re:Mind

A mobile application for bipolar disorder patients

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Abstract — **Several personal healthcare monitoring systems have been proposed to target somatic diseases and specific mental illness. This paper reports on the re:Mind system, which is a helpful tool that supports the treatment of people diagnosed with bipolar disorder.**
We developed the system as a hybrid mobile application to help bipolar patients self-monitor a set of parameters that are known to affect their illness while also allowing them to communicate with their physician.
Based on data collected from medical personnel, clinicians, patients, patients' relatives and persons akin to them, we created a user-friendly application while making it possible for the patients to customize the application to fit their specific needs.
Preliminary testing with patients confirms the usefulness and effectiveness of our current application.

Keywords-component: mobile application; self-monitoring; bipolar disorder.

I. INTRODUCTION

Recently, there has been an increase to use software applications for medical and health-related purposes. Broadly speaking, such applications can be categorized according to their functionality. Common applications include software that supports the decision-making process e.g. to calculate the dose of a certain medicament. Very popular are also informational tools targeted to a particular user group to provide information e.g. about a medical condition. Further, applications have been used to collect, track, and monitor a set of health related behaviors, states, indices, social interactions, and other contextual signals entered manually by a specific individual and/or automatically in real-time using dedicated devices. The combination of data measurements coupled with some form of automated reasoning techniques enables to create new tools that can describe, predict, improve health behaviors, and provide personalized advice to individuals. Several applications that have only a communicative/administrative function, such as booking an appointment with a specialist or requesting a prescription, have also emerged.

At first, these software systems were primarily developed as web applications and/or standalone applications. Lately, fueled by the rise in popularity and adoption of mobile devices, by their availability and affordability, many companies and developers have started either using responsive web design or offering native applications to create mobile versions of their (web) applications. The impact of mobile technology on health can be far-reaching and cost-effective: digital content can be accessed, stored, manipulated, and transmitted at affordable price, in real time, from anywhere, anytime. Because of that, mobile health and wellbeing applications also referred to as m-Health apps in short, have become a major focus of research.

This paper describes re:Mind; a mobile application designed for the treatment of bipolar disorder patients. Re:Mind can be used by both patients and medical personnel. It runs smoothly on smartphones, tablets, and mobile devices equipped with Android, iOS, and Windows Mobile operating system. In re:Mind, patients can proactively enter personal health-related data, display the data, manage their medicaments and prescriptions, and communicate with their physicians.

The system was designed based on the information that we gathered from medical personnel working on a daily basis with bipolar disorder patients as well as on the analysis of data collected from a survey over 266 people who either directly suffer from bipolar disorder or in close contact with them.

We tested the application with five patients suffering from bipolar disorder who participate in a psycho-education group at the Copenhagen affective disorder clinic. The results of such preliminary testing are very promising concerning both the application interface and its functionality.

This paper is structured as follows. Following this introductive section, we outline a few related works in the field of m-Health for mental illness. After that, we embark on the description of the development process and functionality of the re:Mind application with focus on the data collected from several surveys and its evaluation. Eventually, we draw some preliminary conclusions and discuss future works.

II. RELATED WORK

To date, several mobile applications have been developed for the management of a broad range of health-related issues, conditions, and diseases. Only some of them focus specifically on mental illness including the bipolar disorder condition.

Future directions and challenges for the identification of m-Health applications in the prevention, diagnosis, monitoring and treatment of mental disorders using case studies from

Denmark are discussed in [1]. The MONARCA project [2] attempts at developing mobile solutions on Android platforms for long term self-monitoring of behavioral and physiological information relevant to bipolar patients. In [3, 4], a mobile application is used to analyze the data collected with a smartphone and to correlate such data to the onset of cyclic episodes. The study presented in [4] concludes with: "..*Personalized models are better suited to detect early signs of an onset of a bipolar episode and facilitate timely intervention..*". A mobile application that monitors a set of vocal patterns of a person during everyday phone conversations is a first promising effort for detecting mood changes in patients with bipolar disorder [5]. In [6], a cross-platform mobile application for panic disorder that integrates an internet-based treatment into the patients' daily life is presented. A useful list of health and wellbeing related applications ready to be downloaded on different mobile devices can be consulted on the website of the U.S. Department of Health & Human Services [7].

