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A South African Mhealth App for Depression Management and Treatment: a Survey and Requirements Analysis[1]

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ABSTRACT

Mental health issues in Africa, such as depression, have taken a backseat to more visible diseases such as AIDS and malaria. However, the prevalence and impact of depression is significant and increasing. Access to quality public mental healthcare is limited and mHealth poses a possible and exciting channel to potentially manage or treat depression. This research first surveyed the literature to identify core requirements and then the mobile app market place to see what existing solutions offer. Crucially, it seems that no applications exist to link patients and healthcare providers within the healthcare system, integrating multiple stakeholders across the levels of care in the context of South Africa's eHealth system. The research aims to fill this gap by providing a proposed set of requirements for a depression mHealth solution based on the literature and market review, but expanded and contextualized through the input from interviews with a panel of experts. Hopefully, the resulting specifications will facilitate in designing an effective mHealth intervention which is appropriate to the South African context.

Keywords: mHealth, South Africa, mental health, depression, major depression disorder (MDD), mobile health app, eHealth.

1 INTRODUCTION

With mobile phones being almost ubiquitous in modern society, mobile health interventions ("mHealth") empower the mental health care user (MHCU) to monitor their own wellbeing. mHealth interventions can increase access to rudimentary health services, which is vital in a health system characterised by inequitable distribution of health services. Furthermore, by remotely connecting the patient to their health team or the health system, mHealth can aid in long-distance monitoring, which could potentially reduce the need to physically access services and thus reduce the burden on the health system while also benefiting the patient by reducing health care costs and the inconvenience (often extreme and costly in rural areas) of visiting clinics.

mHealth research in Africa has focussed on the major burden of disease such as AIDS, malaria, TB etc. However, despite the high and increasing prevalence of mental health issues in Africa, hardly any attention is devoted to the mHealth potential for diagnosing, treating and managing mental health issues. This study aims to fill this gap by focussing on a serious and highly prevalent mental health issue, namely depression. The objective of the study was to gain an understanding of how an mHealth application for depression can be developed for the South African context as well as to consolidate health care and technological aspects of designing an mHealth intervention for depression to provide a backbone for future development of such interventions. Our research questions were:

- What are the current mHealth options for depression?
- What are the requirements for a South African mHealth application which could be integrated into the national health system, including the health care practitioners and national health information system (NHIS)?

These research questions were pursued through a combination of literature review, an mHealth app market survey, and interviews with a panel of experts. The paper then offers a comprehensive set of functionalities for a mobile health application aimed at treating or managing depression in the South Africa eHealth context.

2 LITERATURE REVIEW

[1] Van Belle S., Van Belle J.P. & Weimann E. (2017). A South African Mhealth App for Depression Management and Treatment: a Survey and Requirements Analysis. African Conference on Information Systems & Technology (ACIST), Cape Town, 10-11 July. ISSN 2467-8988

2.1 MENTAL HEALTH IN SOUTH AFRICA: PROVIDING CARE FOR DEPRESSION

An estimated 16.5% of South Africans suffer from major depressive disorder (MDD) and other common mood disorders (CMDs) per year. 75% or more of these cases are untreated (Peterson & Lund, 2011). Hundreds of mobile applications ("apps") on online marketplaces are offering depression-specific screening, monitoring and treatment solutions (Schierenbeck, Johansson, Andersson, & van Rooyen, 2013), that are cheap, accessible and convenient in modern life. Online sources estimate smartphone penetration in South African in 2016 was as high as 45% (mybroadband.co.za, 2016), suggesting that use of apps for promoting wellbeing through mHealth interventions is becoming a real possibility.

In general, there is a significant lack of literature regarding the epidemiology in South Africa of CMDs such has aniety, depression, substance use disorder and impulse control. in South Africa. A now somewhat dated study, the *South African Stress and Health Study* by M. Tomlinson, Grimsrud, Stein, Williams, and Myer (2009) attempts to fill this gap by investigating the epidemiology of depression, (WHO, 2015)They reported a 9.8% lifetime prevalence, and a 4.9% 12-month prevalence of major depressive episodes. The mean age of onset for females is 26, and 25.6 years for males, and prevalence is highest between ages 40 and 49. The mean days out of role (affecting productivity in the workplace) was 57 days per year– this is in comparison to less than 15 days for most chronic conditions. Those who have left school after achieving a Grade 7 or below are reportedly 3.8 times more likely to experience a major depressive episode in a year than those with higher levels of education, which supports the suggestion that South Africa's high levels of unemployment, poor education, high exposures to traumatic events and childhood adversity (such as violence and HIV/AIDS bereavement), and history of discrimination and exclusion all have a direct impact on the high prevalence of CMDs in South Africa (Peterson & Lund, 2011). However, it is difficult to find comparative international statistics, and M. Tomlinson et al. (2009) note several limitations of applying international surveying techniques in South Africa. Furthermore, the study did not include any findings on usage of health care services. A publication released by the, South African Department of Health (2013) reported an average of 9.3 mental health workers per 100 000 people (although there was a high variance between provinces. . There was very little information on standard protocols regarding screening, management and treatment of CMDs, but WHO guidelines note that typical treatment for anxiety and depression centres around a programme of psychotherapy as well as psychotropic medication for moderate to severe cases(WHO, 2015), noting that both elements require sufficient and accessible local resources in current healthcare frameworks.

