



Introduction to Continuous Behavioral Health Measurement



KSANA HEALTH



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Introduction

At Ksana Health, we believe that digital technology can dramatically improve behavioral health care and the best care will be provided by combining technology with the unique skills and capabilities of human clinicians. The therapeutic alliance between clinicians and their clients helps to sustain engagement and make care more effective. At Ksana Health, we do not believe that technology will ever replace clinicians, but we do believe that clinicians who leverage technology will replace those who do not.

Easy-to-use patient-centered technology saves time for behavioral health clinicians, administrators, and leaders. It enables them to personalize care and optimize resources by intervening with the right level of care at the right time. This technology ultimately allows them to provide better care that improves lives and mental health.

Ksana Health is an integral part of this process to improve care delivery, bringing therapy out of the office and into everyday life. We are changing how care is delivered and creating new standards of objective measurement that can improve the quality of care. Our digital tools continuously and objectively measure client activity through smartphone sensors along with subjective feedback from the patient. This generates insight for the clinician and enables them to intervene with the client.

Project Amber, an early stage “moonshot” mental health project from Google X, fell short of its goal to identify a single biomarker for depression, but they found something interesting in the process. In



November of 2020, they reported that although clinicians showed less interest in diagnosis by biomarkers than they had expected, “there was a notably strong interest in using technology as a tool for ongoing monitoring – capturing changes in mental health states over time – to learn what happens between visits.”

In our rapidly changing world, clients expect accessible, personalized care that provides value by improving their health and well-being. These value-based outcomes are something people now expect from services in other domains and is increasingly expected in behavioral health care. The current model, which primarily provides services that are limited to occasional, office-based consultations, is not capable of providing the access, quality, and effectiveness needed to meet the needs of the community. Thank you for joining us in co-developing the evidence and tools required to help more people and improve the lives of those living with behavioral health challenges.

Dr. Nick Allen
CEO, Ksana Health



Definitions

What is **Continuous Behavioral Health Measurement**?

Continuous Behavioral Health Measurement, or passive remote monitoring, uses the sensors in digital devices, smartphones, and wearables to capture objective information about the user or wearer of those devices, offering insight into everyday behaviors and activities not captured by clinical scales or self-reporting.

What are **nudges** and **interventions**?

Nudges are positive and indirect interventions administered by clinicians between clinical appointments. They may be recurring reminders, or “just-in-time” notifications based on the client’s condition in real time. Nudges can alert the client about their behavior in a predictable manner without restricting user options or altering their incentives.

Interventions are implemented by clinicians to bring about change in people. A wide range of intervention strategies exist, and they are directed towards a myriad of issues. Used generally, an intervention refers to an activity used to modify behavior, emotional states, or feelings. Behavior change interventions are coordinated activities implemented by providers to change behaviors, feelings and/or attitudes.



Psychological interventions seek to alleviate symptoms and target the root cause of the disorder. Psychological interventions have many different applications.

What is a **service**?

The term service in the context of this white paper refers to mental health services provided to behavioral health service users by care providers, through payers and health administrators.

What is **Vira** and **Vira Pro**?

Vira is a **continuous behavioral health measurement solution** developed by Ksana Health. Vira uses the smartphone most clients already have and requires no wearable. It includes a mobile app called Vira for clients and Vira Pro, a dashboard for clinicians and administrators.

Vira Pro includes a professional web portal for clinicians, allowing “just-in-time” notifications that are delivered to the client’s smartphone and provide support for following through on the therapy plan. This dashboard also allows supervisors and administrators to access real-time data on the recovery of their clients and information on which therapy approaches are being used by their clinicians. This allows each service site to rapidly learn which approaches are most effective for the communities they serve.

Vira is built on years of research by experts in behavioral science, intervention design, mobile sensing, and machine learning from the Center for Digital Mental Health at the University of Oregon.

What is **EARS**?

EARS, the Effortless Assessment Research System, is an end-to-end solution for academic and clinical research. It leverages smartphone sensors and is designed for academic and clinical researchers. EARS is trusted by leading research organizations, top universities like Duke, Yale, and Cambridge, and behavioral health leaders globally.



