**A software tool to predict relapse related readmissions and provide post-discharge care coordination.**

**Research Idea**

According to the Substance Abuse and Mental Health Service Administration (SAMHSA) approximately 43.6 million of adults in the United States experience a mental illness. Among these, 7.9 million have both a mental disorder and a substance use disorder (SUD) which highlights the high co-occurrence of SUD and mental disorders. However, a majority of SUD patients with co-occurring mental illnesses are typically hospitalized in inpatient psychiatric facilities. These facilities coupled with regulatory agencies and health insurance companies use patient readmissions or re-hospitalization within 30-days as a proxy measure of treatment outcome during a hospitalization period. However, a recent study commissioned by the Centers for Medicare & Medicaid Services (CMS) reported elevated re-hospitalization rates among alcohol/substance use disorder patients and therefore posing a significant burden to inpatient psychiatric facilities (IPFs). Indeed, CMS recently published the 30-day readmission rule indicating that from year 2019 IPFs will no longer be reimbursed for a readmission that takes place within 30 days of discharge coupled with subsequent reimbursement penalties. This rule commensurates with previous studies which have reported that 20% of psychiatric patients are readmitted within 30-days – which translates into $723 million in hospitalization related costs. Therefore, we are proposing to develop and commercialize a software as a service (SAAS) product able to perform the following tasks and return value to our customers. **1)** Implement a machine learning software tool able to analyze clinical informatics data and identify a relapse related 30-day readmission risk for individual patients. **2)** Once a patient is identified as at high risk of readmission, a discharge planner with the assistance of our software tool will identify care gaps (e.g. lack of housing) and recommend resources available in the community. This will entail developing an exhaustive community resource database in collaboration with social workers, discharge planners and case managers. **3)** Our SAAS product will assist case managers to coordinate transition of care between IPFs and outpatient facilities. We have developed these hypotheses based on an exhaustive customer discovery process guided by the lean startup approach. Specifically, we recently participated in the Southwest National Science Foundation (NSF) Innovation Corps program and tested four value proposition hypotheses by interviewing our customer segments (e.g. psychiatrists, social workers, discharge planners and policy makers). Indeed, this 5 month process allowed us to confirm the hypothesis that frequent psychiatric readmissions which is partly driven by substance use comorbidities is a major pain to IPFs and policy makers/regulators such as CMS. Through our customer discovery interviews we identified three problems encountered by care providers leading to patients being re-hospitalized within 30-days. **1)** Patients are not stratified for readmission risk – a process with the potential to guide allocation of post-discharge clinical and social resources. **2)** Discharge planners, social workers and case managers spend a significant amount of time matching patients’ needs to social service resources (e.g. housing, transportation) – a process that is hampered due to lack of a well curated database and web portal. **3)** A majority of patients are re-admitted due to poor post-discharge follow-up or care transition strategies. For example, case managers have consistently mentioned that many psychiatric patients are re-admitted as they do not attend their first post-discharge appointment. We envisage solving this problem through our SAAS product.

**Team background**

**Benson Mwangi Irungu Ph.D** - Dr. Irungu will be a co-founder and the team lead in the current project. He is currently an Assistant Professor in the Department of Psychiatry at The University of Texas Health Science Center at Houston (UTHealth). He was trained in computer science, computer vision, robotics and machine learning through prestigious European Commission Erasmus Mundus scholarships at the University of Girona – Spain, Heriot-Watt University – Scotland, UK and University of Burgundy - France. He further pursued a PhD in psychiatric neuroimaging at the University of Dundee - UK. He is a renowned expert in psychiatric neuroimaging and machine learning with numerous awards and honors in Europe and USA. He has been actively involved in multiple federal and privately funded studies that develop and apply novel machine learning and big data analytic tools to analyze high-dimensional biological and clinical data - particularly in the Departments of Psychiatry, Neuroscience, and Bioinformatics. He previously co-founded a startup company which setup a digital web-based platform which linked college job seekers to prospective employers. He later served as the Information Officer of the Uganda Commodity Exchange – where he was involved in setting up a digital platform to link farmers to agricultural produce markets.

**Mon-Ju Wu Ph.D** - Dr. Wu will be the co-founder and the Entrepreneurial Lead in the current project. He is a Postdoctoral Research Fellow in the Department of Psychiatry and Behavioral Sciences at UTHealth. Dr. Wu was trained in biomedical engineering and pattern recognition at the University of Wisconsin- Madison. In graduate school, he filed two intellectual properties using computational algorithms to improve medical image qualities for future analysis and diagnosis in 2011 and 2013 respectively. Shortly after his first patent application, he joined Echometrix, a startup company in Madison Wisconsin, as a consultant in charge of innovation and algorithm development in 2012. Since joining UTHealth in 2013, Dr. Wu has been involved as a lead or team member in multiple locally or nationally funded projects that use advanced machine learning algorithms along with clinical informatics to further enhance early detection and treatment of mood disorders.