Some of the main barriers to treatment that have been identified include stigma (self-stigma, perceived stigma and actual stigma) resulting in isolation, unemployment and a lack of health-care seeking behaviour (Peterson & Lund, 2011; South African Department of Health, 2013); poor residential, community-based and/or psychosocial care characterised by a lack of resources (Peterson & Lund, 2011); and poor forward and backward referral pathways with inadequate communication/monitoring, skills (Peterson & Lund, 2011). a(Peterson & Lund, 2011; M. Tomlinson et al., 2009). Due to poor health information systems infrastructure, not only is there poor longitudinal patient tracking, but there is a paucity of data on disease prevalence, resource allocation and consumption, intervention/treatment effectiveness, which is a berrier for future iniatives (Peterson & Lund, 2011; M. Tomlinson et al., 2009). Other shortcomings include inconsistent and irregular identification and treatment of CMDs because of a lack of time, training and support amongst primary health care (PHC) staff and inequalities in resource allocation and subsequent quality of care (Peterson & Lund, 2011). A "vicious cycle" is also described of increased childhood adversity leading to poor education and thus a greater risk of unemployment, poverty, ill-health and exposure to violence. These lead to poorer mental health, which in turn results in increased social exclusion and poorer conditions (South African Department of Health, 2012).

The studies mentioned above were part of a significant rise in the number of studies and reviews in 2009-2010 on the state of mental health care in South Africa, which potentially helped to inform and spur the development of the National Mental Health Policy Framework and Strategic Plan for 2013-2020 (South African Department of Health, 2013). This plan seeks to address some of the major gaps in treatment by focusing on integrating mental health care into general PHC services; by increasing public awareness (and thereby decreasing stigma and increasing help-seeking behaviour); by empowering communities by encouraging MHCU, community, inter-sectoral and non-governmental organisational (NGO) participation and collaboration; and finally by establishing a monitoring and evaluation system that will help insure that all planning and initiatives are based in evidence. It is rooted

on the principles of mainstreaming mental health care and integrating it into all levels and all aspects of care (promotion, prevention, treatment and rehabilitation) (see appendix for principles of PHC), to bring it into parity with other aspects of health care, as well as incorporating it into all aspects of governmental policy. It hopes to encourage accessible care in the community, focusing on recovery and rehabilitation that is delivered in the least restrictive form possible, with acceptable, culturally relevant care that is sensitive to gender-related issues and broadens the network of support to include families and carers. Admission should be seen as a last resort, deinstitutionalisation should happen in a step-wise, supported fashion and the focus of all care should be on encouraging citizenship and participation and reducing discrimination (South African Department of Health, 2013).

The policy suggests a pyramid of service distribution: the majority of care should be self-driven, supplemented by self-help and peer-led services through NGOs and family organisations(South African Department of Health, 2013)Community health workers (CHWs) are trained layworkers who would ideally work in the community and in the clinics, providing a link between informal and formal care. Formalised community services at the local clinics will be provided by nurses and GPs. These services will be closely monitored and supported by supervisory specialist health teams. Routine screening, detection and monitoring, medication monitoring and psychosocial rehabilitation care will be provided, with reference to stepped management and referral frameworks (South African Department of Health, 2013). However, because these frameworks and policies are so recent, there is little to no information regarding their implementation, which makes it difficult to assess the needs of a shifting health care system and how interventions can potentially align themselves to services that are not yet established.

2.2 ASSESSING COMPUTERISED INTERVENTIONS FOR DEPRESSION

As a technologically savvy population seeks to take control of their own health, the online mobile app marketplace has responded by bringing out a large number of "solutions". mHealth can travel in the user's pocket, offering customisable, contextualised care (Watts et al., 2013) that is accessible across geographical and socio-economic barriers (Shen et al., 2015). Two key drivers are the relatively low cost, as world-wide health care costs soar with the increasing prevalence of chronic conditions, and the almost exponential increase in smartphones penetration (Ernst & Young, 2012). eHealth (any electronic system of health care delivery) for depression seeks to overcome the recognised barriers to psychotherapy of cost, distance to health care facilities, practitioner work-overload, time (average psychotherapy sessions require 12-16 hours), and even attitudes and stigma – where discreet use of apps in public appeal more to patients than standing in a queue outside a health facility (Castro, Garcia-Palacios, Mayoral, Botella, & Garcia-Herrera, 2015; Payne, Lister, West, & Bernhardt, 2015).

