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PRELIMINARY RESEARCH

Leveraging Trauma Informed Care for Digital Health Intervention Development in Opioid Use Disorder

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Abstract
Digital health refers to the use of information and communication technologies in medicine (including smartphone apps, wearables, other non-invasive sensors, informatics and telehealth platforms) to prevent illness, deliver treatment, and promote wellness. This rapidly proliferating group of technologies has the potential to reduce harm for people with opioid use disorder (OUD) and facilitate the recovery process; however, development in this space for OUD has been slower compared to that for other medical conditions. Unique issues with OUD management surrounding patient provider relationships, interaction with the healthcare system, autonomy and trust sometimes hinder care approaches, including those in digital health. The trauma informed care framework (TIC), developed for use by organizations to support individuals who have experienced trauma, has particular applicability for digital health interventions in OUD care. This manuscript will serve as a review of TIC principles and how they can be applied to digital health interventions to increase access, equity, and empowerment for people with OUD. We will highlight representative current and pipeline digital technologies for OUD, challenges with these technologies, TIC models for OUD, and the integration of TIC principles into digital technology development to better serve people with OUD. Finally, we will posit strategies to incorporate the aforementioned principles into future research efforts. We ultimately aim to use TIC as a lens through which to develop digital technologies to help individuals with OUD while minimizing harm.

Keywords Digital health · Trauma informed care · Opioid use disorder

Introduction

Despite tremendous efforts on the parts of healthcare providers, public health officials, and the government, the opioid crisis (and the number of opioid-associated deaths) continues to escalate [1]. Overdose-related death, however, is only one of the many devastating consequences of opioid use disorder (OUD); the associated morbidity also has significant physical, social, and financial tolls. As such, the benefits of effective treatments for OUD reach beyond reduction in mortality to include economic, interpersonal, and health related impacts for individuals with OUD and their communities. Current standard of care for OUD includes behavioral therapy and pharmacologic therapies: both of which struggle with poor retention and high rates of return to use. Even the most effective therapies (medications for opioid use disorder) have long term adherence rates of only 25–50% [2, 3]. Novel solutions are desperately needed.

Digital interventions, which include both diagnostics and therapeutics, have been proposed, developed, and disseminated for numerous chronic health conditions, including cancer and diabetes [4–6]. Digital health refers to the use of information and communication technologies in medicine (including smartphone apps, wearables and other

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non-invasive sensors, informatics and telehealth platforms) to treat illness and promote wellness [7]. In recent years, there has been promise shown in designing digital health technologies for people with OUD. These technologies have the potential to reduce harm for people with OUD and facilitate the recovery process. However, the development of digital health technologies for OUD has progressed at a slower pace than that for other disease processes. Unique issues with OUD management surrounding patient provider relationships, interaction with the healthcare system, autonomy and trust sometimes hinder care approaches, including those in digital health. The intersectionality of OUD with many social determinants of health (e.g. socioeconomic status, education) and other stigmatizing conditions (e.g. justice system involvement and unstable housing status) further complicate the issue.

Trauma informed care (TIC) is a theoretical framework obtained from social work practice that was originally developed to support individuals who have experienced trauma. The TIC approach seeks to acknowledge and understand the role that trauma plays in health care interactions and integrate that knowledge into practice to actively avoid re-traumatizing patients. The five guiding principles of TIC that organizations (or interventions) need to consider to achieve these goals are: safety, trust, choice, collaboration and empowerment. Although designed for broader use, this model is particularly well suited for OUD interventions, as it is common for people with OUD to have experienced marginalization and trauma in some form [8]. This manuscript will serve as a review of TIC principles and how we can use them to make digital health technologies more accessible, equitable, and empowering for people with OUD. We will highlight challenges with the development of digital technologies for OUD, representative current and pipeline digital technologies, TIC models for OUD, and the integration of TIC principles into digital technology development to better serve people with OUD. Finally, we will posit strategies to incorporate the aforementioned principles into future research efforts.

Challenges with Designing Technology for OUD Management

As the role of digital health technologies in the management of OUD has expanded, several design considerations have come to the fore. Key issues that could introduce (as opposed to reduce) harm are punitive applications of technology, privacy loss, perpetuation of stigma, and technology not being tailored to the unique needs of this population.

