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Thematic Analysis of Reddit Content About Buprenorphine-naloxone Using Manual Annotation and Natural Language Processing Techniques

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Background: Opioid use disorder (OUD) is a major public health crisis for which buprenorphine-naloxone is an effective evidence-based treatment. Analysis of Reddit data yields detailed information about firsthand experiences with buprenorphine-naloxone that has the potential to inform treatment of OUD.

Methods: We conducted a thematic analysis of posts about buprenorphine-naloxone from a Reddit forum in which Reddit users anonymously discuss topics related to opioid use. We used an application programming interface to retrieve posts about buprenorphine-naloxone, then applied natural language processing to generate meta-information and curate samples of salient posts. We manually categorized posts according to their content and conducted natural language processing-aided analysis of posts about buprenorphine tapering strategies, with-

drawal symptoms, and adjunctive substances/behaviors useful in the tapering process.

Results: A total of 16,146 posts from 1933 redditors were retrieved from the */r/suboxone* subreddit. Thematic analysis of sample posts (N = 200) revealed descriptions of personal experiences (74%), nonpersonal accounts (24%), and other content (2%). Among redditors who reported tapering to termination (N = 40), 0.063 mg and 0.125 mg were the most common termination doses. Fatigue, gastrointestinal disturbance, and mood disturbance were the most frequent adverse effects, and loperamide and vitamins/dietary supplements the most frequently discussed adverse effects adjunctive substances/behaviors respectively.

Conclusions: Discussions on Reddit are rich in information about buprenorphine-naloxone. Information derived from analysis of Reddit posts about buprenorphine-naloxone may not be available elsewhere and may help providers improve treatment of people with OUD through better understanding of the experiences of people who have used buprenorphine-naloxone.

Key Words: buprenorphine, opiate substitution treatment, opioid use disorder, qualitative research, social media

(*J Addict Med* 2022;16: 454–460)

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Received for publication July 1, 2021; accepted October 13, 2021.

Dr Abeed Sarker is currently receiving a NIDA award (R01DA046619).

Research reported in this publication was supported by National Institute on Drug Abuse (NIDA) of the National Institutes of Health (NIH) under award number R01DA046619. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

The authors report no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's Web site (www.journaladdictionmedicine.com).

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ISSN: 1932-0620/22/1604-0454

DOI: 10.1097/ADM.0000000000000940

Buprenorphine-naloxone is a safe, effective, evidence-based treatment for opioid use disorder (OUD), and long-term success in recovery/remission with buprenorphine-naloxone treatment is well documented.^{1–5} It is prescribed as an oral or sublingual medication in office-based primary care or addiction medicine practices, and it is increasingly being prescribed in hospitals and emergency departments to initiate therapy and bridge patients to outpatient programs for treatment of OUD.

However, questions about patients' experiences with buprenorphine-naloxone and how to manage the care of patients taking buprenorphine-naloxone remain. Social media, with its widespread adoption,⁶ is a potential source for such important information. The use of social media data for health-related research has increased alongside its ever-expanding public reach. Social media data have been investigated as potential sources of meaningful information in a wide array of health-related applications including infectious

disease outbreak monitoring, detection of adverse drug reactions, and description of behavioral and mental health trends.^{7–9} Included in this research are multiple publications describing the analysis of social media data for the purpose of

exploring topics related to opioid use. These studies have demonstrated the potential of social media analysis to yield previously unidentified strategies for the treatment of OUD and detection of important trends among people who use opioids.^{10–15}

There are unique aspects of the social media platform Reddit which make it particularly well-suited for the investigation of sensitive topics like substance use disorders (SUDs). With about 430 million active monthly users, Reddit is currently one of the most popular and rapidly growing social media platforms.¹⁶ Reddit enables its users (also called “redditors”) to post and discuss information in topic-specific forums called *subreddits* with large numbers of other redditors who have experience or interest in a given topic. It is not a forum for self-promotion, image-branding, or other individual-oriented metrics. This “idea-centric” model differs from other networks such as Twitter. Thus, the content on Reddit tends to have less noise (e., less promotional material) and more posts that represent personal experiences associated with targeted topics (ie, higher signal-to-noise ratios). Providing a safe and largely anonymous space for its users is at the core of Reddit’s design and culture, supported by elaborate community-established rules known as “*etiquette*.”¹⁷ Multiple recent studies have capitalized on this potential to conduct studies about SUDs, including OUD.^{11–15,18,19}