What is **stepped care**?

Stepped care is a system of delivering and monitoring mental health treatment so that the most effective and least resource intensive intervention is delivered first, and only stepped up to more intensive interventions as required based on the client's level of distress.¹

What is **objective** and **subjective assessment**?

Objective assessment is quantitative measurement not influenced by the responder's feelings, opinions, or beliefs. It relies on independent measures. It is often associated with reporting from a sensor about one's location, physical activity, patterns of communication, language usage, sleep patterns, and more.

Subjective assessment is a qualitative measurement where the outcome may have multiple meanings. It is based on feelings and opinions related to the responder's perspective and preferences. Subjective assessment relies more on the observer and respondent than on independent measures. It is often associated with self-reporting, like when one reports on their daily mood.

By assessing objectively collected data and analyzing it along with subjective self-reporting, clinicians and clients get better, more balanced data for clinical decisions.

What are **edge computing processes**?

Edge computing refers to the practice of not removing raw, identifiable data from the service user's device or smartphone. Instead, in edge computing, machine learning algorithms process information on the device directly. The only data securely shared to the cloud is the result of that machine learning processing. To protect the privacy of the user, the information shared is not personally identifiable and only includes insights into patterns of behavior and use.

¹ Sourced from www.campusmentalhealth.ca.



What is Continuous Behavioral Health Measurement and Its Benefits?





What is Continuous Behavioral Health Measurement?

Continuous behavioral health measurement, also referred to as personal mobile sensing, collects and analyzes data from sensors embedded in the context of daily life with the aim of identifying human behaviors, thoughts, feelings, and traits.²

This approach collects rich data through connected digital devices most clients already have, producing valuable objective data in addition to self-reporting.

This **continuous** and **remote** data collection happens wherever the user interacts with their smartphone, smartwatch, wearable, or other connected digital devices. In the behavioral health context, this sensing is used for analysis and intervention.

Continuous behavioral health measurement also gives clinicians the ability to send **ecological momentary interventions**. Clinicians can nudge clients with small motivating requests, like reminders and supportive encouragement, to proactively engage the client in their own mental health and wellness. Ecological momentary interventions may be sent by the clinician between appointments manually or these interventions can be automated, based on client condition and behavior.

2 Mohr, D. C., Zhang, M., & Schueller, S. M. (2017). Personal Sensing: Understanding Mental Health Using Ubiquitous Sensors and Machine Learning. *Annual Review of Clinical Psychology*, 13(1), 23-47. doi:10.1146/annurev-clinpsy-032816-044949



What are the Benefits of Continuous Behavioral Health Measurement?

Continuous behavioral health measurement adds value to behavioral health systems as we face increasing burdens of distress and illness, an overtaxed number of clinicians, and misaligned resources. When applied effectively, objective continuous behavioral health measurement has great beneficial potential which include:



1. Better Insights and Interventions Between Appointments

Continuous behavioral health measurement allows **insights and interventions between appointments** which are otherwise lost by self-reporting gaps and lack of client access. Additional benefits include richer clinical notes, strengthened clinician-client alliance, and increased revenues through decreased appointment no-shows and drop-outs, which can range as high as 24% to 66%. Inclusion of just-in-time intervention improvements between appointments, like appointment scheduling, follow-up phone calls, and reminders, have also been found to reduce appointment dropouts.





2. More Effective Appointments

Continuous behavioral health measurement can enable **more effective appointments** as clinicians are equipped with richer insight about client behavior and the effects of their ecological momentary interventions. This additional insight is beneficial for individual appointments and helps behavioral system administrators understand how to improve appointments and optimize intervention mixes across clinicians in their systems.



3. Increases Clinician Caseload Capacity

Continuous behavioral health measurement can **increase clinician caseload capacity** as increased line of sight across a clinician's caseload allows a greater ability to better calibrate appropriate care levels to clients, based on need. These calibrations can be made to both individuals and across client population levels. Continuous behavioral health measurement solutions typically provide dashboard capabilities which aid clinicians in caseload management. They may further create draft clinical notes that the practitioner can edit and add to their electronic health records (EHR) or utilization review (UR) reporting processes. This time-saving feature aids the clinician in ongoing reporting and provides an empirical basis for care and treatment planning. Improved caseload management decreases administrative time, provides the option for increased client time, and decreased potential for burnout. This benefit goes hand-in-hand with better optimized population and stepped care approaches to behavioral health services delivery.





