

Digital Interventions for Substance Use Disorder: Promise, Pitfalls, and a Path Forward

November 6, 2025

Editor's note: This op-ed was prepared by Krishna Venkatasubramanian, PhD and Stephanie Carreiro, MD, PhD. Dr. Venkatasubramanian is an Associate Professor of computer science in the Department of Computer Science and Statistics at the University of Rhode Island. He is the Director of the Accessible and Socially Aware Technologies (ASSET) lab. His research is situated at the intersection of accessibility, human-computer interaction, design, and machine learning applied to understand and meet the needs of marginalized populations. Dr. Carreiro is a physician-scientist reimagining how digital technology can transform addiction care. An Associate Professor, Vice Chair of Research, and Director of the Tox(In)novation Lab at the University of Massachusetts Chan Medical School, she bridges emergency medicine, toxicology, and technology to improve how we prevent, detect, and treat substance use disorders. More complete biographies for each contributor can be found below. This op-ed is part of our [Special Series on Addiction and Technology](#), which was funded by a research and consulting contract with DraftKings.



Digital technologies (e.g. smartphones and smartwatches) and the array of associated sensors have exploded in the commercial market over the last 10-15 years. Adoption by the lay public has been rapid, but healthcare systems and providers have taken an

(appropriately) more cautious approach to the integration of digital health tools into standard of care workflows. Concerns from the healthcare perspective include efficacy, cost, privacy, and security, and importantly the provision of appropriate contexts for the sheer volume of data they produce.

Substance use disorders (SUDs) are a particularly appealing, albeit challenging, case for digital health interventions. Although pharmacologic and behavioral treatment options are available, long-term retention is generally poor, and the disease itself is chronic. The disease invokes physiologic and behavior changes, both of which can be detected and monitored via non-invasive sensors and/or technology interactions. And triggers of SUD occur in the real world, outside of the clinical milieu, sometimes making it difficult for traditional treatment to be effective when and where people need it the most. Potential roles for digital health interventions include identification of pre-drug use states such as craving and stress paired with just-in-time support, identification of overdose paired with deployment of emergency services, and monitoring of withdrawal to optimize (and automate) medication titration.

As the role of digital health interventions in the management of SUD has expanded, several design considerations have come to the fore. Based on our experience in this space, we describe some of the best practices that interventions in the addiction space should follow.

First, it is important to understand that digital health interventions do not exist in a vacuum but in a specific ecosystem surrounding the people using it. Often designers of digital health technologies make implicit assumptions about the lifestyles of the individuals for whom it is designed. Consider the relatively recent trend of self-monitoring digital health technologies targeting people with various forms of SUD. Such technologies often assume a certain level of privilege that affords its users 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, they would require stable access to an electrical source to charge the device and a WIFI connection to upload data. It further assumes that a person's stressors are manageable or responsive to typical coping strategies, which may not be realistic for those contending with persistent adversity—such as unstable housing, unsafe relationships, or hunger.

It is no surprise that the sustained use of digital health technologies, often helpful ones, drops as the precarity of the target population increases. One of the best ways to address this problem is to understand the lived experience of the population you are designing for the design to meet them where the people are. Engineers and computer scientists are often driven by the excitement of building

something new and “cool,” but their training usually centers on technical problem-solving rather than direct collaboration with end-users. However, in our experience when designing for marginalized communities (like those with SUD), this approach does not work, leading to wasted effort in designing solutions. The deeper one goes into the community where the end-users are situated the better. Deep interviews, contextual inquiries, ethnographic studies should be conducted to understand the population being designed for. Such an approach would help digital health interventions designed in this space to be useful for all in the SUD community by making them, i.e., the interventions, appropriately simple and intuitive in terms of usability, interface, and maintenance.

Further, no technology is perfect. With the increasing use of machine-learning (ML) and AI-based approaches in the context of addiction, it is important to understand for all the stakeholders that these methods have limited contextual information on an individual and they can make a lot of mistakes. Compounding this issue is the high-stakes nature of data related to SUD: even the suggestion of a return-to-use event can lead to substantial legal, financial and social consequences. It is therefore crucial that end-users of these models (be it clinicians, pharmacists, people with SUD, etc.) understand that AI’s outputs are but one source of information and should be interpreted carefully. Further, it is crucial to incorporate appropriate mechanisms for recourse for any automated decision-making system, so that if end-users have issues with the decisions made based on the output of the AI being used, they can appeal it in a timely and effective manner. We strongly advocate against the use of digital health tools in a punitive fashion (e.g., as a tool for monitoring by the justice system) but rather as a tool for collaboration with healthcare professionals to understand when a treatment is working and when it may be time to change course.

Finally, 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 SUD is sensitive, and the patient might want to keep such information private because of associated stigma or fear of other social consequences. We believe that in the SUD context, the current permissive model of asking consent once based on complicated end-user policies and then gathering data incessantly is fundamentally unethical. Any effort at data gathering in the SUD context has to in fact adopt the opposite posture, that is, the default has to be not to collect and store locally and not share information. Any data collection and sharing should

then be to be done based on explicit and continued consent of the person/user whose data is being collected.

With intelligent and thoughtful design, digital health interventions have the potential to derive dynamic personalized insights, and provide support when and where people with OUD need it to support sustained recovery. In order to achieve this laudable goal, designers must consider the population we intend to serve, respect the stigmatized nature of the disease, and protect end-users from maleficent use or weaponization of the technology that is designed to help them.

- Krishna Venkatasubramanian, PhD and Stephanie Carreiro, MD, PhD

Full bios:

Krishna Venkatasubramanian, PhD is an associate professor of computer science in the Department of Computer Science and Statistics at the University of Rhode Island. He is the director of the Accessible and Socially Aware Technologies (ASSET) lab. His research is situated at the intersection of accessibility, human-computer interaction, design, and machine learning applied to understand and meet the needs of marginalized populations. His recent work has focused on the designing technologies to meet specific needs of people in a variety of communities including those with substance use disorder, intellectual and developmental disabilities, and people with mobility impairment. Venkatasubramanian earned his PhD from Arizona State University and did his postdoctoral work at the University of Pennsylvania. His research is funded by the National Science Foundation and the National Institutes of Health.

Stephanie Carreiro, MD, PhD, is a physician-scientist reimagining how digital technology can transform addiction care. An Associate Professor, Vice Chair of Research, and Director of the Tox(In)novation Lab at the University of Massachusetts Chan Medical School, she bridges emergency medicine, toxicology, and technology to improve how we prevent, detect, and treat substance use disorders. Her work focuses on digital phenotyping, digital therapeutics, and promoting health equity through real-world innovation. Carreiro earned her medical degree from New York Medical College, trained in emergency medicine at Brown University, and completed both a medical toxicology fellowship and a PhD in Biomedical Sciences at UMass Chan. Supported by the National Institutes of Health in addition to foundation and industry partners, her

research turns everyday data into tools that make care more personalized, accessible, and effective for people affected by substance use.
