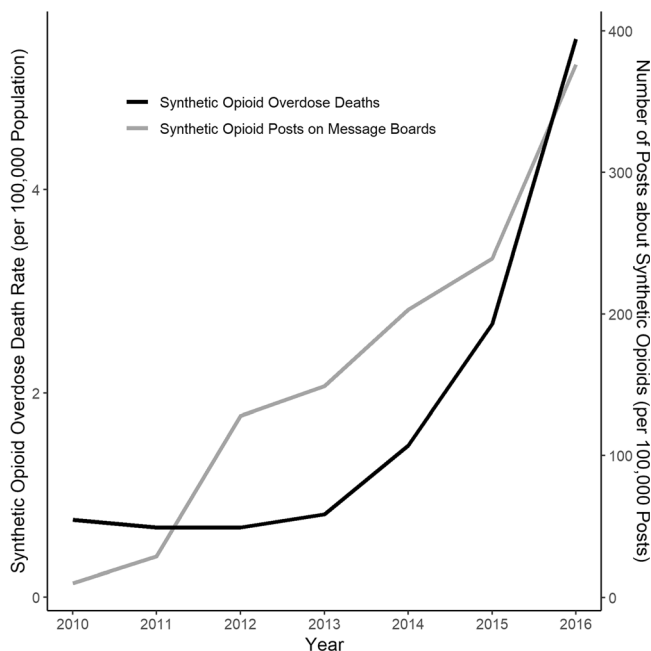


Figure 1 Rate of posts discussing synthetic opioids on substance message boards and unintentional synthetic opioid overdose deaths, 2010–2016. **Note:** The rate of unintentional overdose fatalities resulting from synthetic opioids (a category that includes fentanyl and fentanyl analogs but excludes methadone) was ascertained from death certificate data processed through the National Vital Statistics System (underlying cause of death code X40–X44 and a multiple cause of death code of T40.4). Terms used to identify synthetic opioid posts were assembled from the top 40 words identified by the word2vec and fastText algorithms as most semantically similar to “fentanyl” as measured by cosine similarity; lists of the top 20 terms produced by each algorithm were reviewed by an expert and combined to include 34 unique terms: fent, butyrfentanyl, fentanils, carfentanil, fentanyls, fentnyl, fetanyl, furanylfentanyl, fentantyl, fentynal, butyryl, lofentanyl, carfentanyl, sufentanyl, truckfentanyl, butyrfentanyl, fentanyli, fentynyl, carfent, ocfentanyl, fentayl, furanyl, fentany, fentanyl, acrylfentanyl, carafentanyl, fentynl, sufentanyl, butyr, fentanylso, acetylfentanyl, busfentanyl, fentanayl, fentanil.

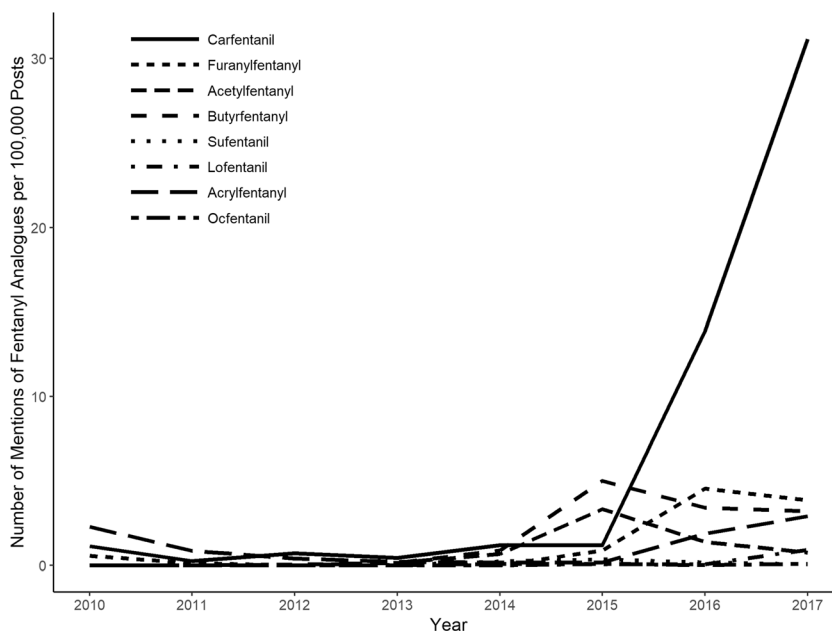


Figure 2 Rate of posts discussing fentanyl analogs on substance message boards, 2010–2017. **Note:** The fentanyl analogs examined were those identified from the list of terms used in Figure 1. The word2vec and fastText algorithms were then run for each of the analogs to identify any spelling variants that existed. Terms used to identify the various fentanyl analogs underwent expert review and included carfentanil, carfentanyl, carfentanils, carfent, csrfentanil, carefentanil, carfentnyl, carfentail, carfentetil, carfenteny, carfentini, carfentynal, carf, butyrfentanyl, butyrfent, butyrylfentanyl, butyr, butyryl, butryfentanyl; furanylfentanyl, furanylfent, furanyl, fuf; acrylfentanyl, acryloylfentanyl, acrylfent, acryl; sufentanyl, sufentany, sufenta; lofentanil, lofentany, lofent, ocfentanyl, ocfentanil, acetylfentanyl, acetylfent.

Limitations of this study include an inability to perfectly capture all variants of drug compounds and reliance on a single data source. In addition, given the time needed to establish toxicology testing, synthetic opioids may contribute to deaths before they are detected by post-mortem testing. Nonetheless, use of novel data sources could help to scale-up toxicology testing for emerging substances. Furthermore, while this work retrospectively confirms the utility of online data by examining the emergence of synthetic opioids, further research is needed to develop automated procedures using the word clustering algorithms we employed to prospectively identify new compounds. Work is also needed in understanding the temporal relationship of posts to death data once an emerging substance becomes widespread. In conclusion, this work lends further support to the urgency of advancing robust procedures utilizing novel data sources to supplement traditional public health methods.

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Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they do not have a conflict of interest.

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