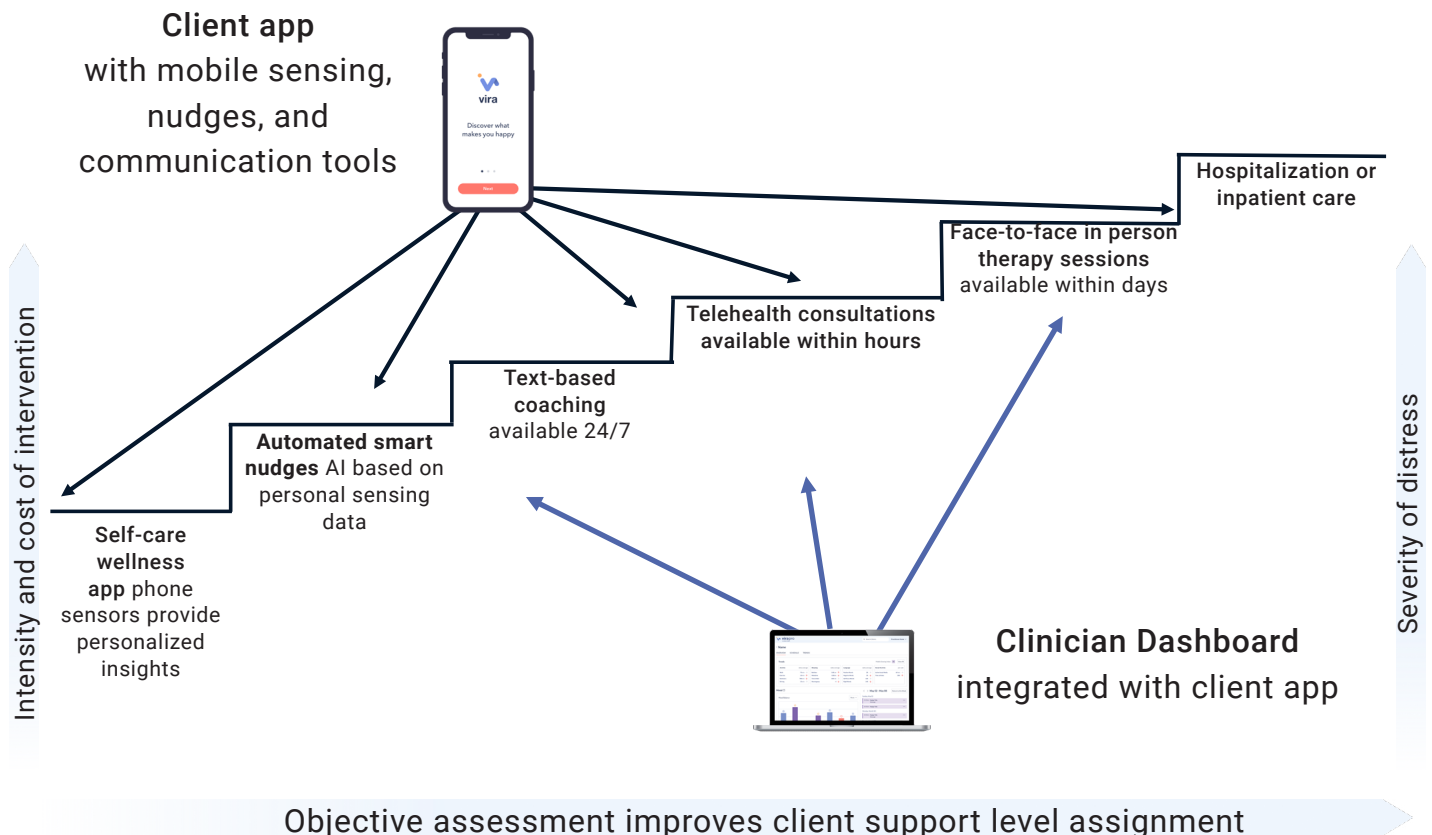
4. Better Optimized Stepped Care Approach

A **stepped care approach** to behavioral health services delivery assures appropriate interventions are allocated to persons who can best benefit from them. More systems are working to avoid intervention mismatches so that those with mild distress are not overtreated while those with severe distress are not undertreated.

