

Review

Potential use of virtual reality technologies for opioid use disorder treatment

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CITATION

Garett R, Young SD. Potential use of virtual reality technologies for opioid use disorder treatment. *Computer and Telecommunication Engineering*. 2024; 2(1): 2375.
<https://doi.org/10.54517/cte.v2i1.2375>

ARTICLE INFO

Received: 10 November 2023

Accepted: 19 March 2024

Available online: 29 March 2024

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Abstract: The opioid epidemic is a serious national public health crisis. Although effective medications are available to treat opioid use disorder, there are low rates of uptake and treatment retention. To mitigate these problems, novel engineering devices, such as using virtual reality (VR), warrant examination. Certain opioid use disorder (OUD) populations may especially benefit from virtual reality to assist with treatment initiation and retention, such as incarcerated persons living in pre-release facilities, adolescents and young adults, and patients of methadone treatment facilities. However, prior to implementing VR in research and the community, issues such as side effects (e.g., VR-related nausea) need to be considered. This manuscript provides a brief review, identifies potential OUD-related populations that might most benefit from VR, and discusses considerations needing addressing prior to widescale implementation of VR for OUD.

Keywords: virtual reality; immersive technologies; methadone; opioid use disorder

1. Introduction

Opioid use disorder continues to be a public health crisis, with nearly 50,000 people succumbing to overdose in 2019 [1]. Currently, there are three Food and Drug Administration-approved medications for opioid use disorder, though use of these medications remains low despite availability. Barriers to treatment include financial challenges, regulatory restrictions, geographic variation in availability, negative attitudes, and logistic barriers [2]. Novel approaches have been used to leverage digital tools to increase uptake of medications for opioid use disorder (MOUD) and retention, such as telehealth [3], mobile apps, and wearable devices [4]. This paper explores using virtual reality to increase retention of opioid use disorder treatment among specific populations.

1.1. Applications of virtual reality in health and behavior change research

Use of virtual reality (VR) continues to trend upwards as industries expand the use of VR in their business models. In the US, 78% of Americans are familiar with VR, with 41% of adults open to experiencing VR if given the opportunity [5]. VR has already been used in a variety of health and behavioral change research and is beginning to be studied in the context of substance use. For example, VR has been studied for rehabilitation of motor function, where investigators examined the role of immersion type, enjoyment of VR, and haptics use during the program in improving motor function and patient adherence to the VR rehabilitation routine [6]. Applications

have also included use in inpatient settings for pain management, eating disorders, and cognitive and motor rehabilitation [7].

VR and other online approaches have also been used in various psychological and psychiatric disorders, such as for phobias [8]. Investigators used a VR exposure program delivered over the internet to treat small animal phobia, with pre- and post-test results showing a significant decrease in all measures [9]. With respect to psychiatric disorders, the use of VR had benefits over traditional sessions by eliminating potential barriers and has been widely accepted by patients [9]. One review examined the efficacy of VR for the assessment and (inpatient and outpatient) treatment of substance use disorders such as nicotine, alcohol, cocaine, cannabis, gambling disorder, and internet gambling disorder [10]. Among the studies included in the review that examined VR's use for nicotine dependence, results were somewhat mixed, but most found that VR decreased craving. All three alcohol studies decreased craving. Results for the VR gambling studies were also mixed. The one internet gambling study found a reduction in dependence but did not measure craving [10]. The studies in the review varied in their design and treatment protocol, but do show an impact of VR in studies of addiction and suggest potential for applying VR to increase initiation and retention of medications for OUD.

1.2. Potential use of virtual reality in opioid treatment

Although VR studies on substance use disorders and addictive behaviors have had mixed results, the application of VR to opioid use disorder may be beneficial in treatment retention, though more research is needed [11,12]. For example, due to the ability to use VR in private places, such as the home [13], use of VR as a tool for education and social support for OUD treatment might address barriers such as stigma, limited access to mental health providers, provide additional social support, and address geographic limitations (i.e., rural regions) [14,15]. Based on program needs and resources, VR simulations can be tailored for the specific population and can be implemented in one of three ways: non-immersive, semi-immersive, or fully immersive simulations.

1.3. Individuals involved in the criminal justice settings

One group who may benefit from VR to maintain treatment are incarcerated individuals, especially those who are pre-release. In a randomized control trial, persons living in pre-release facilities who began a methadone treatment program plus counseling while incarcerated had higher rates of treatment retention and were less likely to have an opioid-positive urine specimen at 12-month follow-up compared to the counseling only and counseling plus community-based methadone program groups [16]. Building on this research, VR might be helpful as a tool for initiating methadone treatment prior to release, as VR might be continued to be used as a remote method for sustaining treatment. This is especially important as incarcerated individuals are likely to have OUD and have low rates of treatment after release [17]. For facilities with limited staffing, VR may be an alternative to live counseling sessions or a supplement to an already existing program. VR could also address some re-entry concerns and simulate potential scenarios to increase confidence in dealing with opioid

exposures through social contacts. Barriers and challenges for treatment maintenance among persons who were incarcerated that resulted in relapse or treatment termination after re-entry include housing insecurity, financial uncertainty, and peers using opioids [18].