**Phillip Beckett Ph.D** - Dr. Beckett will act as the team’s business mentor. He is currently the Chief Information Officer (CIO) at Healthcare Access San Antonio (HASA). He was trained in biochemistry and metabolism at the University of Aberdeen - Scotland, UK. While working as a Postdoctoral Research Fellow at Texas Children’s Hospital, he co-founded a successful startup company – RosettaMed which implemented a patient data capture application with interfaces to electronic medical records (EMR). He led the sale of the company to Kryptiq Corporation, where he later worked as a director responsible for technical sales support and implementation of its product in the Central and Eastern United States. He later joined Baylor College of Medicine as the Executive Director of clinical applications and development before serving as the Chief Technology Officer in Greater Houston Healthconnect. Dr. Beckett brings over 20 years of experience in development and management of data interfaces, device integration, disease management, strategic planning, workflow design, sales force, business management, fundraising , entrepreneurship, leadership, and mentorship.

**Product Description**

Our product is composed of three components: **1)** A prediction model utilizing state-of-the-art computational machine learning algorithms coupled with clinical informatics to identify patients with high risk of relapse related readmissions in a psychiatric hospital. **2)** A comprehensive resource database updated and validated by social workers and community health workers. **3)** A secure HIPPA-compliant two-way communication system between hospitals and resource agencies to track, confirm, and coordinate patients’ transition of care. Once a patient is admitted, our software will extract patient’s clinical informatics from Electronic Medical Record (EMR) and enter them into our machine learning algorithm to evaluate the patient’s risk of being re-admitted. Therefore, if the patient is identified as low risk for readmission, there is no intervention needed and the patient would simply follow their discharge plan. However, if the patient is identified as high risk, our software will then further evaluate the modifiable factors to prevent a possible readmission. Typical modifiable factors would include; lack of housing, transportation and medication. These resources will be made available through a well curated database and web portal of community social support resources. Notably, based on our interviews with more than 50 social workers/discharge planners, we realized that they are constantly searching for resources for their patients. This emphasizes the need to have a user-friendly and comprehensive database that integrates various resources from resource agencies to community services. The database will be categorized into housing, transportation, medication, food, clothing, utility, employment and education. Once the social workers search for the resources near their current location, the database will provide resources of different categories covering the designated neighborhood. In the homepage of every resource, it will provide key information (e.g. eligibility critera, age limit, income limit) to social workers. Moreover, it will also have online application to provide seamless services. In addition, at the homepage of each agency, it will have a section for social workers to share their reviews of the agency. Once the patient’s need is identified and the application to agencies is submitted, it moves on to the last component: a secure HIPPA-compliant two-way communication system between hospitals and resource agencies. Throughout our interviews with case managers and social workers, it has come to our attention that care gaps arise during inpatient-outpatient transition due to lack of communication between hospitals and resource agencies. Therefore, the last component of our product will be a HIPPA-compliant seamless software platform that serves as a hub between hospitals and resource agencies. Once the patient’s application to the resource agency is submitted, the software will instantly create a secure link that is only accessible by hospitals and the agency. The link allows the staff in resource agency to update the status of the patient in real-time. Therefore, if a patient doesn’t check in at the agency as scheduled, it will trigger the alarm of the software and immediately send an alert to both hospital providers and agency staff for further investigation and early intervention on potential crisis and needs. We expect that our software will identify risks at early stage and take early intervention to fill in the missing gap between hospitals and post-discharge care providers as shown in figure 1. 

**Product-market fit and startup growth.**

We will follow the lean startup methodology - which provides a scientific approach in creating and managing a startup. This approach will allow us to identify a desired product-market fit as well as build a scalable business model. Therefore, we will divide our company building process into two major activities namely; **1)** **Search** – which consists of *customer discovery and customer validation* and **2)** **Execution** – consisting of customer creation and company building.

**Customer discovery and validation**

We recently participated in the Southwest National Science Foundation (NSF) Innovation corps lean startup program a process which resulted into 160 customer discovery interviews. In this process we interviewed our customer segment (inpatient psychiatric facilities) and other stakeholders by testing several hypotheses. Noticeably, without doubt a majority of our potential customers including; psychiatrists, nurses, social workers, discharge planners and case managers mentioned frequent re-admissions as a major problem. We also discovered that fulfilling patients’ social support needs (e.g. housing, transportation) contributes to patients’ recovery and reduces the likelihood of readmission. In addition, we identified a missing gap between IPFs and outpatient therapeutic and social support facilities. Therefore, our proposed product is intended to address the identified needs. However, most recently our team has received support from NSF to participate at the national Innovation Corps (I-Corps) to allow us perform additional customer discovery interviews and particularly test the scalability of the business model beyond the Houston metropolitan area.

**Customer creation and company building**

After having fulfilled both the above customer discovery and validation steps, we are confident that there is a product-market fit and the $10,000 being offered in this application will allow us to develop our very first minimum viable product. This MVP will contain two basic features; **1)** A machine learning model able to ingest clinical informatics data and stratify individual patients’ risk of a relapse related readmission. **2)** A curated database and web portal able to link discharge planners and social workers to social support resources within the community. We will partner with the Harris County Psychiatric Center (HCPC) - which is the second largest psychiatric center in the United States to test the proposed MVP. Indeed, we have interviewed the HCPC staff (psychiatrists, discharge planners, social workers and administrators) and identified the above components of the proposed MVP as relevant needs. Most importantly, we will utilize the build-measure-learn loop to guide our experiments and receive user feedback as detailed in figure 2. 