In their comprehensive review of the app marketplace, Shen et al. (2015) note that the majority of apps offer either therapeutic treatment or psychoeducation (34% and 32% of apps respectively). There was also a high prevalence of medical assessment (17%; involving PHQ-9 style questionnaires) and symptom management (8%; checklists or journals); and 4% offered cognitive behaviour therapy-based (CBT) (Shen et al., 2015).

Another functionality that is gaining popularity is the idea of ecological momentary assessment (EMA). EMA refers to the patient data gathering at the time and place that the data sets are produced (Donker et al., 2013). This could refer to the simple manual self-recording of experiences as they occur, or through using "context-aware" programmes that utilise built-in smartphone technology to note the environment: background noise and social interaction (using the microphone), ambient lighting conditions (through the camera), location (through GPS), kinaesthetic activity (with the accelerometer), as well as allowing for the addition of hardware sensors such as wearable technology to monitor heart rate, breathing rate, temperature, etc. (Proudfoot, 2013). Saeb et al. (2015)Ben-Zeev, Scherer, Wang, Xie, and Campbell (2015) (Ernst & Young, 2012)Cost effectiveness assessments must weigh the value of data produced by these systems against the costs (including large-scale accessibility), particularly if extra hardware is required (Ernst & Young, 2012).

Much more research has been conducted into the use of distance cognitive behavioural therapy – as a telemedicine intervention, as a computerised or internet therapy and now as a mobile therapy (c-CBT, i-CBT, m-CBT), the former of these featuring in literature as early as 2002 (Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010). CBT is considered to be suited to distance and computerised therapy because

of its structured yet interactive programme involving "homework" questions (Norris, Swartz, & Tominson, 2013). Richards and Richardson (2012)(Richards & Richardson, 2012).

Other functions for apps relating to depression identified by the literature include cues to action, feedback, social support (including networking with support groups or therapists and sharing information/progress with friends and family), mindfulness-based cognitive therapy, and a mass of self-help applications promoting sleep-hygiene, meditation techniques, exercise routines, etc. Applications designed by professionals often utilise theories of self-determination, social cognition and behavioural activation for understanding negative mood triggers (Payne et al., 2015). Some utilise reward systems(Richards & Richardson, 2012). Payne et al. (2015) and Keeton (2012) claim that mobile interventions have significant potential to bring about behaviour change through the constant and ecological reminders that a mobile phone can provide. Other features that increase user acceptability include limited time per use, integration into daily routine and ease of use, convenience, the discrete use of the app in public, seeing progress over time, and automatic functions (Payne et al., 2015).

3 RESEARCH APPROACH AND METHOD

Based on the nature of the research questions, a qualitative descriptive/exploratory approach was considered the most appropriate research design. This initial feasibility exploration relies on the perspectives proposed in the literature and knowledge provided by a sample of experts in the field. The focus is social and interpretative rather than quantitative (Flick, 2007).

Initially, background research was conducted in the fields of interest in the form of a literature review. A compilation of the functionalities for computerised interventions for mild to moderate MDD was made from the literature. This was combined with functionalities derived from a survey of existing tools available on online app marketplaces – namely Google Play Store and iTunes, using the keyword "depression". Relevant apps mentioned in the literature were also followed up where possible. Apps were selected for inclusion only if their main purpose was treating depression, and they had a sufficient number of downloads and user ratings. The attributes of each app included were recorded, the functionality was listed and key positive or negative comments were summarised (see Appendix 1 for the abridged table).

Expert sampling, a subset of purposeful sampling, was considered the most appropriate for relatively unrestricted exploration of the topics in question. A "flexible, iterative and continuous" (Flick, 2007) interview structure was used, where interview design is adapted throughout the interview process, both within the interview and between interviews – for example, following up leads in later interviews mentioned in previous interviews, and using previous interviews as a guide for changing sampling parameters. Semi-structured interviews were used; a questionnaire of topics and subtopics to be covered was designed before the interview. Salient topics were drawn from the literature in accordance to their relevance to the research questions, focusing on utility, acceptability and perceived challenges to uptake. The interview instruments, which were also included, provided a brief synopsis of the proposed intervention to orientate the interviewee.

After obtaining ethical approval, expert interviewees from various fields were recruited who the author considered would provide insight into the research questions. Professional contacts of the researcher and academics affiliated to the University of Cape Town, used as points of departure, were also asked if they could suggest other participants i.e. "snowball sampling" (Flick, 2007). Field experts were also identified from the literature and contacted. All participants were contacted via email, given a brief introduction to the nature of the study, advised that the interview would take between 30 and 60 minutes, were assured of confidentiality and asked whether they would like to participate. No incentive to participate was given. If a prospective participant responded positively, interviews were scheduled at their convenience and the consent form, certificate of ethics approval and interview instrument were emailed to them.