Objective reporting allows providers to address more severe cases with more robust interventions while not wasting those same interventions on less severe cases.

Stepped Care Approach to Behavioral Health Care Delivery

Continuous behavioral health measurement has potential to optimize the allocation of appropriate interventions across different levels of support





5. Integrates Well into Clinical Workflows

Continuous behavioral health measurement can be integrated alongside teletherapy, electronic health records, and other digital health tools. It complements and improves the effect of these tools and the clinical workflows they support.

As an additional tool, continuous behavioral health measurement requires less engagement on the part of clients because it runs in the background on their smartphone. This lower engagement requirement stands to improve consistent app adoption over time. It also generates additional user insights, and improves clinical decision making, with relatively **little additional clinician effort**.



Continuous Behavioral Health Measurement Evidence Chain

There is a growing body of evidence to support the effectiveness of continuous behavioral health measurement. This evidence follows the flow illustrated below.

Visit [KsanaHealth.com/evidence](https://ksanahealth.com/evidence) to see the supporting bibliography.



Smartphones and wearables can validly measure behavior



These behaviors are related to mental health



Assessing client progress and providing feedback improves outcomes



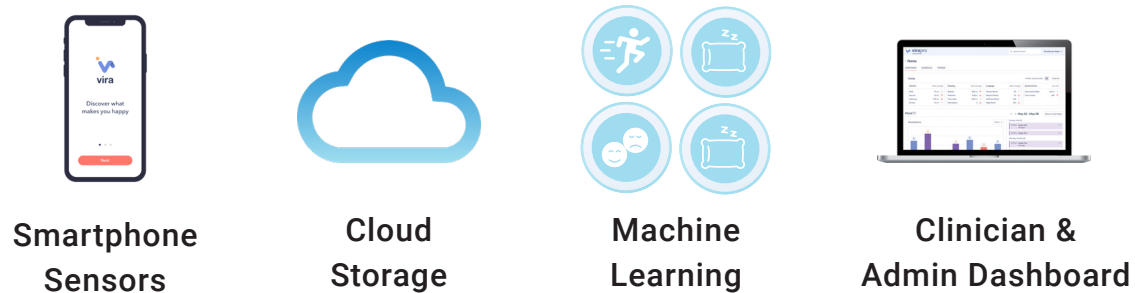
Completing out of session homework improves outcomes



