Voice Based Social Network for Maternal Mental Health Awareness in Rwanda

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Abstract
In low and middle-income countries, 25% of pregnant women and 19% of new mothers experience depression. Maternal mental health often goes untreated because of geographic and social barriers as well as a lack of resources. In sub-Saharan Africa, there are only 1.4 community health workers per 1000 people. However, cell phone penetration is often high as 89% and our idea is to use cell phone technology to amplify mental health resources for young mothers through an interactive voice response system. Since smartphone technology is not widespread especially among the rural population, we focus on simpler voice and text-based solutions, in particular, a voice-based social network with embedded mental health survey, speech and activity analytics to non-intrusively identify and monitor depression. We are collaborating with healthcare providers and an NGO in Rwanda to pilot the concept and would like feedback to build on our initial plan.

Author Keywords
Mental health awareness; expecting mothers; young mothers; depression; IVR; Integrated Voice Response; speech-based information service; behavior change.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction
In low and middle-income countries (LMIC), 25% of pregnant women and 19% of new mothers experience depression [12]. A study in Ethiopia[29] found that 28.7% of young mothers exhibited depressive symptoms and improved detection and treatment of these symptoms would benefit maternal health and neonatal morbidity. These results are consistent with previous studies in Ghana (26.3%) and Cote d'Ivoire (28.3%) which used the same measure [6, 13]. Studies in South Africa, Vietnam [10] and Southern Brazil [3] using other screening tools such as the Self-Reporting Questionnaire and Edinburgh Postnatal Depression Scale[9] showed similar incidence rates. These incidence rates of common perinatal mental disorders (CPMD) in young mothers are significantly higher than those in developed countries. However in developing countries, mental health resources are scarce or overlooked, mental health issues are often stigmatized, and, for the resources that are available, young mothers lack the means to get access to those resources because of geographic, financial, and social

barriers. As a result four out of five people in LMIC with mental illness go without treatment [17].

In sub-Saharan Africa, community healthcare workers form the backbone of health interventions for the rural population. However, there are only 1.4 health workers per 1000 population [44]. Healthcare workers in most cases may not have access to clinical mental health facilities because of geographic and social barriers. To combat the issue, the World Health Organization (WHO) has produced evidence-based guidelines for the treatment of depression with the prescription of antidepressants mental health gap action program[19]. However, for CPMDs it might be complicated to administer these pills when a woman is pregnant or breastfeeding.

Acceptance of mental health and medications is hampered by social stigma [39]. In the sub-Saharan region, some communities connect mental disorders and witchcraft [29]. The young mothers themselves are at a vulnerable period in their lives dependent on others, lacking cash for transport, and physically unable to make the journey to a distant mental health facility. So, there is a need for a community-based solution [7].

Rwanda is a lower income country with a GDP per person near the median of sub-Saharan countries. While not part of the broad initiatives above, Rwanda has an excellent system in place through the RapidSMS Team to support young mothers in their first 1000 days after conception using text messages from community health workers [23]. This use of phone technology for reaching out to young mothers suggest that other low-cost interventions may be possible, especially with respect to early mental health detection and treatment in Rwanda [42].

Related Work

In the past few years, there has been a rise in organizations to identify mental health issues early, capacity building initiatives and low-cost interventions to support patients in developing countries. The Program for Improving Mental Health Care [40] is a consortium of research institutes and health ministries across Uganda, Ethiopia, India, Nepal and South Africa. The Africa Focus on Intervention Research for Mental Health, [1] studies Africa-specific interventions promoting capacity building, organizational collaboration, and a research network. The RAND Corporation has undertaken a study in Uganda to integrate depression treatment into HIV care [24]. They have incorporated economic incentives into microfinance to help HIV-positive patients benefit from the process through regular focus groups [18]. In the context of mental health, they showed that having a structured model and clinical acumen worked well under the supervision of mental health care workers [45].

The Perinatal Mental Health Project (PMHP) has created a short scale mental health screening tool for pregnant and postnatal women in the South African setting. It consists of a 3 point scale that can be administered by healthcare workers or nonspecialists [5]. This scale is a modified version of the Edinburgh scale which is typically used to monitor depression in young mothers [9]. Additionally, they have curricula meant for community health workers to learn about mental health and administer mental health support during their field visits [11]. In Pakistan, 80 community health workers and 4 community health supervisors were trained in treating maternal depression. They screened 12,000 women for maternal depression using a door-to-door survey The cost evaluation shows a 37% reduction in training costs through the use of technology compared to training by specialists [46]. They proposed to use an Interactive Voice Response (IVR) system to gather data

through a 2 point scale to reduce the cost of monitoring depression.