The interviews were audio recorded with permission, and the length of the interviews was determined by the participants. The interview instruments (available on simple request) were used as a point of departure, and topics that emerged during the course of the interview were pursued. Interviewees were informed that they were free to decline to answer any question that they did not feel qualified to answer. Seven interviews were conducted (in chronological order): a public mental health researcher from the Alan J Flisher Centre for Public Mental Health (ISP); a social sciences researcher involved in an

mHealth project also from the Alan J Flisher Centre (SSR); a clinical psychologist from UCT Student Wellness Centre (PSLGT); a psychiatrist practising in both public and private capacity (PSRT); a professional programmer (ITE); a researcher from the South African Medical Research Council also involved in an mHealth initiative (MRR); and an Information Systems academic from UCT (ISP).

A thematic analysis of the information extracted from the interviews was conducted and categorised into themes which loosely correlated to the research questions which emerged in the literature and design elements of a proposed set of functional requirements. The full thematic analyis is provided in the full report (available on request to the authors) , covering a review of the mHealth marketplace; functionality (including users, user roles, potential functionalities and data flows), business models, privacy security and legal aspects of a medical intervention; development life-cycle considerations (including development and design, interoperability and testing and implementation), and finally user acceptability and an evaluation of the requirements for involved stakeholders . Potential functionalities were evaluated according to their prominence in the literature, and support from the interviews, were combined into an integrated system with defined data flows by the author. Other themes that emerged that would require addressing in future developments of this design included:business models and sustainability; privacy; information security and the legal aspects of health interventions; the development and testing of the tool in terms of technical functioning; and the testing of acceptability to users (including systems acceptability and interoperability) as well asefficacy and safety as a health intervention. Finally, a list of factors that may affect user acceptability was also compiled.

4 FINDINGS AND RESULTS

4.1 REVIEW OF THE MHEALTH MARKETPLACE FOR MDD APPS.

In order to address the first research question, an comprehensive survey of the mobile app market was done to identify existing applications aimed at users suffering from MDD. Although a large number of apps exist, many of these are not fully functional. A representative sample of the most widely distributed, i.e. more popular and well-developed, applications was selected and investigated in more detail. These served as a baseline for essential functionality required by the MHCU. For space reasons, a summary of the identified apps along with some user feedback is provided in Appendix 1.

4.2 GAP ANALYSIS: AN MHEALTH INTERVENTION FOR DEPRESSION TO DEVELOP MENTAL HEALTH CARE AND SUPPORT EHEALTH IN SOUTH AFRICA

Based on the literature review, mental health care – particularly CMDs such as depression – should be a priority for health care interventions and initiatives. There is huge scope for mHealth to act as an intervention for MDD. However, although there are numerous applications online acting as interventions for MDD, these apps may not be living up to their lofty expectations of providing the claimed benefits to the majority South Africans suffering from MDD.

Major gaps in mental health care delivery in South Africa have been identified. These include limited access to a dedicated personal psychotherapist and almost no access to specialists, a lack of skills at primary care levels and associated support structures, poor referral pathways, and stigma of accessing health services (PSLGT, SSR). PSRT notes that help-seeking behaviour, such as recognising a mental health disorder and deciding that it is acceptable to seek treatment, is a huge barrier to access, along with stigma of accessing services. Primary care practitioners often fail to recognise common mental disorders, or are unable to manage them appropriately (PSRT). Along with psychotherapy, psychotropic medication is the other mainstay of treatment. There is a low uptake of antidepressants due to unavailability at primary clinics and PHC nurses being unable to prescribe them (SSR) (Peterson & Lund, 2011). Adherence to medication is another severe problem (M. Tomlinson et al., 2009). In the private sector, affordability of care is the major problem, and practitioners often fail to look beyond individual patients to engage with public health (PSRT).

A mental health app should increase access to psychotherapy (PSLGT) and address the lack of continuity of care (SSR). An app could potentially reduce the time needed for face-to-face therapy (Donker et al., 2013), offer discreet access to care (reducing stigma), andprovide care even if a potential MHCU does not self-identify as “depressed” (depending on how the app is marketed). If rolled out correctly, the care would be accessible, equitable and culturally relevant. Besides providing self-help tools, medication adherence functionalities combined with distance monitoring services can also impact

continuity of care during rehabilitation after discharge from institutionalised care, preventing the "revolving door phenomenon" described by Peterson and Lund (2011).

The apps available on online marketplaces may not be contextually appropriate for South Africans, being Western-based and, in all likelihood, only in English. Many of these do not have explicit quality standards (Shen et al., 2015) and thus their efficacy is questionable. Shen et al. (2015) note that a flooded market can bewilder a potential user, who will have to exercise personal discretion to choose a suitable app, assuming that the MHCU is actively independently help-seeking and sufficiently technologically literate to search these marketplaces themselves.