In this study, we mined and analyzed buprenorphine-naloxone-related posts from Reddit and identified the topics most frequently discussed therein. Our study was inspired by preliminary inspections of Reddit as we discovered elaborate descriptions of buprenorphine-naloxone-based treatment posted there, including information about buprenorphine-naloxone use, physical and emotional side effects and withdrawal symptoms, and step-by-step self-management guidelines and strategies from redditors who describe related personal experiences. The aim of our study was to characterize, qualitatively and quantitatively, this rich content using manual categorization and NLP.

METHODS

Our study protocol was approved by the Emory University Institutional Review Board. The data consisted of public posts from the */r/suboxone* subreddit of Reddit. Suboxone (Reckitt Benckiser, Salt Lake City, UT) is the tradename of the sublingual film containing buprenorphine and naloxone. Subreddits are “chat rooms” within Reddit dedicated to specific topics. Our initial exploration revealed that the */r/suboxone* subreddit, with over 13,000 members, was the primary platform for all discussions related to buprenorphine-naloxone. All the data used was publicly available at the time of the study, so informed consent was not obtained. The study did not involve any interaction with or identification of individual redditors.

Data Collection and Filtering

On December 21, 2018, we collected all publicly available posts from the */r/suboxone* subreddit using the PRAW application programming interface.²⁰ The collected

data contained original posts and comments on those posts, which are collectively referred to as threads. The earliest post included was from February 7, 2013, and the last post was from December 21, 2018. Responses posted within each thread

spanned multiple years. We sorted the posts according to the net number of *upvotes*. Reddit allows its users to upvote or downvote posts depending on whether they find them helpful or unhelpful. Each upvote or downvote contributes +1 or -1, respectively, to an aggregate score, which can be used as an indicator of popularity or usefulness. We randomly selected 200 posts from the subset of posts that had an aggregate score of at least +3 (N = 3725). Taking into consideration the wide variation in post length, we estimated that 200 posts could be feasibly analyzed within our time constraints. The voting mechanism, which is essentially crowd-sourced meta-information, enabled us to focus our analysis on posts that had relatively high engagement and to exclude uninformative posts. We included a maximum of 3 posts by any given redditor to ensure the inclusion of a diversity of perspectives. These methodology design decisions were made by our study team based on our preliminary observations of the data set.

Thematic Categorization

Three of the authors (RG, JL, JP) performed the manual thematic categorization of the 200 posts in two broad phases. After each of the three authors reviewed the entire set of posts, the decision was made to first categorize posts according to whether they described personal experiences or accounts or nonpersonal accounts (eg, general information about an opioid-related topic without mention of a personal experience related to that information). This first categorization (our high-level annotation) separated posts into three coarsegrained categories: personal experience (p), information/nonpersonal accounts (i), and other (o).

After completing the high-level annotation, the same three authors individually sorted the posts according to content into subcategories. The subcategories were not prescribed, limited in number, or otherwise predetermined before review by the authors. The individual subcategorization schemas developed by the authors were then compared among the three authors, and a single subcategorization schema including 14 subcategories was agreed upon. The three authors then used this final annotation guideline to individually subcategorize the posts once more. A multi-label classification approach was employed such that any individual post could belong to multiple subcategories. The authors again compared their individual results, and discrepancies were resolved by group discussion. Because our annotation guideline employed a multi-label classification system, we did not compute an inter-rater agreement statistic. Instead, we decided to reach consensus among annotators through our process of group discussion and iterative coding. Table 1 reflects the results of this final consensus sub-categorization. Example posts for each subcategory are shown in Supplement 1, <http://links.lww.com/JAM/A315>. The entire methodology, from data collection to analysis, is depicted in Figure 1.