In the past, IVR was used to detect postpartum depression through a survey of marginalized women in the US. It was found that IVR could be used to supplement office- and home visit-based screening protocols and to educate patients about mental health resources [36,28]. In Latin America, IVR has been used to monitor depression. The study suggests that IVR could feasibly be used to provide monitoring and self-care education to depressed patients for future work [16]. We hope to build on the prior work and start our initial study by using the modified Edinborough scale to first monitor depression through voice-based technology. To keep the patients engaged and monitor their mental health we expect to provide a community based social network for them.

The idea for the social network in our IVR is inspired by Polly [4], Avaaj Otalo [27], Sangeet Swara [37] and Sunno Abbu [2]. These were IVR systems that low literate people could call to learn about healthcare, agriculture, maternal health and to seek music entertainment. Polly was an entertainment based job portal which uses the concept of peer sharing. Instead of virality, we hope to use peer intelligence as used by Sangeeth Swara for moderation to help identify mothers at risk in a caller's network. Avaaj Otalo an interactive voice application for small-scale farmers in Gujarat provided a forum for asking questions and browsing others' questions. We hope to build on this work to form a social network for mothers that use features (forums, music, and questionnaires) from these systems to form a community for young mothers in rural areas. The goal is to create the atmosphere of support from the community during their period of vulnerability for young mothers. We hope to allow our system to enable community leaders to act as

moderators and help mothers in need in the community.

In Rwanda, there have been a few studies in maternal mental health. One was a demographic survey regarding the mental health of mothers in rural Rwanda [41]. The survey found that factors found to be associated with perinatal depression were: marital status, level of education, husband/partner relationship, husbands' behavior, number of children, unplanned pregnancy, and personal stress. The study implied a need for a larger reach to more patients to study mental health. This study initiated another intervention which involved training community leaders to implement active listening. "The [community healthcare] women did not just listen, they became friends to new mothers." Their study and previous psychosocial interventions suggest the possibility of a social network to combat maternal mental health [15].

We plan to create a similar experience virtually through our voice-based social network. Partnering with an NGO working with women [48], we hope to conduct workshops on mental health and gradually introduce them to the technology. The role of technology is to allow young mothers to communicate with their local peers and community leaders offline using the social network. The social network acts as a portal to seek support (through forums, music, and questionnaire) from community leaders. Additionally, through partner organizations, we hope to provide immediate help during domestic violence and clinical support for the mothers. The mothers' and pregnant women's activity will help us learn about user behavior through qualitative and quantitative means through speech analysis.

This study is inspired, in part, on prior research on speech analysis that is able to analyze a speech signal [30,31,32,33] for various social applications and recently been used to estimate 19 clinical diagnostic

factors for mental health [32]. Interestingly, these results are language independent and so useful in a multi-lingual context or a context using languages for which effective speech recognition systems have not been developed. Some systems have used IVR [49] to gather voice input for depression so we see an opportunity to collect speech samples for analysis that can be used alongside survey responses to make more accurate responses. In addition, user activity can be included such as how long they take to respond to survey questions or the type of content that is being sought out from the social media applications.

The IVR system can use a variety of technologies such as IVR junction [47], open source Asterisk servers or cloud-based services through Twilio or Tropo. The cost of the system is a limitation and our partners in Rwanda and India have expressed their limitations in resources. In the initial studies, we plan to use a cloud-based solution but we hope to implement a cost-effective solution using Asterisk or IVR junction for large-scale experiments.

Research Questions
Based on our interactions with stakeholders in Rwanda, we would like to build a low-cost IVR tool to measure depression and build a social network. Our idea is to identify more mothers suffering depression earlier leading to more effective interventions. At its core is a simple voice-based social network with embedded speech and activity analytics to non-intrusively identify and monitor depression. The mothers call a toll free number from their phone for entertainment and community support through storytelling, lullabies, and shared experiences. The IVR system will have an embedded 3 point contextualized scale to measure maternal depression. The social network encourages young mothers to engage with the community through shared stories and other voice-based content and also to seek support. For each mother, the analysis identifies appropriate topics and interventions to

address mental health issues. The system provides interfaces for health workers to monitor and provide counseling to patients using their phones. The goal is to leverage mental healthcare resources and better target interventions such as general advice, home visits, clinical visits, and medication.