There is also place in the market for multifunctional apps that can adequately keep track of comorbidities, or monitor general health as well as depression, or programmes that are highly customisable to the patient's specific needs or triggers. This could include tailored modules which could be selected, targeting common South African experiences, considering the high incidence of HIV-related depression, and exposure to traumatic events and untimely bereavement in this country. Although one or two apps are linked to health providers who also have profiles on the system (Apps Q,R) (Proudfoot, 2013), the majority of apps require manual exporting and sending of data to health care practitioners.

An app independent of the health system would have limited efficacy because of the lack of communication between patients and health providers in the health system (Ernst & Young, 2012). Health systems endorsement of an application would also have a greater reach as practitioners can recommend an app to MHCUs and thus, if correctly scaled up, the app can reach all outposts of the public health system. Patients may have greater trust in an app that is vetted by health professionals and the government compared to those freely available on online marketplaces.

For an app to be applicable to the public health system, it would need to fit into the prospect model of "pyramidal care" (South African Department of Health, 2013), where the majority of the burden of care is placed on the patient, with support from NGOs and Clinical Health Workers (CHWs) who provide evidence-based counselling in supervised teams, along with primary care services, with hospitalisation and access to specialists being provided only when necessary (ISP). Self-care empowers patients to take control of their own health, and an intervention that utilises mobile technology is likely to be highly acceptable, considering that a mean age of onset of MDD is estimated at 25.8, with the highest prevalence between ages 40 and 49 (M. Tomlinson et al., 2009).

Technology that aids screening, diagnosis and basic treatment, as well as providing basic training, would support CHWs, in addition to facilitating the communication between CHWs and supervisors/clinics. The system would link patients to CHWs, CHWs to specialists, health workers to clinics, and clinics to secondary and tertiary institutions. Facilitating communication between health practitioners and allowing efficient transferral of patient data and instructions would be highly beneficial to integrating care across South Africa.

A mobile application as an epidemiological data collection tool that records patient information, but also tracks access to health care services and monitors CHW activities is ideal – collecting data from both the user and the supplier of health services. According to PSRT, "patients are potentially an enormous resource." Data collected through mobile technology is instantaneous and far more efficient than paper-based systems. Data sets are more complete and there is no loss of information (ISP). Indeed, several of the current mHealth projects seek to collect epidemiological data, although this tends not to extend to patient data.

Creating an application that is linked to health information systems – beyond providing more holistic care for the patient – can also potentially feed into mHealth programmes established by the government, and can contribute towards mHealth goals(South African Department of Health, 2015), providing patient data and integrating health services, as well allowing for on-going in-depth epidemiological data collection. However, in order to achieve health systems endorsement, the intervention must be proven to be efficacious, cost-effective and sustainable, yet the health system should be involved from the start, resulting in a catch-twenty-two situation.

However, despite the supposed emphasis on self-care in the NHI, there are very few mHealth tools that have any functionality beyond basic health information provision. Any mHealth communication with

patients is limited to SMSs, mobisites or USSD codes. The main focus of mHealth has been on CHW coordination/facilitation, epidemiological surveying tools or diagnostic tools. Although private sector eHealth tools are giving patients control over their electronic health record (EHR) and allowing for independent entry of data, national eHealth development seems to completely neglect the concept of having a patient terminal for accessing information and as a data source, linking patient mHealth apps to practitioner interfaces to a greater eHealth framework.

All mHealth and eHealth initiatives tend to be stand-alone, independent projects with little interoperability either with other apps or with existing Health Information Systems (HISs), which often fail to make it beyond trial phase (M Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). Designing apps for individual disorders that can share data and connect to the same back-end database could create a holistic picture of a patient, while treating their specific set of requirements. Thus mHealth needs to be integrated with eHealth, so each intervention feeds into single patient EHRs that can be accessed throughout the system.

However, a point neglected by mHealth and eHealth strategies is that mental health is a national health priority – considering the high morbidity, decreased life-satisfaction and days out of role that are associated with CMDs (Peterson & Lund, 2011). M- and eHealth guidelines and interventions focus on HIV, TB, maternity care and lifestyle diseases such as diabetes.

The frameworks and policies take a top-down approach, establishing health information systems that can be rolled out nationally, with special functionalities added later. Rather than wait for all stakeholders to come to the table, another possibility could be to develop an eHealth intervention from an mHealth intervention, from the bottom up; an intervention that is fully functional as a stand-alone app (in this case an intervention for MDD), but which is sufficiently flexible to add user profiles, connectivity and data flows as more parties become involved and the initiative scales up. The intervention can grow its own EHR database through unique identifiers, so that it is not dependent on a currently non-existent NHIS/SA, but has clearly defined application programming interfaces and is adherent to standards that are fast becoming policy so that data is freely exchangeable with any future endeavours, meeting them "half-way", so to speak.

4.3 PROPOSED FUNCTIONALITY FOR MHEALTH APP FOR MMD

Following on from the gaps identified in the previous section, the author describes in this section the potential functionalities that will help improve self-care for MMD suffers and allow for the creation of EHRs, while creating a flexible system to connect MHCUs to health care services, and link health professionals to each other.