Use of Technology to be Punitive

Digital technology provides a means of tracking behavior. In a marginalized population such as that of individuals with OUD, tracking enabled by these technologies could theoretically be used to police and/or punish the monitored individuals, even if that was not the initial intent of the technology. For example, a digital technology system designed to objectively track buprenorphine adherence may be intended to prompt providers to explore driving factors and trigger support interventions in the case of non-adherence. However, it could also be used to deny prescription refills or insurance coverage, disqualify individuals for treatment, prompt legal action if diversion is suspected, or otherwise restrict access to a lifesaving medication.

Loss of Privacy and Exposure to Stigma

The tracking of behavior using digital technology raises the issue of privacy associated with the collected data. The information gathered by these digital technologies in the process of helping a patient manage their OUD is sensitive, and the patient might want to keep such information private because of associated stigma [9] or fear of other social consequences. This need for privacy applies not only to the data itself but also to the manner in which the data is collected. For instance, if an OUD management technology requires the use of monitoring devices such as a wearable sensor (e.g., a watch, band, a patch, textile, etc.), the visibility of the device might provoke questions from others about the condition of the person wearing it. Considering the stigma associated with OUD, the loss of privacy could thus add to the level of traumatization of individuals with OUD.

Ignoring the Lived Experience of the Target End-User

Technology design often makes implicit assumptions about the lifestyles of the individuals whom it is designed for. This is especially true when the technology is designed with a "do-it yourself" ethos: an approach which puts the onus of using the technology on the user. Given the limitations of care-related resources for OUD, it is understandable why technology would be designed in this way. However, following the "do-it-yourself" ethos requires a certain level of privilege that affords users (individuals with OUD) the mental and physical wherewithal to deal with the complexities that such technologies bring. For example, if a person were using a smartwatch to track their level of stress, a known trigger for opioid use relapse [10], they would require stable access to an electrical source to charge the device and a wifi connection to upload data.

It has been noted that most modern digital technologies are often part of what is referred to as "self-tracking culture" [11] and assume a certain level of health consciousness on the part of the user, both of which are only fully available to those with sufficient socioeconomic privilege and stability in their lives. Thus, those with challenges in various social determinants of health (e.g., older age, lower education or socioeconomic status, rural or remote locations, or housing insecurity) cannot fully benefit from these technologies, which can widen existing healthcare disparities. The simple translation of existing technologies (which have been generally designed for highly resourced population) may not be sufficient to improve the wellbeing of people with OUD: interventions must incorporate pertinent health behavior theories to provide motivation and support, and to optimize their impact.

Current and Pipeline Technologies for OUD

Existing technologies within the digital health space around OUD can be organized into two categories: diagnostic technologies and therapeutic technologies.

Digital Diagnostics for OUD

Potential digital diagnostic applications for OUD include monitoring of opioid exposure, overdose and withdrawal. Physiologic data from wrist-worn sensors have coupled with machine learning models to identify opioid administration in both outpatients [12] and hospitalized patients [13, 14]. Sonar technology in off the shelf smartphones has been used to detect opioid induced respiratory depression and apnea [15]. More recently, researchers have developed a prototype device which uses a wrist-worn sensor to detect hypoxia as a marker for opioid overdose [16]. Other investigators have focused on models to detect withdrawal, including a heart rate and accelerometry from a wrist worn sensor [17] and accelerometry from a chest worn sensor [18]. These digital diagnostic technologies, most of which are still in the research and prototype stages, could enhance the safety of opioid prescribing, identify early markers of OUD, and/or serve as harm reduction tools in OUD.

Digital Therapeutics for OUD

Digital therapeutics for OUD span from AI technologies optimizing naloxone distribution [19] to mobile health interventions.

Numerous smartphone applications, targeted towards OUD treatment or opioid management, have been developed or are in development. Many apps deliver educational interventions, such as Opioid Management for You (OPY) tool, which aims to facilitate safe opioid use in the post-operative period [20, 21], or the Technology- facilitated Resilience Recovery Program (TRRP) mobile app, which provides interactive education modules on OUD to adolescents recently discharged from the hospital following traumatic injury [22]. Other apps leverage contingency management, such as the PROCare Recovery app which delivers micropayments for reaching recovery goals [23]. Establishment of a social connection is another common theme in apps such as the Heal Overcome Persist Endure (HOPE) app, which enables people with OUD to share affirmations with peers and messages with their care team [24, 25]. Finally, other apps promote mindfulness as a coping strategy for OUD, such as the RAE health app which uses wearable sensor detected stress and craving states to trigger self-reflection and de-escalation exercises [26].