III. THE APPLICATION

A. Understanding bipolar disorder

Bipolar disorder is a mental condition that makes a person shift between depression and mania. This behavior is characterized by unusual changes in mood and energy levels. Bipolar disorder affects millions of people worldwide, with potential devastating effects on each of them, including suicide.

The current standard for the diagnosis of bipolar disorder uses subjective clinical rating scales based on self-reporting. The Hamilton Depression Scale, the Young Mania Rating Scale, and the Bipolar Spectrum Diagnostic Scale are the most commonly used scales. Filling out forms does not solely form the basis for diagnosing bipolar disorder though. Interviews with a psychiatrist are also necessary and often lab tests (e.g. blood samples) need to be taken to rule out other illnesses.

B. Data collection

The re:Mind application was developed following an iterative process. We started by collecting qualitative and quantitative data from the perspective of both treatment providers and the patients. Specifically, we first designed an interview with members of the medical staff at the Copenhagen Affective Disorder Clinic, at the Copenhagen University Hospital in Denmark. The interview consisted in semi-structured questions about the interviewee's personal experiences with bipolar patients. We run the interviews in order to identify the most dominant symptoms and triggers in both mania and depression episodes. Following the interviews, we created a questionnaire. We tried to administer the questionnaire to a large amount of people by contacting several different Danish organizations involved with mental illness. Some of these organizations posted the questionnaire on their Facebook page, which turned out to be an extremely effective distribution channel. Within only 4 days, 266 participants had completed the questionnaire. We dropped the data from 50 of these participants because they declared not be have been diagnosed with bipolar disorder and proceeded to analyze the

data from the remaining 216: 181 (84%) of them were female and 35 (16%) were male, with age ranging from 15 year old to 72 year old. The low number of male participants seems to confirm a study [8] that, shortly put, concludes that men are more likely than women to keep their mental disorder a secret, even to their partner and family. In fact, our Facebook post about participating in the questionnaire could only reach people who have "*liked*" the organizations' Facebook page. In our context, we hypothesize that male participants might feel that clicking the "*like*" on Facebook pages about mental illnesses could reveal their secret. 195 (90%) of the participants declared to own and to regularly use a smartphone. With regard to the symptoms, we added to the questionnaire a set of closed questions and offered a range of answers to choose from. These questions were designed as checklists. We also did make use of open-ended questions to allow participants to freely add their personal symptoms not mentioned in the checklists. Table I shows a summary of the most self-reported symptoms as extracted from the questionnaire for both the onset of depression episodes and maniac episodes.

TABLE I. SUMMARY OF SYMPTOMS

Symptom (depression)	Nr. participants	Symptom (mania)	Nr. participants
Anxiety	199 (92%)	Hyperactivity	166 (77%)
Low energy level	198 (91%)	Hyperverbosity	157 (73%)
Urge to isolate	194 (89%)	Reduced need for sleep	152 (70%)
Problems concentrating	174 (80%)	Irritability	128 (59%)
Self-loathing	166 (77%)	Problems concentrating	126 (58%)
Sleep disturbances	140 (64%)	Loss of inhibitions	96 (44%)
Changes in appetite	131 (60%)	Increased sexual drive	89 (41%)
Thoughts of death	131 (60%)	Increased money spending	61 (28%)
Decreased sexual drive	114 (52%)	Increased alcohol consumption	57 (26%)
Increased alcohol consumption	57 (26%)	Racing thoughts	50 (23%)

The questionnaire also revealed that other factors like e.g. stress (184 participants i.e. 85%), many social arrangements (154 participants i.e. 71%), and menstruation (47 participants out of 181 females i.e. 26%) can negatively affect patients. At the same time, 122 (56%) participants indicated physical exercise as a beneficial factor.