Due to the structure of Reddit threads, individual response posts within a thread may lack context on their own, although they are often sufficiently descriptive to convey the content of the original parent post or topic in question. A post that otherwise meets inclusion criteria may not be the original post that starts a thread but rather a response to another post. Analyzing a post without information about the contents of the parent

TABLE 1. Subcategories of Topics of Reddit Posts (N = 200) on the Subreddit/r/Suboxone and Their Distribution in Manually Annotated Data

Subcategory	Code	Description	Count (% of Posts)
Specific advice on how to use buprenorphine	as	Firsthand or self-reported advice on how to use buprenorphine	110 (55.0%)
Dosage	d	Discussions of buprenorphine doses redditors are taking	71 (35.5%)
Tapering	t	Discussion of strategies or experience with lowering buprenorphine dose over time	64 (32.0%)
Providing information and answering questions	i	Redditior-provided information about drugs/medications or answers to questions posted by other redditors	42 (21.0%)
Questions	q	Information seeking (eg, how to taper buprenorphine)	42 (21.0%)
Withdrawal	w	Discussions or descriptions of withdrawal from buprenorphine	33 (16.5%)
Advice on topics other than buprenorphine use	ao	Advice not related to buprenorphine use	28 (14.0%)
Side effects	s	Discussions of side effects of buprenorphine use	27 (13.5%)
Use of other substance(s)/drugs to mediate symptoms of opioid withdrawal	os	Discussion or description of substance(s) other than buprenorphine (eg, kratom, loperamide etc) for mediating symptoms of opioid withdrawal	18 (9.0%)
Illegally obtaining or misusing buprenorphine	ab	Discussions about obtaining buprenorphine without a prescription or misusing buprenorphine	5 (2.5%)
Other	o	Content outside of other defined categories	4 (2.0%)
Relapse	r	Discussions or descriptions of relapse	3 (1.5%)
Stigma	st	Expression or description of stigma associated with buprenorphine use	3 (1.5%)
Cravings	c	Discussions of cravings for other drugs or modes of drug administration (eg, the need to inject)	2 (1.0%)