Other interventions take a hybrid approach, coupling digital diagnostics with more invasive pharmacologic interventions. Naloxone auto injectors are often coupled to accelerometry and/or pulse oximetry to detect opioid induced depression, and to administer naloxone upon detection [16, 27, 28]. Using predefined algorithms, they identify insufficient respiratory effort or hypoxia and trigger and implemented reservoir to release naloxone.

All of the described technologies developed for diagnosis or therapeutic applications in OUD will need to address the aforementioned challenges. Given the marginalization of individuals with OUD, these considerations should be explicitly considered in the design of digital health technologies targeting OUD.

Trauma Informed Care (TIC): A Framework for Supporting Individuals with OUD

Trauma informed care (TIC) can play an important role in the design of digital health technologies for people with OUD. In recent years the TIC framework has been considered for people with OUD and more broadly substance use disorder (SUD), based on the observation that trauma often plays a major role in the development of SUD [29]. The idea is for providers to be cognizant of and understand the role of trauma in OUD and thus increase patient retention in treatment and decrease return to use [30]. In recent years, TIC has been considered as an important method for support organizations for people with OUD. The principal idea is for TIC-oriented services to rely on theory and practice of other humanistic paradigms, notably harm reduction and patient-centered care. The Substance Abuse and Mental Health Services Administration (SAMHSA) outlines that any organization seeking to provide TIC services must

satisfy five core criteria: safety, trust, choice, collaboration, and empowerment [31]. Based on the prior work by Bartholow et al., the five criteria of TIC can be defined in the context of OUD interventions as follow [30]:

- Safety: Programs should explicitly provide an environment where the person with OUD feels physically and emotionally safe and avoids any form of re-traumatization. This includes feeing safe enough to share information and engage with the intervention, feeling protected from inadvertent disclosure of their information, and not fearing repercussions if they, for example, have a return to use event.
- Trust: Trust between the patient and the organization and its staff is essential to the care process of someone with OUD and is necessary to ensure retention in treatment. To achieve this, organizations should clarify expectations and provide consistent service delivery.
- Choice: Trauma often causes people to lose their sense of control over their lives and their bodies, which can contribute to the development of OUD. A core element of TIC is to allow individuals to make their own decisions and regain their sense of control.
- Collaboration: Individuals with OUD often lack stability and social support. Support should be provided to the individuals with OUD in a way that facilitates their active participation and partnership in the treatment program.
- Empowerment: This criterion involves recognizing and leveraging the unique strengths, skills, and abilities of the individual person with OUD as a way to aid them in their recovery.

Incorporating TIC in the Design of Technologies for Managing OUD

To our knowledge, no prior work has specifically focused on leveraging TIC in technology design for OUD. Trauma informed care criteria can be adapted to the design technologies for managing OUD by exploring important design guidelines related to each criterion.

Designing for Safety

The first criterion we consider is that of providing patients with a sense of physical and emotional safety. We define safety in the technology design context as designing with the intent to minimize any re-traumatization of patients. We propose the following guidelines to design for safety.

Be Actively Supportive of the Lived Experiences of Patients

Individuals with OUD have extremely diverse lives and lived experiences. This can vary from people who are unhoused or experiencing housing instability to those with substantially more economic resources. Consequently, when designing technology to support those with OUD, it is crucial to understand who the intended users of the system are and what their daily lives entail. Any technology that is not actively supportive of the lived experience of its target population will at best remain unused and at worst could cause trauma if perceived as being disdainful of capacities of individuals in the population. For instance, if designing an app to provide unhoused individuals with OUD information on outpatient treatment facilities near their current location, we need to make sure the app is: (1) *small in size* and does not take too long to download given that internet access can be precarious; (2) is *not memory or processing intensive* and works on some of the simplest and least expensive feature or smartphones, which are probably several generations behind the latest models in terms of hardware and operating system; and (3) has a *simple user interface* that can work for people who may lack digital literacy or may otherwise be distracted.