A 52% of the participants declared that they had filled out a mood monitoring form before, which is positive since *"Bipolar patients who are trained to use self-help treatments can benefit from greater control over their care and life decisions and can detect early warning signs of serious illness."* [9]. While asked about the reasons for not self-monitor their state and their symptoms, 25% of the participants stated that they do not see the point for doing so. The remaining participants justified their choice with reasons that can be linked to the limits of the standard paper and pencil forms commonly administered to

bipolar patients (see Figure 1). This response seems indeed to call for a digital version of a self-monitoring tool geared towards the symptoms highlighted in Table I.
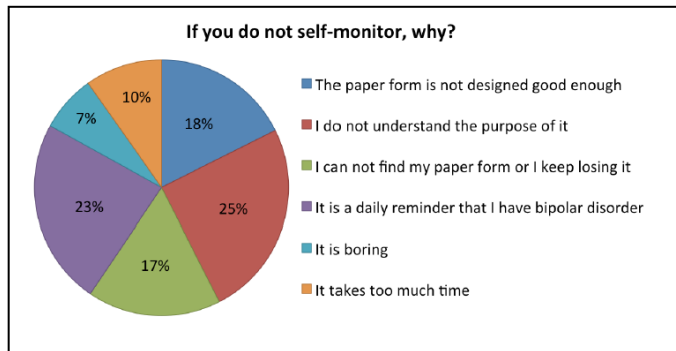

Figure 1.   Reasons why patients do not self-monitor their mood and state

C. Developing the application

Based on the analysis of the data collected with questionnaires and interviews, we identified a set of self-assessment features that we wanted the application to collect. Table 1 shows that 80% of the participants reported concentration problems when depressed and 58% when manic. Moreover, the patients using existing mobile apps for self-reporting of symptoms commonly complained that these apps offer too many options such as chat rooms, weather reports, diary, tags and camera features. The patients described many of these features as being useless and distracting. Based on that, we decided that our application should not be overly complex and overwhelming when it comes to user options and number of features to self-report. Consequently, we restricted our interest to the symptoms most people experienced and even combined some of them into one single parameter. We also arbitrarily chose to draw the line at 25% of reported symptoms, meaning that we would require to self-report only those symptoms that at least 1 out of 4 patients had experienced. For instance, we combined "hyperverbosity" and "loss of inhibitions in social contexts" into a single parameter that we refer to as "social". These two symptoms are mainly present in manic episodes, however if the combined symptom labeled as "social" is low for a long period of time, it could disclose isolation as well which is instead a symptom common in phases of depression. We further combined the symptoms "reduced need for sleep" and "increased need for sleep" into a category "sleep time". If a patient sleeps for only a few hours or too long it could indicate the onset of mania or depression, respectively. Similarly, we clustered a few more symptoms into single categories for the sake of keeping the number of self-reporting categories relatively low, yet expressive enough to describe the physical and psychological state of a patient.

We then started with the actual development of a mobile application for users to self-report symptoms. To avoid the development of different applications for each mobile platform, we used state-of-the-art cross platform web technologies. Since we also created a web version of the mobile application, to cut development time, we adopted a responsive web design approach. In an attempt to make the application user-friendly and maximize usability, we adopted a minimalistic design. At each development iteration, we resorted to expert support and, when necessary, incorporated it into the new version of the application. We started by creating paper mockups for a few specific functionalities (see Figure 2), which we incrementally modified as development and testing went on. Our mockup was refined until it reached the functionality we desired and no major issues were reported in the iterative tests.

Eventually, our application includes the capability for users to keep a fixed-scheduled daily diary, to self-report a set of symptoms, to store data, to see a graphical progress of their symptoms thus allowing the monitoring of changes over time, to access online information about their disease, to keep track and manage their medicaments, to contact medical personnel in case they need immediate attention, to exchange text messages with their physician(s), and to watch informative multimedia.