1.4. Adolescents undergoing treatment

Use of prescription opioids among adolescents and young adults is high, and approximately 3.8% and 7.8% misuse opioids, respectively [19]. The American Academy of Pediatrics has advocated MOUD use for adolescents and young adults along with behavioral counseling [20]. Factors affecting retention in MOUD for adolescents include concurrent substance use, MOUD adherence, family conflict, and MOUD dosage and flexibility [21]. As adolescents and young adults are typically early adopters of technology, a technology-based program may be beneficial for this group of digital natives. Studies using VR in adolescents show promise, for example, as a distraction during wound care to reduce pain [22] or exposure therapy to reduce public speaking anxiety [23]. Findings from Kahlon and colleagues highlight the feasibility and scalability of VR use among adolescents, as well as the acceptability of clinicians to adopt VR in clinical practice [23].

1.5. Patients receiving treatment at a methadone clinic

Another group that may especially benefit from the application of VR are patients undergoing treatment at a methadone clinic. One study found that of all factors examined, only counseling was significant in predicting treatment maintenance at 6 months and a negative opioid urine test [24]. In another study, patients and counselors agreed that part of the reason for premature exit from a methadone treatment program was due to conflicts with the counselor [25]. Given that there is some data that counseling improves treatment but that disagreements with counselors may lead to premature treatment exit, a novel approach would be to use VR. In addition to incorporating behavioral change therapy techniques, programmers must minimize stigma within the program that people with opioid use disorders often experience. A non-human counselor may be effective in reaching out to individuals interested in MOUD but hesitant to initiate counseling sessions due to previous negative experiences with counselors. Additionally, VR may be a convenient alternative for patients with busy schedules if they can participate in counseling sessions at their own leisure.

The COVID-19 pandemic has disrupted opioid treatment programs, from the provision of services to the implementation of alternatives to obtaining therapies and personal protective equipment [26]. This has opened up opportunities to apply and evaluate the efficacy of technology-based interventions such as providing therapy via telepsychology [27]. One study that designed VR telepsychology for elderly users to increase mood state and happiness was well received by participants [28]. VR telepsychology might increase counseling sessions needed for MOUD by addressing barriers like transportation issues.

1.6. Considerations for implementation

In applying new technologies to research or clinical practice, certain considerations should be addressed prior to development and implementation to ensure appropriateness for the target population and that risks are minimized. Specific to the use of VR for OUD treatment retention, one important issue to take into account is the potential adverse events experienced by participants during a VR session, such as nausea, oculomotor, and disorientation symptoms [29]. Patients who receive MOUD may already experience side effects from those medications; these side effects might be exacerbated due to VR experience and need to be studied. Along with resource and protocol implementation constraints, possible side effects by participants may inform the type of VR format used, for example semi-immersive vs. full-immersive. One way to gain insight about the feasibility and acceptability of using digital tools is the inclusion of the target population as part of the design process to explore what virtual environment, messaging, and approaches would appeal to potential participants and patients. The knowledge obtained from these informants could also be useful in getting buy-in and interest from a group that may be disinterested in using technology alongside MOUD [30]. Another consideration would be the lack of access to VR by the program or facility. Fortunately, VR can be implemented using a 2D monitor and computer for the non-immersive simulations. An additional resource that can be used is YouTube 360. The price of digital tools, such as cameras and other equipment necessary for VR, tends to decrease as technology becomes more prevalent. Opioid treatment programs and facilities may take advantage of this and leverage publicly available social media platforms to disseminate their VR program.

2. Conclusion

As technology continues to evolve, novel applications of digital tools warrant examination to mitigate the ongoing opioid crisis [31]. VR has had some success in treating substance use disorders and has features that may appeal to both program administrators and patients. Although there is potential for adverse events to occur, certain populations may benefit from the implementation of VR alongside MOUD to minimize premature treatment exit. More research is needed on this topic prior to implementation.

Funding: This work was supported by grants from the National Institute on Drug Abuse, National Center for Complementary and Integrative Health, and National Institute on Minority Health and Health Disparities. The funders played no role in the design or decisions for the manuscript.

Conflict of interest: RG has received small business (SBIR) grants from the National Institutes of Health for ElevateU to help substance use researchers. SDY is a consultant for digital health companies.

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