Use Appropriate Language in the Messaging and Prompts that Accompany the Technology to be Supportive and Non-Stigmatizing

It is crucial that any technology introduced into the OUD community avoids language that further exacerbates the stigma associated with the condition. One of the ways of creating unwanted stigma is through carelessness in any communicative language that accompanies the technology. Examples of communicative language include everything from manuals on how to use the technology to individual prompts and messages displayed during the use of the technology. In recent years there has been considerable effort in ensuring that discussion around OUD is non-stigmatizing. A common example is using person-first language, which focuses on the person—not their illness and thus does not define a person by their condition (e.g. a person with OUD as opposed to an "opioid addict") [32]. This effort ought to be extended to technology as well. Designers of technology and engineers often are not trained to pay attention to the language that they incorporate in their work. However, when designing for marginalized and stigmatized communities the use of inappropriate or careless language can be problematic and stigmatizing and should be actively avoided. Furthermore, language needs to be simple, comfortable and non-intimidating, such that the information (whether it is an ask to complete a task or education being delivered) is

plainly communicated. The vast majority of digital health apps do not adhere to readability recommendations from the American Medical Association and the National Library of Medicine, which stipulate that patient information should be provided at a third to sixth grade reading level [33]. This is particularly important for the OUD population where lower baseline literacy levels and decreased tolerance for frustration will rapidly lead to disengagement if the language accompanying a technological solution is too complex.

Designing for Trust

When it comes to OUD management technologies, we define trust as the technology's ability to foster confidence in patients that they and their information will be protected. We suggest the following guidelines to design for trust.

Design the Technology to be Privacy Preserving

As stated above, OUD technologies must protect the privacy of patients. In this regard, privacy preservation has to be done in two broad ways: (1) in terms of ensuring presence/use is not obvious to others and (2) any personal/medical data collected by the technology is protected.

Protecting the privacy of use of OUD technologies, depends on the type of technology being developed. Technologies based in consumer electronic devices, such as smartphones, are easy to conceal. However, not all technologies can work in such systems. For instance, in many situations we might need a wearable device to interface with the smartphones to collect the requisite data. In such cases, the choice of the device's location on the body should be strategically considered to enhance its acceptability and discretion. If the device is intended to be visible on the body, the aesthetic should be akin to that of consumer wearables, which are generally well-received and adopted socially. This approach helps in reducing the stigma associated with the use of a medical device, as it blends seamlessly with everyday wearables like fitness trackers or smartwatches. Designing devices that resemble everyday technology can prevent users from feeling marginalized or labeled, thus fostering a more accepting attitude towards the use of such technologies [34, 35].

Protecting patient data collected by the technology is also critical. The data collected by digital technologies in the OUD context can be of many types, such as patient's health (e.g., vital signs, physiological biomarkers, tremors, etc.); behavioral traits (e.g., sleep, physical activity, ecological momentary assessment etc.); and movement patterns (e.g., GPS-based location). Patients should have the ability to control how their data will be used, stored, protected, and accessed by others. Further, the technologies should be carefully designed to collect only the most essential information from the patients to achieve the objective of the specific technology and avoid the current practice of over-collection of patient data [36]. Tas et al. noted that people who use opioids expressed concerns about the security of their data and information, and some specifically worried that government agencies might use the data for punitive purposes or to implicate individuals in criminal activities [35].

Geolocation data is a prime example of sensitive data that needs protection. While geo-location tracking can be valuable for ensuring safety and providing contextual data for interventions, it also raises significant privacy concerns [37]. It is essential that the use of geo-location features be transparently communicated to end-users, and that they retain control over this function. End-users should have the ability to opt-in or out of location tracking, and clear information should be provided about how location data will be used, stored, and protected. Given the sensitive nature of these data, ongoing consent must be ensured. This may come in the form of periodic "check-ins" to inform the user how their data is being used, and/or to assess their perceptions on any privacy concerns, followed by re-attestation to continue collection of these data modality. This would increase transparency and promote confidence in the organization's respect for user privacy.

Clearly Communicate to Patients About the Privacy Protection Practices Incorporated in the Technology

It is not enough to have good privacy-preserving features in the design of technology for OUD; their presence must also be conveyed to the individuals using the technologies. Transparency and control are crucial for maintaining trust and respecting end-user privacy. For instance, if a wearable device is being designed to monitor the physiology of the individual with OUD to understand various situations, it is not enough to make sure that the information is protected from unauthorized access. It is equally as important that the end-user understands that their privacy is being protected in this manner. Traditional privacy policies and terms of agreements for commercial products are cumbersome, difficult to understand, and unlikely to convey the key information to the average technology consumer [38]. Alternative strategies to enhance transparency include: (1) having an always visible message within any accompanying app that clearly, explicitly states that the information collected by the device is secured; (2) explicitly guiding the patient to set their privacy and access settings when the technology and its app is used for the first time; and/or (3) reminding patients intermittently who has access to their information and how it is secured through easy to consume messaging and prompts.