Figure 2.   Paper mockups for a few specific functionalities of re:Mind

IV.   USABILITY STUDY

We conducted a usability test at Copenhagen Affective Disorder Clinic where we recruited five volunteers who were in a psychoeducation group. The group consisted of three females and two males, with age ranging from 26 years of age to 43 years of age. We run and audio-recorded a testing session where participants were given eight different tasks to perform with different mobile devices like an iPhone 4S, an iPhone 4, and a Samsung Galaxy S2. We then required each subject to provide a feedback on his/her subjective experience in form of an open discussion.

The group agreed upon the design being pleasant and the font reader-friendly. A subject said: "*See, this really is*

friendly. When I click 'Daily Report' it asks me how my day has been." Everyone in the group thought that the app is "*easy to navigate*", and "*self-explanatory*". No subject noted any relevant difference in the look and functionality of the app on the different devices. Four participants said that they would like to monitor their mood and symptoms but they have not done so because they either loses their paper, or forgets to fill it out or are too bored when doing so. All subjects reported that they would be more motivated to track their state if they used a mobile app instead of doing so on a standard paper form. When asked if this application would be useful in their therapy all subjects but one replied positively: "*definitely*", "*for sure*". One participant said that it did not matter if it was a paper form or an app, since he would not self-report his mood anyway because he still could not see the purpose of doing so. Similarly, all participants but one thought it was a good idea to share their data with their doctor. One of the subject suggested that this feature should however be able to switch on or off, at times, because "*This app would be just for me. It would be too Big Brother-ish if my doctor could follow me every day.*" The messaging service feature received positive reviews. One of the participants felt it was too impersonal to "*be diagnosed via text messaging*". The same subject stated however that he would use the system only if the doctor used the messaging system to set up appointments to meet in real life. Four patients pointed out the need to include a reminder mechanism. In that regard though, one subject stated that he would rather not receive any message for such a message would remind him of his mental condition. All subjects found that entering self-assessment data was quicker, easier, smoother, and more efficient than filling up a paper-based mood assessment form. They found that the system is useful for monitoring important features that relate to their condition. In summary, all but one subject valued the possibility to enter their experiences into electronic patient diaries, resulting in a quicker and more effective monitoring and diagnosis.

CONCLUSION

Patients and medical specialists are using increasingly more and more mobile applications to monitor their state and that of their patients, respectively. Using expert information from clinicians and subjective data from patients affected with bipolar disorder, we created the re:Mind application.

Testing our application we discovered that it can be difficult to get bipolar patients to understand the purpose and benefits of self-monitoring and ultimately to get them use it on a regular basis. As pointed out in [2], when mentally ill patients are required to use a specific technology, it is arguable of whether they would actually follow suit or not. Getting patients to use the application is therefore a paramount step since giving them updated info about their health state and showing them progress over the course of their disease has the potential to help stimulate the patients' motivation for taking a proactive approach towards the improvement of their health [10].

Based on our survey (see Figure 1), switching media from paper form to mobile application might help the 17% of the patients who stated that they always lose their paper form.

People are less likely to lose their phones than a simple piece of paper. Additionally, by "appifying" the paper form, we might as well reach out to both the 7% of patients who stated that filling out a paper-based mood monitoring form is boring and the 17% of them who reported that the paper-based form is not designed well.

We believe that self-assessment should be done as soon as data is available. Also based on patients feedback, we plan to add a reminder mechanism to support that requirement. For instance, the "sleep" parameter should be self-reported in the morning and/or late in the evening while a reminder could be set to appear on the mobile device at these times. Technical constraints limit the capability to include in the current version of our application multiple customizable alarms that remind patients to take actions about specific events or to adhere to specific treatments and tasks. To have a fully functional SMS-based reminder functionality in re:Mind, we need to convert it into a native app e.g. using a mobile development framework.

Preliminary testing with the system indicates the feasibility of mobile applications in allowing patients to track both their physical and their psychological state, to manage their intake of medicaments, to be informed about their disease, and to keep in touch with their physician. While we are very satisfied with the encouraging results from the initial testing, we are aware that our application still needs additional testing and improvements before patients will value it enough to keep it on their devices.

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