The full research report has described users and user roles, and explored data flows, usability considerations, business models, privacy concerns and ways to address these and other concerns in great details. Due to space limitations, this conference paper focusses only on the required functionalities and the information flows. The functionalities identified are listed in Appendix 2.

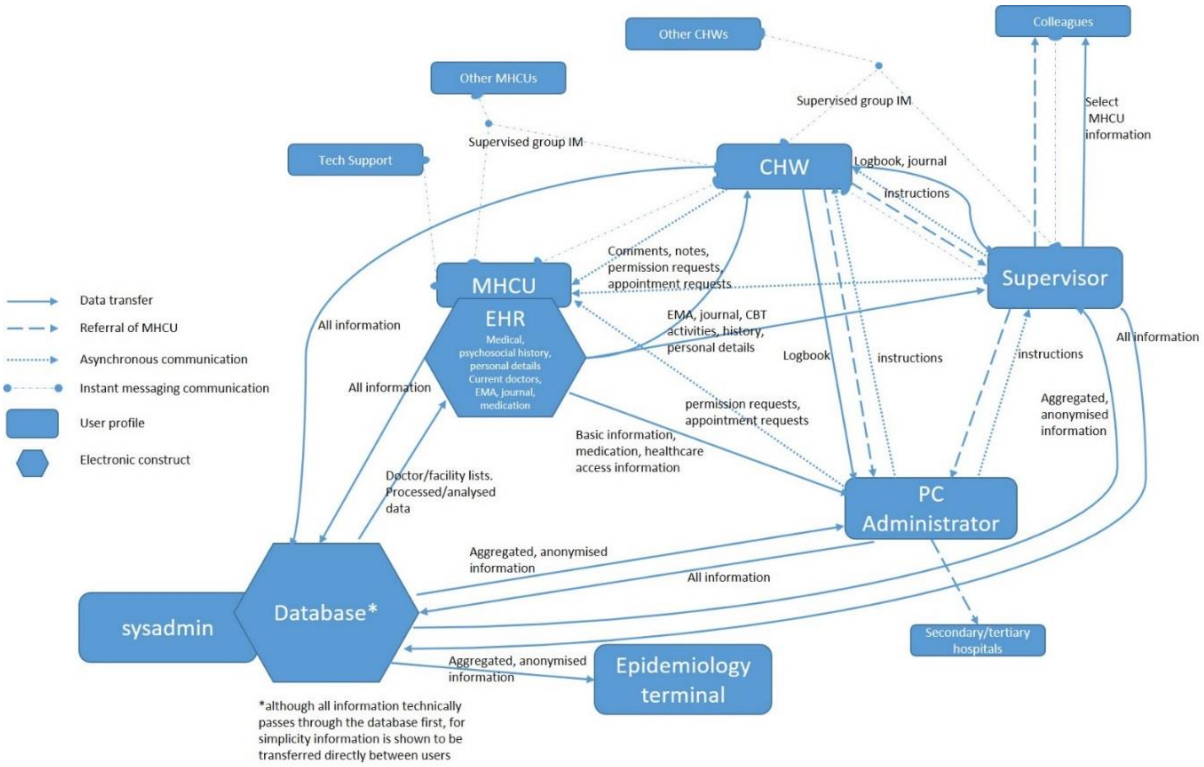
Different functionalities require different levels of communication and interaction with the backend database. Figure 1 is a proposed high-level design of the flow of information in the proposed system.

5 CONCLUSION

The purpose of the study was to gain an understanding of how an mHealth application for depression could be developed for the South African context. A major focus should be on consolidating both health care and technological aspects of designing an mHealth intervention for depression to provide a backbone for future development of such interventions. A gap analysis revealed the necessity of an intervention that could be integrated into the greater eHealth framework, requiring an additional health information systems aspect to be included in the amalgamation of disparate fields of study. Not only would an additional focus on eHealth allow for integration of data collected by the programme to be incorporated into general patient information, but the initiative could be used as a stepping stone to a more effective eHealth framework for public health HIS development. As a health intervention (in itself multifaceted), such an app would serve to empower a marginalised population that is underserved by the health system, and, from the provider perspective, would assist in patient management for CHWs and primary care workers with minimal training, providing support and management frameworks. This

research made a first step by identifying not only the functionalities required from a mental health care user perspective, but also the requirements identified by other stakeholders in the national eHealth system, including the first-line health care worker, the specialist and the epidemiologist.

Figure 1: *Proposed flow of information for a MDD mHealth app integrated with eHealth systems.*



Looking purely from a health perspective, it is unlikely that a stand-alone mobile depression app, as a self-management tool or a health professional tool, would be cost effective in the context of a depression initiative unless it is connected to greater health information systems; there are likely to be greater priorities for the health system that could be implemented at a lesser cost. Similarly, unless combined with effective technological development, the initiative would not be scalable or be acceptable to patients or users. From a purely technological perspective, a stand-alone mHealth depression app developed without proper attention to health perspectives will not only inherently have limited efficacy, but it will simply add to a flooded market of untested and unreliable health apps. While private health corporations are beginning to realise the potential of incorporating mHealth into eHealth, integrating patient-centric mHealth applications into public health system services is a novel concept that fills an important gap in the market. However, health systems integration cannot be done without attention to the fidelity of the intervention itself.