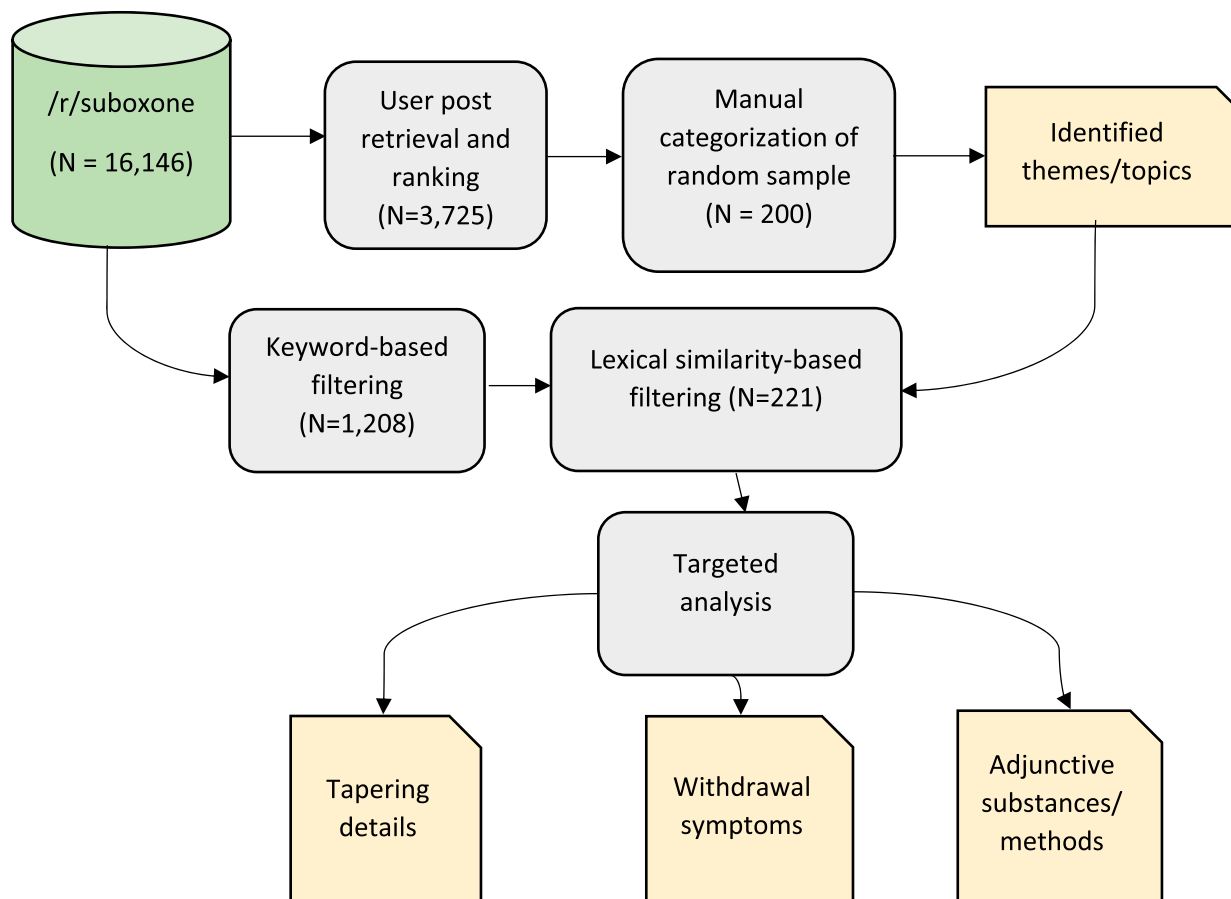


FIGURE 1. Flowchart summarizing the analyses conducted in this study.

comment may make accurate interpretation difficult or impossible. Therefore, for each selected post, we also included its parent post, and annotated the pair together. If a selected post itself was the parent post for a thread, we randomly selected a response within the thread that also met the inclusion criteria for consistency.

Topic Investigation

The thematic analysis of the 200 posts enabled us to identify frequently discussed topics that were promising targets for further investigation. We identified commonly suggested strategies for tapering buprenorphine-naloxone, symptoms of withdrawal from buprenorphine and other opioids, and adjunctive substances/behaviors reported to be useful by redditors.

Manual identification of all posts containing relevant information from the large set of posts we collected initially was not feasible, so we applied NLP to sequentially filter posts prior performing further analysis. From the set of 200 manually coded posts, we first computed frequency distributions of terms to find commonly used keywords within the posts belonging to each manually coded topic. We discovered a number of frequently used terms or keywords (eg, “taper,” “dose,” “mg”). Then, we retrieved all posts from the original set that contained at least 2 of these keywords. This keyword-based retrieval still generated a large sample (N = 1208; N = 428 for 3+ upvotes) and an inspection of a sample of those posts revealed that some of the information was incomplete or unrelated to our topics of interest. To exclude these extraneous posts, we applied a second lexical similarity filter, which only kept posts that were lexically similar to the manually categorized posts representing personal experiences. The lexical similarity filter was applied at the sentence level and similarity was measured using the *Levenshtein ratio* measure. Posts with less than 20% sentence-level similarities were discarded and the resulting subset contained 221 posts.

Finally, we manually reviewed each of these 221 posts, excluding non-first person reports and repeated posts by the same redditor. We qualitatively studied the suggested strategies for buprenorphine-naloxone tapering and discontinuation discussed in these posts, and, when available, quantified the attempted termination doses reported. We also identified and computed frequencies of withdrawal symptoms and adjunctive substances or behaviors used for treatment of withdrawal symptoms. Distinct lexical representations of the same concept (eg, “RLS” and “restless legs”) were merged before computing the frequencies. The relative frequencies of the concepts were computed using the formula $rfc_i = \frac{n_i}{\sum_k n_k}$ where n_i is the number of occurrences of concept i and $\sum_k n_k$ is the sum of occurrences of all concepts in the set.