Just-in-time nudges will improve completion of therapy homework



Continuous Behavioral Health Measurement Technology Components

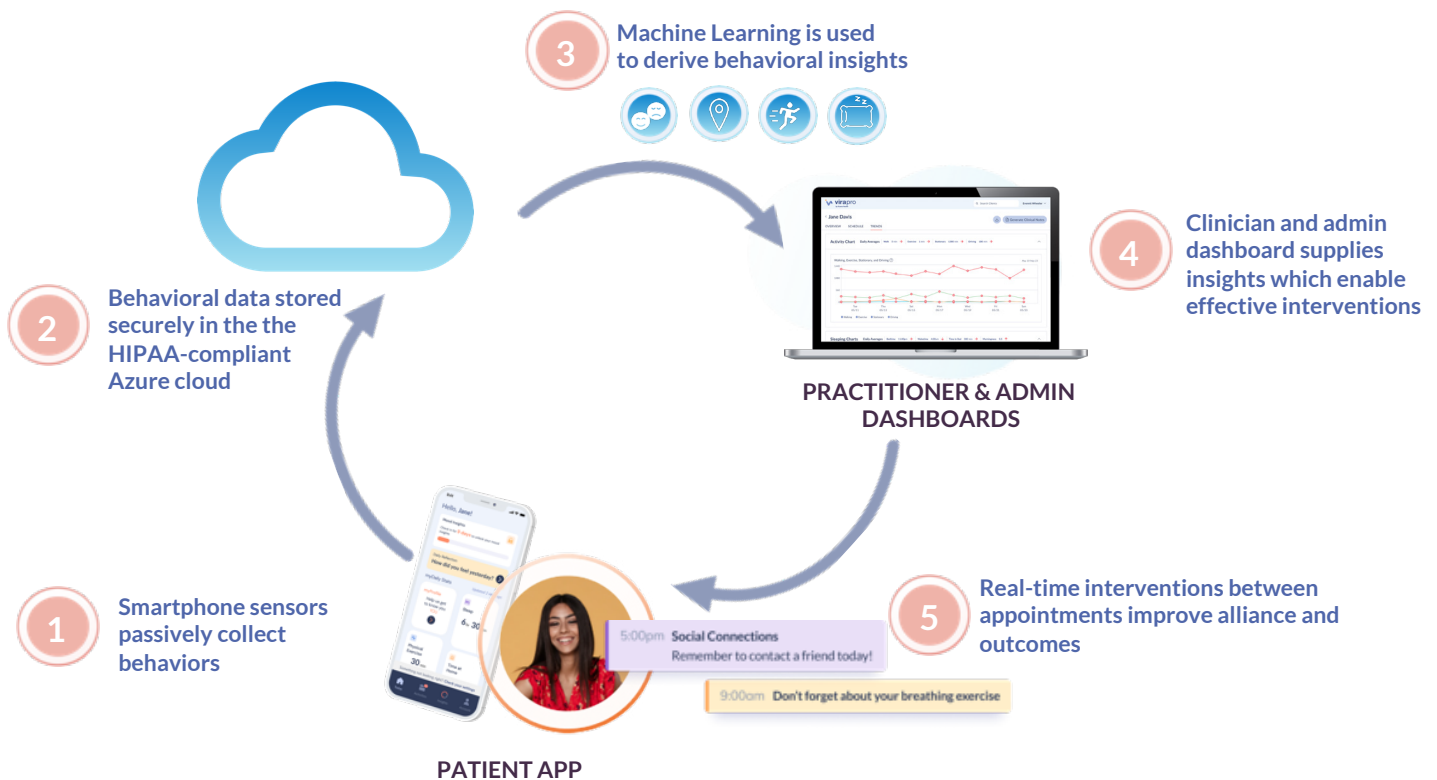


Continuous behavioral health measurement consists of several technology components, namely:

- **sensors** embedded in smartphones and wearables capable of detecting behaviors inclusive of location, movement, sleep, language patterns, and more
- **cloud and data lake technology** that enable receipt, storage, and organization of sensor-generated data
- **artificial intelligence** and **machine learning** which enable processing, analysis and development of insights from the data collected in the cloud and data lakes
- **user interfaces** in the form of **mobile apps** and **desktop dashboards** which enable visualization and reporting of data trends and insights, informing the understanding of behaviors and feedback that improve outcomes based on those behaviors



The Continuous Behavioral Health Measurement Process



The continuous behavioral health measurement process converts:

1. **Sensor-detected behaviors** related to movement, location, language patterns, sleep, and more, into,
2. **data** housed in data clouds and lakes, leading to,
3. **machine learning-produced insights**³ reflective of one's ongoing and real time mental state, leading to,
4. **dashboard visualization and intervention management**, resulting in,
5. **app-mediated interventions** designed to prevent a worsening of one's condition.

It is worth noting that the intervention management noted above provides clinicians and administrators with trends and alerts that allow them to more optimally manage larger caseloads, resulting in better clinical decisions as clients change over time.⁴

3 Seko, Y., Kidd, S., Wiljer, D., & McKenzie, K. (2014). Youth Mental Health Interventions via Mobile Phones: A Scoping Review. *Cyberpsychology, Behavior, and Social Networking*, 17(9), 591-602. doi:10.1089/cyber.2014.0078

4 Rohani, D. A., Faurholt-Jepsen, M., Kessing, L. V., & Bardram, J. E. (2018). Correlations Between Objective Behavioral Features Collected From Mobile and Wearable Devices and Depressive Mood Symptoms in Patients With Affective Disorders: Systematic Review. *JMIR MHealth and UHealth*, 6(8). doi:10.2196/mhealth.9691



Implementing Continuous Behavioral Health Measurement: Considerations and Watchouts





Implementing Continuous Behavioral Health Measurement: Considerations and Watchouts

Any digital health platform's potential is limited by the degree to which it is implemented, adopted and used. This section highlights several implementation considerations and watchouts, or risks, which are critical factors for success in implementing continuous behavioral health measurement.