This allows the patient to build trust within the system over time and increase the chances that they would consistently use the digital health technology.

Designing for Choice

The criteria of choice entails giving people with OUD the opportunities to make decisions and gain control over their recovery and life. When it comes to technology design, we view choice as the ability of the patient to configure the technology in a manner that is convenient for them. We suggest the following guidelines to design for choice.

Design the Technology to Give the Patient Complete Control Over the use and Operation of the Technology

When designing for marginalized communities, it is important to ensure that they have complete control over its operation. In the context of technologies designed to support OUD recovery, this means allowing patients the ability to configure the device to operate in a way that they are comfortable with. For instance, any OUD technology that can collect data from its patients and has the ability to share it should allow: (1) end-users to easily select and modify the types of data they wish to collect and ensure their control over the local or remote storage of this data [39, 40] and (2) facilitate easy recovery in the event of loss of access to the data – especially when stored remotely on the cloud [41]. Another element of control over the technology can be ensured by promoting ease of use over it That is, the design of technology should ensure that patients can engage with the device and integrate it seamlessly in their daily lives [42–44]. For instance, when designing a wearable device in the context of OUD management, the device should provide intuitive methods for putting on and removing the device, as well as straightforward controls such as switches or buttons for logging events. Additionally, the physical design should minimize the burden of time and effort required for managing and maintaining the device, including charging, cleaning, and storing [45]. Furthermore, incorporating clear visual indicators and feedback can ensure the patient's confidence in controlling the operation of the technology.

Provide Choices in Setting up and Deploying the Technology

Technology end-users will have variable experience with use and understanding of the technology's functionality. An important element of the choice criteria, therefore, is for the technology to be designed so that it is customizable to the needs and mental model of the end-user. This means that the device configuration should be flexible and intuitive [46]. Further, the device must function reliably no matter how the patient configures and chooses to use the device [47, 48]. Some ways of ensuring this include: (1) the technology's response time should be efficient and satisfactory to all configurations of the device; (2) no matter the configuration the battery life of the technology should minimize the frequency of recharges, thus reducing disruption to the patient's daily activities; (3) the technology should facilitate a richer interaction by allowing users to view their data, receive personalized insights, and adjust settings; and (4) any interoperability capabilities of the technology with other devices should be safe, convenient, and under the patient's control.

Designing for Collaboration

The collaboration criterion involves providing support to the individual such that the effort toward recovery from OUD involves their active participation. From a technology standpoint, we define this criterion as involving appropriate stakeholders in the design process of any OUD-focused technology and promoting social connection as part of the design.

Involve the Appropriate Stakeholders in the Design Process

As stated earlier, an important part of designing technologies for individuals with OUD is understanding their lived experiences. One of the best ways to achieve this is to collaborate with appropriate stakeholders. That is people who are part of the recovery ecosystem - interested in helping individuals with OUD with their recovery. This includes a diverse set of people, including peer recovery coaches, case managers, mental health workers, social workers, physicians, nurse practitioners and of course, most importantly, the individuals with lived/living experience of OUD. Further, when interacting with these stakeholders, it is important for the designers to keep an open mind and listen to the ideas, opinions, and perspectives around OUD being discussed. Designers should be willing to fundamentally reformulate (or even abandon) prior design ideas based on feedback from the stakeholders. This work with stakeholders also organically fulfills one of the fundamental requirements of working with individuals with OUD: nothing about us without us [49].

Research studies can engage persons with lived experience as both participants and/or study team members, and both strategies have distinct advantages and challenges. A more traditional approach is to engage target end-users as study participants in usability and acceptability studies which can use quantitative (e.g. survey) or qualitative (e.g. focus groups, semi-structured interviews) methods

to understand needs, perceptions, facilitators and barriers related to proposed solutions. This approach requires no prior training or longitudinal commitment for individuals in the community to participate, and it allows a variety of voices and points of view to be captured. Research participants who see their feedback implemented and taken seriously are often willing to re-engage and are also outstanding advocates to recruit others. More recently, professional organizations and researchers alike have advocated for the inclusion of people with lived experience with OUD as part of the research team as opposed to solely as participants [50, 51]. This strategy introduces the voice of the target population into the research process much earlier and can improve the design of the studies themselves. Study team members with lived experience can, for example, provide input into selection of important variables and outcomes of interest, recruitment and retention techniques, language used in participant-facing materials, and interpretation of outcomes. Study team members with lived experience with OUD may have limited prior research training and may have barriers to longitudinal commitments, which are important for study teams to accommodate. These accommodations pay off over time, through valuable input and also by helping bolster the team's overall credibility in the community.