Results

We retrieved a total of 16,146 posts from 991 threads and 1933 redditors (mean ~16.3 posts per thread; minimum number of posts = 1; maximum number of posts = 144). The number of posts increased steadily over the years, with 32 posts in 2013, 142 in 2014, 595 in 2015, 1566 in 2016, 2352 in 2017, and 11,456 in 2018. The number of threads also increased over the years in question with 7 threads started in 2013, 18 in 2014, 48 in 2015, 137 in

2016, 178 in 2017, and 603 in 2018. Thematic analysis of the initial 200 posts verified the content-rich nature of the */r/suboxone* subreddit. High level annotation revealed that 74% (N = 148) of the posts described personal experiences, 24% (N = 48) provided buprenorphine-naloxone-specific information not from direct personal experience, and 2% (N = 4) could not be categorized as either (eg, speculations about intents of pharmaceutical companies). Subsequent thematic subcategorization showed that the five most frequently discussed topics included: specific advice about how to use buprenorphine-naloxone as pharmacologic treatment for OUD (55%), information and guidance on buprenorphine-naloxone dosage (35.5%), information about buprenorphine-naloxone tapering (32%), side effects of buprenorphine-naloxone and withdrawal information (30% combined), and specific questions about buprenorphine-naloxone usage (21%). Table 1 presents the subcategories and their distribution in the reviewed sample.

Treatment Discontinuation and Tapering

Self-managed tapering strategies were frequently discussed within the */r/suboxone* subreddit. Redditors who reported to have successfully used buprenorphine-naloxone as opioid agonist therapy and then ultimately tapered off it provided meticulous accounts and recommendations to others. Suboxone tapering strategies involved cutting 2 mg strips into as many as 32 pieces and taking decreasing doses over time before terminating use completely. Similarly, redditors who had been prescribed Subutex (Reckitt Benckiser) described methods for dissolving solid pills in water and decreasing the dose over time to taper. Among the posts we reviewed, the dose of buprenorphine-naloxone most frequently used just before complete cessation was 0.063 mg (17/40; 42.5%). Doses of 0.063 mg and 0.125 mg (10/40; 25%) were both common; 2 mg strips of Suboxone can be cut into 16 equal pieces so that each piece contains approximately 0.125 mg, or into 32 pieces so that each piece contains approximately 0.063 mg. These two doses combined represented over two-thirds of the termination doses (27/40; 67.5%). Figure 2 shows the frequencies of reported buprenorphine-naloxone termination doses (N = 40). Those who reported tapering buprenorphine-naloxone, successfully or otherwise, overwhelmingly suggested that the most difficult period of the tapering process occurs when decreasing the dose from 2 mg to 0 mg. People tapering over longer periods reported higher rates of self-defined success than those who attempted to taper quickly.

Withdrawal Symptoms and Adjunctive Substances or Behaviors

Table 2 shows the relative frequencies of adverse effects described by redditors who reported self-management of buprenorphine-naloxone dosing and tapering (N = 56). Fatigue, gastrointestinal disturbance, and mood disturbance were the three most common adverse effects, each with relative frequencies greater than 10%. Table 3 shows the relative frequencies of the substances and/or behaviors redditors reported to have aided their self-management process (N = 44). Imodium (Johnson & Johnson, New Brunswick, NJ) (18%), vitamins/dietary supplements

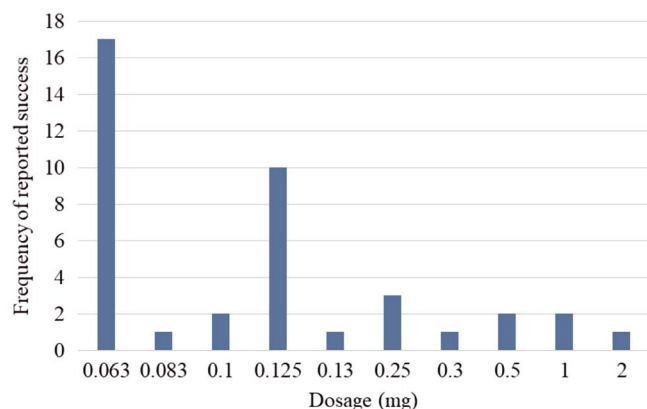


FIGURE 2. Frequency of dosages (mg) at which the selected subset of Reddit users reported to have terminated buprenorphine-naloxone use.

