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Development and Usability Evaluation of an Opioid Management App

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Abstract. We describe the development and usability evaluation of a novel patient engagement tool (OPY) in its early stage from perspectives of both experts and end-users. The tool is aimed at engaging patients in positive behaviors surrounding the use, weaning, and disposal of opioid medications in the post-surgical setting. The messaging and design of the application were created through a behavioral economics lens. Expert-based heuristic analysis and user testing were conducted and demonstrated that while patients found the tool to be easy to use and subjectively somewhat useful, additional work to enhance the user interface and features is needed in close partnership with developers and stakeholders.

Keywords. Opioid abuse, opioid addiction, weaning, technology, patient-centered design, medication disposal, post-surgical patients

1. Introduction

In the United States, 2021 was the worst year yet in the nation's ongoing thirty-year opiate epidemic [1]. Tremendous resources have been invested to curb this epidemic, falling largely under the umbrellas of "treatment" or "prevention." Treatment programs are unable to stem the rising tide of new patients afflicted with opioid use disorder, while prevention programs have previously been largely framed at restricting prescribers from initiating new opioid prescriptions. These laws have been fruitless in stemming the tide of the opioid epidemic; despite opioid prescriptions now reaching an all-time low, the number of opioid overdose deaths are at an all-time high.

Part of this disconnect is attributable to imperfect counseling around how patients should use, discontinue, and dispose of addictive opioid medications. But even in ideal circumstances, the deck is stacked against patients and in favor of addiction. Patients are frequently in pain or have already received opioid medication at the time of counseling, especially in emergent and post-surgical situations—either of which can impair robust memory formation and information retention. The prescribed opioid medications intrinsically produce altered mentation, further impairing successful recall. The confluence of these factors potentiates the patient towards opioid addiction.

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Digital health applications can address some of the timing challenges surrounding opioid guidance. Instead of being limited to the clinical encounter, counseling can take place at any time and be responsive to specific patient needs. These tools can also collect information directly from patient behaviors.

Behavioral economics (BE) offers an avenue to help improve the problems of opioid overutilization without the restrictive or coercive nature of current interventions. The essence of BE is that populations can be induced to make better decisions without sacrificing freedom of choice or resorting to punishment, through an open and transparent process. "Nudges" can be deployed to help guide patients to optimal outcomes by taking advantage of innate cognitive heuristics. BE approaches have been successfully used to help patients pick better health insurance plans [2], prevent and treat diabetes [3], and improve medication compliance [4-6]. BE-based programs have been harnessed to help treat patients with opioid use disorder, but there are no programs which have used BE-based interventions for primary prevention.

Our objective is to create a user-centered opiate guidance application (Opiate Program for You, "OPY") using BE approaches to provide timely advice to help patients successfully use, wean off, and dispose of their postoperative opiate medications.

2. Methods

This study took place at M Health Fairview (MHF), an academic health system with 10 hospitals based in greater Minnesota and western Wisconsin (United States) (Institutional Review Board approval STUDY00014614). This study had two phases: a) app build and b) usability evaluation. To build OPY, we collaborated with the MHF IT team to create a workflow with Epic Care Companion (ECC). ECC workflows are integrated into an existing patient portal mobile app, available on iOS, Android, and web browsers. The application functionality is as follows: OPY helps patients self-monitor their postoperative pain and medication through medication reminders, periodic check-ins, educational content, and a to-do list. OPY can inform changes to the care plan and escalations by patients, their care team, and caregivers. We utilized an iterative process to build OPY involving a group of subject matter experts (SMEs) with various backgrounds (i.e., designers and implementers, patient educators and clinicians, physicians, and usability experts). The focus of this manuscript is on the usability evaluation of an early version of the tool founded on the social influence aspect of the BE principles.

Usability testing was performed via (a) expert-based heuristic evaluation (HE) and (b) patients-based use testing. Three experts (a physician informatics/usability expert; a surgeon; and a patient education expert) conducted the HE using Nielsen's 10 usability heuristics. The validated process entailed four phases (i.e., training; independent evaluation of usability violations; severity scoring of the violations; and consensus).

A convenience sample of patient participants (adults without opioid use disorder who underwent surgery and had pain managed with opioid medications, n=5) was recruited. We created the OPY prototype by incorporating OPY screenshots into an interactive PowerPoint (ppt) where participants could click on buttons and use the app as they would in the fully deployed app.

Sessions were conducted via Zoom. One researcher served as the moderator and two researchers as note takers. Participants were asked to use the app twice, once as they would have done on their worst day of pain and again on their best day of pain, and share

their thoughts aloud. The moderator conducted an interview, allowing the participant to provide additional feedback. Each session was audio recorded and screen recorded with transcription enabled. After the interview, participants completed a Single Ease Questionnaire (SEQ) [7] rating the difficulty of the task on a 7-point scale, the mHealth Application Usability Questionnaire (MAUQ) [8], and demographics survey. MAUQ consists of 18, 7-point Likert scale questions assessing overall OPY usability.

We performed thematic analysis of qualitative data using inductive reasoning. Two independent coders (MG, SP) reviewed and coded the data from one participant to generate the initial codebook. A third coder (RR) served as an arbitrator to address any discrepancies. Themes and sub-themes were generated in a dynamic fashion as they emerged. Quantitative analyses included calculating the mean SEQ scores for each task under the "worst pain" and "least pain" conditions and combined across both conditions. Mean and standard deviations were also calculated for each MAUQ question. Patient demographics were reported as percentages.

3. Results

Expert heuristic evaluation identified 61 usability problems. Two of the 10 heuristic principles violated the most were "Match between system and the real world" i.e., using familiar words, phrases, and concepts rather than system-oriented terms (30%) and "Consistency and standards" i.e., using conventions and standards, so that users know what to expect and how to operate the interface (26%). The highest number of catastrophic violations (n=2) was associated with "Match between system and the real world."