These considerations include good workflow integration, confidence in personal privacy and data security, and user engagement.



1. Platform Integration into Clinical Workflow

Platform Integration is critical to continuous behavioral health measurement success. Success requires finding a good fit within the workflows and lifestyles of those that benefit from continuous behavioral health measurement.

For clinical users who already have an established workflow, continuous behavioral health measurement data must be integrated into current electronic health records alongside other data the clinician



uses. When done well, the clinician will enjoy enhanced data and improved insight into the ongoing behavior of their patients. For this to happen, implementers must establish the case for change, get buy-in, and implement change management plans alongside of technology integration plans and training. It is also important to measure and recognize ongoing customer success on the path to institutionalization.

For service users, continuous behavioral health measurement must fit into their lives in a way that does not impede regular smartphone use, in terms of trustworthiness, ease of use, and reasonable battery use. Users have limited time and virtually unlimited options. If a product is not easy to use many users will lose interest or stop using the product.

Considerations **that mitigate the risk of poor integration** include:

- Assessing the clinician's current workflow to make sure that continuous behavioral health measurement will fit into the workflow with as little disruption as possible. While disruption cannot be entirely avoided, it can be helped by managing expectations, providing training, modeling successful cases, and sharing remedies for potentially problematic cases.
- Assuring app and dashboard user interfaces are intuitive, professional, clean, consistent, and simple. Every page must have a primary and obvious action. Navigation should be clear and simple and should not make users think. Good interface design and experience is part of what builds trust and engagement with users.⁵
- Execution of change management plans which include early user and stakeholder engagement, solution co-creation, managed expectations regarding benefits and disruptions, training, and social support in adoption. Diligence in change management requires the development of needs assessment, stakeholder analyses and plans, role and responsibility charts, project charters, and workflow journeys.

⁵ (2020). Ecommerce User Experience Vol. 09: Trust and Credibility, 4th Edition. Fremont, CA: Nielsen Norman Group.





2. Personal Information Security and Privacy

Let's be transparent and acknowledge that the monitoring involved in continuous behavioral health measurement may invite suspicion of abuse and invasiveness. When seeking to implement behavioral health measurement technology, administrators must be vigilant to ensure that data collected is safeguarded to maximize user benefit and eliminate any potential for misuse. Healthcare data security breaches and misuse^{6 7} are on the increase, and mental health datasets are a particular target.⁸

The importance of this consideration is accentuated by findings which reflect that:

- only 29.9% of survey respondents would be willing or somewhat willing to share GPS location,
- the most-named reasons for non-willingness to share information are privacy and anonymity concerns (44.3%), general unwillingness without a provided reason (9.5%), the desire to have more control over the process, knowing who will be using their data and for what purposes (7.5%).⁹
- 72% of teenagers think that apps are manipulating them.¹⁰

Considerations **mitigating the risk of personal privacy and data security, loss, and misuse** include:

- Prioritizing end-user power and control over their own information and its use.