(18%), clonidine (14%), and benzodiazepines (14%) were the most frequently mentioned among these.

DISCUSSION

The value of social media platforms like Reddit for people who use opioids is multidimensional. The function of the Reddit platform as a space for discourse is described by many as a crucial asset. One of the most frequently seen and striking aspects of the content of the Reddit posts we reviewed was the explicit reference to and appreciation for the support and insight generated by other redditors. Prior studies have demonstrated that many redditors seek support and advice from their peers on the platform and are willing to provide detailed accounts of their own experiences, successes, and struggles.^{9,10,21}

This aspect of the Reddit community is of particular importance given the relative difficulty of accessing appropriate medical care and the absence of medical guidelines which address the needs of people who use opioids, particularly when they wish to taper their buprenorphine use. Many patients want

TABLE 2. Relative Frequencies of Withdrawal Symptoms/Adverse Effects Reported During Buprenorphine-naloxone-based Treatment and Tapering by the Reddit Cohort Studied (N = 56)

Withdrawal Symptoms/ Adverse Effects (N = 56)	Relative Frequency N (%)
Fatigue/lethargy	9 (16%)
Gastrointestinal disturbance	9 (16%)
Mood disturbance	7 (13%)
Restless legs	6 (11%)
Insomnia/sleep disturbance	5 (9%)
None	4 (7%)
Chills	3 (5%)
General discomfort	3 (5%)
Sneezing	2 (4%)
Headache	2 (4%)
Body aches/soreness	2 (4%)
Night sweats	2 (4%)
Difficulty concentrating	1 (2%)
Watery eyes	1 (2%)

The label “none” refers to redditors who specifically reported having no withdrawal symptoms/adverse effects.

TABLE 3. Relative Frequencies of Substances and Behaviors Reported by Redditors to be Helpful in Managing Withdrawal and Other Symptoms Experienced During Buprenorphine-naloxone Treatment, Tapering, and Cessation

Supplementary Substances and Behaviors (N = 44)	Relative Frequency N (%)
Imodium	8 (18%)
Vitamins/dietary supplements	8 (18%)
Clonidine	6 (14%)
Benzodiazepines	6 (14%)
Exercise	3 (7%)
Kratom	2 (5%)
Gabapentin	2 (5%)
Vivitrol	2 (5%)
Marijuana	1 (2%)
Tramadol	1 (2%)
Ibuprofen	1 (2%)
Melatonin	1 (2%)
“Clean” food	1 (2%)
Water	1 (2%)
Antihistamines	1 (2%)

to taper or discontinue buprenorphine-naloxone therapy for numerous reasons including stigma, expense, and the perception that using medications to manage OUD does not represent legitimate recovery or remission.^{21–28} When and if people do wish to taper buprenorphine use, they often encounter significant obstacles and general lack of support. The lack of funding, dearth of available prescribers, and inability to obtain appropriate follow-up certainly contribute to difficulty obtaining buprenorphine for treatment in the first place, and likely also contribute to the choice to discontinue use.^{29–35} Distrust of the medical community was described in numerous posts we analyzed in our study, often resulting from in-person interactions with medical providers that were frustrating or ineffective, or left the redditor feeling stigmatized and isolated. This sentiment echoes findings from a 2014 study by Brown et al²¹ and a 2017 study by D’Agostino et al⁹ which reported that people who use social media express greater trust for their chosen online community than for medical providers, including physicians and pharmacists.