Despite the limitations of a small expert sample and the lack of available comprehensive and up-to-date literature on mental health services and mHealth progress in South Africa,this research could facilitate the motivation and basis towards the development of a multi-tier mHealth application which is integrated into the larger eHealth ecosystem.

6 REFERENCES

Andrews, G., Cuijpers, P., Craske, M., McEvoy, P., & Titov, N. (2010). Computer therapy for anxiety and depressive disorders is effective, acceptable and practical health care: a meta-analysis. *PLoS One, 5*(10), e13196.

Ben-Zeev, D., Scherer, E., Wang, R., Xie, H., & Campbell, A. (2015). Next-generation psychiatric assessment: using smartphone sensors to monitor behaviour and mental health. *Psychiatric Rehabilitation Journal*.

Castro, A., Garcia-Palacios, A., Mayoral, F., Botella, C., & Garcia-Herrera, J. (2015). Efficacy of low-intensity psychological intervention applied by ICT for the treatment of depression in primary care: a controlled trial (study protocol). *BMC Psychiatry, 15*(106).

Donker, T., Petrie, K., Proudfoot, J., Clarke, J., Birch, M. R., & Christensen, H. (2013). Smartphones for smarter delivery of mental health programs: a systematic review. *J Med Internet Res, 15*(11), e247. doi:10.2196/jmir.2791
Ernst & Young. (2012). mHealth: mobile technology poised to enable a new era in health care. Retrieved from http://www.ey.com/gl/en/industries/technology/mhealth---mobile-technology-poised-to-enable-a-new-era-in-health-care
Flick, U. (2007). *Designing Qualitative Research*. London: SAGE Publications.
Keeton, C. (2012). Measuring the impact of e-health. *Bulletin of the World Health Organisation, 90*(5), 326-327. doi:10.2471/BLT.12.020512
mybroadband.co.za. (2016). Smartphone penetration in South Africa hits major milestone. Retrieved from https://mybroadband.co.za/news/smartphones/180894-smartphone-penetration-in-south-africa-hits-major-milestone.html
Norris, L., Swartz, L., & Tominson, M. (2013). Mobile phone technology for improved mental health care in South Africa: possibilities and challenges. *South African Journal of Psychology, 43*(3), 379-388.
Payne, H., Lister, C., West, J., & Bernhardt, J. (2015). Behavioural functionality of mobile apps in health interventions: a systematic review of the literature. *JMIR Mhealth Uhealth, 3*(1), e20.
Peterson, I., & Lund, C. (2011). Mental health service delivery in South Africa from 2000 to 2010: One step forward, one step back. *South African Medical Journal, 101*, 751-757.
Proudfoot, J. (2013). The future is in our hands: the role of mobile phones in the prevention and management of mental disorders. *Australia New Zealand Journal of Psychiatry, 47*(2), 111-113.
Richards, D., & Richardson, T. (2012). Computer-based psychological treatments for depression: a systematic review and meta-analyis. *Clinical Psychology Review, 32*(4), 329-342.
Saeb, S., Zhang, M., Karr, C., Scheuller, S., Corden, M., & Kording, K. (2015). Mobile phone sensor correlates of depressive syndrome severity in daily-life behaviour: an exploratory study. *Journal of Medical International Research, 17*(7), e175.
Schierenbeck, I., Johansson, P., Andersson, L., & van Rooyen, D. (2013). Barriers to accessing and receiving mental healthcare in Eastern Cape, South Africa. *Health and Human Rights, 15*(2), 110-123.
Shen, N., Levitan, M. J., Johnson, A., Bender, J. L., Hamilton-Page, M., Jadad, A. A., & Wiljer, D. (2015). Finding a depression app: a review and content analysis of the depression app marketplace. *JMIR Mhealth Uhealth, 3*(1), e16. doi:10.2196/mhealth.3713
South African Department of Health. (2012). National eHealth Strategy. Retrieved https://www.health-e.org.za/wp-content/uploads/2014/08/South-Africa-eHealth-Strategy-2012-2017.pdf
South African Department of Health. (2013). Policy: National Mental Health Policy Framework and Strategic Plan 2013-2020. *National Mental Health Policy Framework Strategic Plan 2013-2020*. Retrieved from https://www.health-e.org.za/wp-content/uploads/2014/10/National-Mental-Health-Policy-Framework-and-Strategic-Plan-2013-2020.pdf
South African Department of Health. (2015). mHealth Strategy: 2015-2019. *mHealth Strategy 2015-2019*. Retrieved from http://www.hst.org.za/sites/default/files/mHealth%20Strategy%202015.pdf
Tomlinson, M., Grimsrud, A. T., Stein, D. J., Williams, D. R., & Myer, L. (2009). The epidemiology of major depression in South Africa: results from the South African stress and health study. *South African Medical Journal, 99*(5 Pt 2), 367-373.
Tomlinson, M., Rotheram-Borus, M., Swartz, L., & Tsai, A. (2013). Scaling up mHealth: where is the evidence? *PLoS Med, 10*(2), e1001382.
Watts, S., Mackenzie, A., Thomas, C., Griskaitis, A., Mewton, L., Williams, A., & Andrews, G. (2013). CBT for depression: a pilot RCT comparing mobile phone vs. computer. *BMC Psychiatry, 13*(49), 49. doi:10.1186/1471-244X-13-49
WHO. (2015). WHO Mental Health Gap Action Programme (mhGAP). Retrieved from http://www.who.int/mental_health/mhgap/en/