Promote Social Connection and Community as Part of the Design

The need for community and critical importance for social support are well established factors that influence recovery and success in OUD treatment [52, 53]. Technologies that support this pillar of recovery would provide several benefits; however, important challenges need to be considered. Technologies could serve to strengthen connections within an existing network identified by the end-user, for example by suggesting they reach out in the case of a triggering event or by sharing progress (e.g. accomplishments, challenges). Connection to others outside the individual end-user's predefined network creates potential issues with privacy and requires built in protections to ensure safety (e.g., anonymous posting and professional moderation of content). An alternative strategy could leverage social networking structures to build connections with others in recovery. Although still in early stages, generative Artificial Intelligence (AI) can be used to simulate human conversations and may be a useful alternative tool to provide a just-in-time adaptive intervention when another human is not available.

Designing for Empowerment

The final criterion, empowerment, involves leveraging the individual strengths, skills, and abilities of the person with OUD in helping them with their recovery. From a technology standpoint, we define this criterion as providing information about various aspects of OUD, its causes, and recovery to allow the patient to take action toward their recovery.

Provide Relevant Education About Various Aspects of OUD and the Recovery Process

One common and powerful use of technologies is to provide accurate and trusted medical information. This is especially important in the current culture of internet misinformation. Although purely informational technologies may not be attractive as stand-alone tools, incorporating education into more engaging tools provides an opportunity to get important information into the hands of those who need it the most. The educational content should be curated to reflect the most pressing needs. For example, a system designed to monitor opioid withdrawal may present accessible information about the withdrawal process and the pharmacokinetics/dynamics of the MOUD of choice in any accompanying app. Content should also be designed with engagement from key stakeholders (see Designing for Collaboration above) to ensure the language and content is engaging for end users.

Future Research Directions

Trauma informed care is a powerful tool through which to develop and evaluate digital health interventions, particularly for those with OUD. They can allow us to study the unique needs of people with OUD as opposed to extrapolating strategies from the general health and wellness device user population. These principles are not new to the clinical realm but are more novel in their application to research. Investigators should consider each of the principles of TIC and how they can (or will) be met during the early study design phases. Ideally, this will include incorporating viewpoints of people with lived/living experience in the design process, either through qualitative methodology and/or adding them directly on the research team.

As a use case, our team's ongoing study aims to develop a digital health system (MINDER) which supports buprenorphine therapy by monitoring adherence and efficacy. The system includes a custom wearable device (which uses continuous physiologic data to identify digital biomarkers of buprenorphine ingestion and opioid withdrawal), a mobile app to visualize data and a cloud-based server to communicate information to healthcare providers. In the conceptualization phases of our study, we were met with polarizing opinions regarding such a technology with many people being excited about the prospect while others were concerned it could lead to inadvertent harm to people with

OUD if used incorrectly. Thus, we propose to use TIC as a lens through which to fabricate and test the system to maximize benefit and minimize potential harm.

Specifically, during fabrication of the device and system we will:

- Conduct qualitative interviews with people with lived/living experience with buprenorphine therapy to understand their existing digital routines, and to build their desired features (choice, collaboration).

During end user testing we will:

- Focus on transparent information sharing strategies, whereas end-users are informed (in plain language) and have control over who has access to their data (choice, trust, safety).
- Implement test user feedback and wherever possible demonstrate the outcome of their implemented feedback in real-time (collaboration, empowerment).

Ultimately, we aim to produce to a beneficial and ecologically valid digital health system that people want to use to support their recovery. We also hope it will generate new insights that will improve the way we care for people with OUD and their communities.

Conclusions

Given the design challenges associated with digital health interventions for OUD, we posit that their design should follow the five pillars of TIC – safety, trust, choice, collaboration, and empowerment. We then further defined these pillars in the technology design context and presented a list of guidelines that we believe all designers of technology in the OUD space should consider. By following these principles, we can avail people of the benefits of the digital technologies to help individuals with OUD while importantly minimizing harm.

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Declarations

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