The lack of trust for medical professionals among the people whose posts we examined may be understandable given the absence of products and guidelines that meet the needs of people who use opioids, particularly in the case of people who wish to taper their buprenorphine dose. The Suboxone packaging insert states that the film should not be cut; despite this recommendation, and the absence of formal tapering guidelines, physicians prescribe film fractions for use during tapering.²³ The method by which patients should divide the film into smaller doses is not supported by formal recommendations, and different methods of apportioning the film may result in irregular doses. For example, cutting the film with scissors or folding and ripping the film may produce less accurate portions, and thus inaccurate dosing, as compared to using a razor or ruler.²³ In the absence of guidelines and physical drug formulation that supports tapering practice, people are essentially left to their own devices and, if they wish to taper, to seek out what information they can from other sources, like Reddit.

Clinicians may help to counter the absence of such guidelines and engage more effectively with their patients by asking them about all of their treatment goals, including, potentially, goals related to tapering. Physicians prescribing buprenorphine should consult with their patients who have OUD about what their perception of treatment are, and what their goals entail. First and foremost, this includes helping them to establish and continually assess their treatment goals. For some, this may also include the goal of tapering their dose and eventually discontinuing buprenorphine. Among patients who indicate interest in tapering their buprenorphine, education, evidence, and best medical practices where they are available to best inform their patients and support them in achieving their desired outcomes.

Prior studies have described the methods people who wish to taper their buprenorphine use to facilitate self-management of the tapering process.^{21,23,28} However, details that are sufficiently specific to provide a basis for the development of guidelines and practices that could potentially be used by providers, or even drug manufacturers, are lacking. Our study contributes to existing work the analysis of detailed descriptions of tapering regimens, particularly termination dosing, and quantifies the frequency both of specific adverse effects people encounter while attempting to taper and the strategies they use to manage those effects.

Furthermore, while earlier research has established the utility of social media for studying SUDs, addiction, and recovery/remission, there is no study that has attempted to mine and quantify strategies from social media pertaining to self-driven medical treatment for OUD. As methods for mining data from social media are maturing and adoption of social media is increasing, the value and possible applications of knowledge garnered from this resource are becoming more evident. Most applications of social media mining to date, including our own past research, have pertained to population and public health.^{8,36–38} However, perhaps due to the infrequent translation of social media research into public health guidelines or medical practice, some studies have raised questions about the real-life applicability of social media data.^{39,40} Our paper describes a unique application of social media-based data mining that could be used directly to inform clinicians treating patients with OUD.

Limitations

Reddit users are disproportionately likely to be younger and male and do not comprise a representative sample of the general population. Comments about buprenorphine-naloxone products, tapering schedules, withdrawal, and other topics may reflect public perspective or hearsay rather than reliable information. Reddit posts are largely anonymous, so it is difficult to follow timelines or outcomes of suggested strategies. Posts are based on self-reporting of redditors' perspectives or experiences rather than on objective data (eg, documentation of drug-free urine samples to determine abstinence from opioid use). Although the large volume of information is promising, our current effort is largely manual and based on the analysis of a small number of potentially relevant Reddit posts.

CONCLUSIONS

Anonymized forums such as the */r/suboxone* subreddit provide important platforms for many people who describe

challenges related to opioids to openly discuss their concerns and to seek and provide support. Many posts within the subreddit are first person self-reports, which generates a higher signal-to-noise ratio compared to other popular social networks such as Twitter. Discussions about the tapering of buprenorphine-naloxone or buprenorphine is commonly shared in specific Reddit subforums. Redditors in this sample undergoing treatment with opioid agonist therapy who describe tapering buprenorphine-naloxone report greater success using longer tapering schedules. Withdrawal symptoms of buprenorphine-naloxone treatment, tapering and supplementary substances and behaviors used in the buprenorphine-naloxone tapering process are commonly described on Reddit. This content may be a useful source of information about buprenorphine-naloxone therapy for patients and providers. Accounts of the use of buprenorphine-naloxone on Reddit may introduce opportunities to enhance patient-centered practice and inform medical practice. Specifically, treatment providers may be able to use knowledge gathered from social media platforms such as Reddit to devise and customize treatment strategies for OUD.

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