Our initial research questions are

1. Is an IVR system able to effectively measure perinatal depression in Rwanda?

By effectively measure we are referring to the accuracy, reach, and timeliness of the information. We believe the IVR may improve accuracy as compared to simple surveys since it can include voice analysis and other factors in the decision. In addition, the impersonal phone system may encourage less guarded responses than when communicating with a human. The automated IVR response may improve reach meaning a larger population of women may receive screening than do today. It may increase timeliness meaning that women with CPMD will be identified earlier than with current community healthcare worker visits.

2. Can a voice-based social network improve community healthcare workers ability to provide interventions to young mothers and pregnant women?

By improving we mean the community health care workers are able to better manage limited mental health care resources and provide more interventions to more women.

Longer term we would like to build on our learnings to test low-cost interventions to support our users and provide data to help influence policies.

Methodology

Our general approach is to understand the mental health problem, identify clinical indicators that can be collected from the IVR and social media platform, work with mental healthcare providers to develop a useful dashboard for working with mental healthcare patients. Finally, we will measure usage and outcomes of our research questions. We develop each in turn.

Gather data about mental health and build a network of young mothers:

We are speaking with a number of NGOs and practitioners that focus on mental health and women's health issues identified through our existing activities in Rwanda and India. As a first step, we are partnering with an NGO in Rwanda which supports women who undergo gender-based violence throughout the country. We are currently working with them to build an IVR system to measure depression and anxiety in their clients. Our partner NGO conducts themed workshops for women in distress regularly. These workshops are facilitated by community leaders elected from the local community and occasionally from NGO workers. We intend to introduce women to conduct participatory design through these workshops. We expect to get survey data about mental health through our initial pilots in the workshops.

After our initial pilots, we plan to conduct workshops for mothers 1) as a medium for participatory design and 2) base group for creating the social network's initial content and members. The young mothers meet their peers for entertainment and discussions, they use the social network to continue their discussions offline through technology. We expect that seeing and interacting with their peers regularly through these workshops will help form the basis of the social network. We will test mother engagement through user interviews and track individuals' usage over time. Factors for success will be positive attitudes toward the application, frequency of use by mothers, and the new user uptake rate.

Identify indicators of depression based on platform activity and voice signals:

The application will capture user activities and record spoken responses. These activity and speech samples will be analyzed for indicators of the state of mental health of the mother. We expect small speech samples to give us hints about the current emotional state of the mothers. Our initial studies will be used to measure the cost/tradeoff of using these indicators with questionnaires of different lengths. For example, the Patient Health Questionnaire - 2 and Patient Health Questionnaire - 9 (PHQ2 and PHQ9) have been used to validate depression [38]. The PHQ9 scale provides a better estimate but is cumbersome for the user in an IVR. We hope to use the two question (PHQ2) [5] to learn about features that can help make decisions early through other indicators like speech, age, abuse history, literacy, etc. In these ways, we seek to gain sufficient data over the test deployment to assess the quality of the analytics output. The findings from these experiments can help us develop more non-invasive ways to detect depression and evaluate interventions for future research questions.

Develop a dashboard to assist healthcare providers:

We will work with the existing network of safe spaces, clinics, and telephone access lines of the partners. The goal will be to study the existing workflows and at what points the information from the social media application can assist in identifying depressed mothers earlier and lead to targeted interventions. We expect the data to provide information to community healthcare workers to take action and delegate resources towards maternal mental health.

Measure usage and outcomes against our research questions:

We will collect both quantitative and qualitative information about the IVR and voice-based social media systems. The systems themselves will record usage information such as the number of unique users, frequency, and timing of usage, responses to questions and information content that was listened to on the site. The dashboard will provide a back-end and ways for mental health care workers to annotate and classify the status of end users. In addition, end users and health care workers will be interviewed as to their views about the applications. These measures and feedback will be compared to current practice.

Conclusion

For the initial study, the primary goal will be to measure the effectiveness of an IVR to detect perinatal depression in terms of accuracy, reach, and timeliness. Our goal is to create a community-driven social network for pregnant women and young mothers and provide mental health resources through technology. Partnering with a CBO, we plan to conduct regular workshops for young mothers to create awareness for their mental health. These workshops will be moderated by women leaders in the community. These workshops will allow us to build technology through participatory design with the community. Technology will then be used to supplement for offline interaction through a voice-based social media platform. The data from the social network will be used to monitor mother's mental health and build nonintrusive indicators such as activity and speech for detecting depression. If these tests are successful, then the concept warrants further development to guide healthcare workers to the most appropriate interventions, develop other analytics measures, understand how to scale the social network to many young women while maintaining a local trusted community and build tools that extract data to support national policies for mental health.

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