Usability session participants were largely between 25-44 years old (80%), and males (100%) who also identified as nonbinary (40%) or transgender (40%). A majority had a bachelor's degree (60%), rated their health as fair (40%) or good (40%), and considered their comfort with technology as intermediate (40%) or expert (60%). Qualitative data were grouped by the three MAUQ themes: a) Usefulness, b) Ease of use, and c) System Information and Arrangement. Table 1 summarizes themes, subthemes, and exemplar quotes.

Table 1. Themes, subthemes and supporting quotes.

Themes (definitions)	Sub-themes	Exemplar quotes
Ease of use and satisfaction Attribute assessing if user interfaces are easy to use	- Clarity in language - Visual appeal - Desire to use	"...it's not clear if it's a choose one or pick multiple. – [Participant 1] "...Too many words. I don't like apps that have too many words in them. I think this can be explained in a couple of visuals." – [Participant 3]
Usefulness The value ascribed to the application by the user	-Utility -Acceptance	" To have an app that is educating me and guiding me day to day is very beneficial." – [Participant 5]
System Information and Arrangement Functionality, organization, user workflow exchange of information and feedback	- Intuitiveness - Auto-population/app responsiveness - Additional resources - Discrepancies in instructions - Motivational language	"I know that that's a link but it's not intuitive to me that that's where I need to click to get more resources." – [Participant 3] "Sometimes it was just a little confusing because I felt like I had already started weaning, but it still asked me if I was ready to start weaning… I would assume that I am already weaning." – [Participant 4]

SEQ ratings, where participants were asked "Overall, how difficult or easy was the task to complete?" on a scale of 1 (very difficult) to 7 (very easy), were high, ranging from an average of 6.4 to 6.7. We analyzed MAUQ by categorizing questions into three main themes [9]. MAUQ ratings (Table 2), where participants were asked 18 questions and responded on a scale of 1 (strongly disagree) to 7 (strongly agree), were variable. Responses to "Ease of use and satisfaction" questions were highest for "I feel comfortable using this app in a social setting" (6.2) and "The app was easy to use" (5.8), and lowest for "I like the interface of the app" (3.8). Responses to "Usefulness" questions were highest for "The app helped me manage my health effectively" (5.2) and lowest for "The app improved my access to healthcare services" (3.75). Responses to "System information and arrangement" questions were highest for "Whenever I made a mistake using the app, I could recover easily and quickly" (6.0) and lowest for "The app has all the functions and capabilities I expected it to have" (4.0).

Table 2. MAUQ Results.

Ease of Use & Satisfaction Questions	Average (SD)
The app was easy to use.	6.00 (0.71)
It was easy for me to learn to use the app.	5.80 (1.10)
I like the interface of the app.	3.80 (1.92)
The information in the app was well organized, so I could easily find the information I needed.	4.20 (1.92)
I feel comfortable using this app in social settings.	6.20 (0.84)
The amount of time involved in using this app has been fitting for me.	5.25 (2.36)
I would use this app again.	4.25 (2.75)
Overall, I am satisfied with this app.	4.00 (2.24)
Usefulness Questions	
The app would be useful for my health and wellbeing.	4.80 (2.68)
The app improved my access to healthcare services.	3.75 (3.20)
The app helped me manage my health effectively.	5.20 (1.79)
I could use the app even when the internet connection was poor or not available.	4.50 (NA**)
System Information and Arrangement	
The navigation was consistent when moving between screens.	5.40 (2.51)
The interface of the app allowed me to use all the functions offered by the app.	5.60 (1.52)
Whenever I made a mistake using the app, I could recover easily and quickly.	6.00 (1.00)
The app adequately acknowledged and provided information to let me know the progress of my action.	4.20 (1.92)
The app has all the functions and capabilities I expected it to have.	4.00 (1.73)
This app provides an acceptable way to receive healthcare services, such as accessing educational materials, tracking my own activities, and performing self-assessment.	5.40 (1.52)

***Standard deviation could not be calculated as several participants did not answer this question.*

4. Discussion

Heuristic evaluation (HE) of the OPY prototype identified major usability issues with relatively minimal use of resources. Out of all usability issues identified (61), 44% (27) were considered either catastrophic or major, a finding consistent with other studies done, showing that HE is an important step to find major usability issues [10]. The findings from HE were then conveyed to the build team to be addressed in the next iteration.

The end user-testing provided deeper insights from the point of view of patients. Using the interactive ppt prototype helped identify many issues prior to final build and deployment. User testing, both qualitative and quantitative, showed that this app is much

needed. However, the interface and its content need improvement in several areas. Like the HE, we plan to convey user identified issues and their suggestions for improvements to the build team to help enhance design and functionality of the next versions.

There are a few limitations associated with this study. In the vendor-based ECC, many features are hardwired and cannot be altered without the vendor's engagement. Additionally, the patient user testing cohort was a heterogenous convenience sample of patients who have undergone surgery in the past and not users testing the real app during their actual postoperative period.

Our next steps are to revise the design of OPY application based on user testing and heuristic evaluations findings. We will conduct another phase of usability evaluations once we have a working prototype. In parallel, we plan to build and test two more versions of the OPY tool, leveraging the concepts of pre-commitment and gamification. The knowledge gained from this study will be used to hone the design of OPY for a subsequent randomized clinical trial deployed at scale.

5. Conclusions

Integration of a patient-centered tool embedded in a patient portal for opioid management leveraging behavioral economics theory is a promising step. Involving early and working closely with developers, experts and users could lead to an effective intervention that could help combat the opioid crisis.

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