

HealthRhythms: Background Information and Need for the Device

Until now psychiatric medicine has had no objective guide to diagnosis, treatment selection or treatment monitoring, leaving a gaping hole in the ability to care for those suffering from mental disorders, to develop new treatment approaches, or to reliably assess the efficacy of interventions. The rest of modern medicine has benefitted from objective measurement of signs of disease for more than a century and from continuous objective measurement of certain conditions in the patient's natural environment for at least 60 years. In the early 1970's, several groups began to explore objective measurement of sleep and motor activity, both of which were known to be disturbed in a variety of mental disorders. However, the sleep encephalogram and the early wrist actigraphs were restricted to research settings and were not viable for commercialization.

The commercial smartphone has opened vast new possibilities for psychiatric patients and those who care for them. Unlike customer wearable devices that are expensive and place a high burden on the end-user to charge the battery and weave its use into their daily routine, the smartphone is a massively adopted personal device. This nearly ubiquitous, intimate, and relatively inexpensive device provides a continuous window of non-disruptive objective observation into our lives that is particularly relevant to psychiatric medicine that can bring to psychiatric medicine the type of measurement that was well accepted in other areas of medicine. The question for HealthRhythms was how to capitalize on its potential. We saw two critical needs in the area of psychiatric medicine in the 21st Century: the need for affordable and scalable objective *measurement* of disorder risk and severity and the need for *access* to affordable, scalable and efficacious interventions.

To address the first need, we have developed a digital platform for the continuous, objective measurement of behaviors relevant to mental disorders based on a physiologic conceptual model that places psychiatric conditions squarely within, not apart from, the rest of medicine. To address the second need we have developed a model for behavioral intervention that capitalizes on our platforms 24/7 behavioral monitoring capabilities to deliver highly

personalized and timely suggestions for behavior change and have validated that model with respect to the treatment of mood disorders.

Epidemiologic studies completed prior to the pandemic indicate that over 17 million Americans 18 and older were suffering from major depression and nearly 2 million children aged 2-17 had diagnosed depression. These numbers are undoubtedly higher today. Moreover, 25 % of cancer patients, approximately the same number of stroke patients, 33% of heart attack survivors and half of Parkinson's disease patients experience depression that typically goes unaddressed. These individuals with co-occurring depression have significantly worse course of their primary disorder and greatly increased costs of care of that disorder.

With respect to anxiety disorders, pre-pandemic studies indicated that 40 million adults and 7% of children 3-17 had an anxiety disorder. Smaller numbers of individuals suffer from the most severe mental disorders, including bipolar disorders (7 million) and schizophrenia (1.5 million), but the economic and human costs of these chronically relapsing and often psychotic disorders is exceptionally high and adequate treatment resources for these conditions is often lacking outside of major metropolitan areas.

The National Institutes of Health estimated that 47.2% of Americans with a mental disorder received treatment in 2021. Thus, even if less than half of the at least 90 million individuals with a primary diagnosis of a mental disorder in the United States come to clinical attention or are engaged in a pharmaceutical company study, today the total addressable market (TAM) for the populations that HealthRhythms' technology serves almost certainly exceeds 40 million. If we also include those with a chronic health condition complicated by a mental disorder, the TAM approaches 90 million in the US. But we are not focused on the US alone. We note that we have already engaged in clinical studies in Canada, the United Kingdom, South America, and India. Ultimately, we see the market for our monitoring and objective assessment of the course of mental disorders as worldwide, dramatically increasing the future TAM for HealthRhythms' Cue platform.