6 Leaked Document Says Google Fired Dozens of Employees for Data Misuse. (2021). Retrieved from <https://www.vice.com/en/article/g5gk73/google-fired-dozens-for-data-misuse>

7 Facebook Disables Accounts Tied to NYU Research Project (2021). Retrieved from <https://www.bloomberg.com/news/articles/2021-08-03/facebook-disables-accounts-tied-to-nyu-research-project>

8 Inkster, B. (2021, August 16). Cybersecurity: A Critical Priority for Digital Mental Health. <https://doi.org/10.31234/osf.io/p9u3g>

9 Struminskaya, B., Toepoel, V., Lugtig, P., Haan, M., Luiten, A., & Schouten, B. (2020). Understanding Willingness to Share Smartphone-Sensor Data. *Public Opinion Quarterly*, 84(3), 725-759. doi:10.1093/poq/nfaa044

10 Social Media, Social Life Infographic: Common Sense Media. (2018). Retrieved from <https://www.common SenseMedia.org/social-media-social-life-infographic>



- Honoring the user's right to access their data, request corrections, and to request that their data be deleted. This is known as their "right to be forgotten." Users should have as much control over processes related to their data, as possible.
- Minimizing the user's data footprint using edge computing where data is analyzed on device to discern patterns and insights without extracting user data.
- Maintaining an infrastructure which is GDPR¹¹, CCPA¹², HIPAA¹³, NIST¹⁴, and ISO27001¹⁵, SOC-2¹⁶ compliant and auditable.
- Simplifying privacy and security policies to make them easier to interpret.
- Continually gaining insight and providing what makes for user trust, with emphasis on open honesty about what data is collected and why.



3. Ongoing User Engagement

User engagement must be considered alongside integration, security, and privacy as an important success factor. Without engagement that yield insights and intervention opportunities, no positive health outcome will be produced. Typical wellness apps have a 90-day user retention rate of only 27–30%.¹⁷ Such low engagement rates speak to the urgent need to attention in this area.

Considerations **to improve user retention** include:

- Implementation of an effective onboarding experience.
- Making customer success resources conveniently available, including an emphasis on customer listening and customer feedback in a process of co-creation and continuous improvement.

11 European Union's General Data Protection Regulation

12 California Consumer Privacy Act

13 Health insurance Portability and Accountability Act of 1996

14 National Institute of Standards & Technology

15 International Organization for Standardization

16 System and Organization Control 2 Report

17 Farago, P. (2012, October 22). App Engagement: The Matrix Reloaded. Retrieved from <https://www.flurry.com/blog/app-engagement-the-matrix-reloaded/>



- A relevant, timely, and actionable notifications experience.
- Insights about user data with opportunities for reflection and recommendations for action.

The success of continuous behavioral health measurement implementation will be significantly improved by addressing risks in integration, privacy, security, and user engagement. Additionally, use of the RE-AIM Model¹⁸ from public health implementation science practice, can further enhance success.

Its considerations include the following questions:

- How many clinical and client users will be reached by continuous behavioral health measurement, and what does this reach mean for resources and logistics?
- What are the quantitative and qualitative measures of clinical effectiveness for continuous behavioral health measurement?
- Of those reached, how many are likely to adopt continuous behavioral health measurement, and what change management plans will ensure steady adoption over time?
- What are the details of successful implementation and potential barriers, like time, cost, protocols, stakeholders, delivery fidelity, delivery logistics, and supporting infrastructure? How are these barriers being successfully managed?
- How will the mid- to long-term maintenance of continuous behavioral health measurement be orchestrated?

Conclusion

We hope this whitepaper has been helpful in introducing you to continuous behavioral health measurement, its benefits and components, and ways to better assure implementation success.

We welcome the opportunity to help you with planning how you can adopt this technology to benefit your care organization and service users.

18 Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*, 89(9), 1322-1327. doi:10.2105/ajph.89.9.1322



About K S A N A H E A L T H

Ksana Health is improving academic and clinical research and behavioral health care delivery through continuous behavioral health measurement and personalized intervention technology. We facilitate a better understanding of mental states which improve research study datasets, grant proposal capabilities, behavioral health population management, and therapeutic alliances.

Vira is our continuous behavioral health measurement and personalized intervention platform for behavioral health providers. This objective measurement solution personalizes behavioral health assessment and interventions, bringing therapy out of the office and into everyday life.

EARS, the Effortless Assessment Research System, is our end-to-end solution for academic and clinical researchers. It allows behavioral researchers to configure and execute their own behavioral research studies using behavioral health measurement executed through the participant's smartphone.

To learn more about how Ksana Health can support your behavioral health care practice or behavioral health research, please contact us at ksanahealth.com/contact.