APPENDIX 1: REVIEW OF THE MARKETPLACE FOR POPULAR MOBILE APPS FOR DEPRESSION

App name, version (Publ.) Year, Price.	Functionality
MoodTools - Depression Aid 2.1 (MoodTools) 2015. $0	ThoughtDiary; Activities (Behavioural Activation Therapy); Safety Plan; Test (PHQ-9); Video
Depression CBT Self-help Guide v1.8 (Excel At Life) 2014. Free (in-app purchases)	Test (with Graph); Articles ; Suggestions, tracking; Depression Assistance Audio; Cognitive Thought Diary; Emotion Training Audio; Relaxation Audio; Password Protection; Customisation of graphics

How Are You - Mood Tracker v1.6.2 (Quantum Lab Co.) 2015. R156.15	Mood assessment; >30 mood boosting hints; mood tracking; average mood, mood graphics, compare with world results analysis feature; Buddy feature (share with someone close to you; gratitude diary
MoodSpace – Depression Self-Help v1.2 (Boundless) 2015. $0	interactive mood workouts - habit building exercises that are completed on the phone.
Anti-Depression v1.5 (SoundMindz.Org) 2014. Free (in-app purchases)	diagnostic questionnaire; recorded messages providing an action plan; a workbook with information and exercises relating to therapy; daily progress tracker; On-demand reporting. Access to latest research via website
7 Cups of Tea: Care & Therapy v1.04 (7 Cups of Tea) 2014. $0	Free anonymous and confidential conversations with trained active listeners (including licensed therapists). Choose your ideal listener
eMoods Bipolar Mood tracker (Yottaram LLC) 2014. $0	Tracks moods, symptoms, sleep, medications, printable charts at month end. Does not log multiple moods/symptoms per day. Reminder alarms
Life Reboot - Fight Depression v1.3 (photonapps). 2015. Free	Anonymous forum; diary; medicine reminders; daily motivational quotes; jokes; games: painting and tic-tac-toe
MoodKit - Mood Improvement Tools v3.0 (Thriveport, LLC). 2015. $4.99	over 200 mood improvement activities; email/text/Facebook sharing of activities; Thought Checker; Mood Tracker: exportable mood charts; Journal ; Voice entry support.
eCBT Mood v2.1 (mindApps llc). 2012. $0.99	Overview of CBT; Feelings and thoughts log; Automatic thought identification; Structured automatic thought challenge tool; Identify and challenge core beliefs; mood assessment and report.
Sad Scale v1.2 (Deep Pocket Series LLC). 2009. $0.99	Edinburgh Postnatal Depression Scale; Zung Depression scale (monitoring changes over time); Geriatric Depression scale; Children depression scale
Operation Reach Out v1.0.2 (Guidance Group). 2011. $0.	Help Centre - hotlines and emergency personal contacts; help for suicidal people - 12 videos; Help for people trying to prevent suicide - 10 videos.
DBT Diary Card and Skills Coach v2.9 (Durham DBT). 2015. $4.99	a reference manual; behaviour checker; skills coach; password locking; daily reminders; advanced text editing; media playback; skills, emotions, behaviours, coaching, customisability, emergency skills, email.
Optimism v2.5.9 (Optimism Appsa). 2015. $0	Develop and monitor health strategies, learn triggers of a decline in mental health, recognise early warning signs of a decline; detailed charts and reports.
Happy Habits: Choose Happiness v2.2.1 (Excel At Life). 2014. $0	Happiness Assessment; Audio guides; Happiness Journal; 50 CBT suggestions (Customisable); Daily reward points; Graphs; Articles; Emotion Training audios; Relaxation audios; Password; Customisable graphics
MoodTrek V1.4 (Cerner Corporation). 2015. $0	Mood tracking/rating; Journals; Syncs to Fitbit® to track physical activity; Autocapture sleep quality; sharing to doctors (Cerner EMR); HIPAA compliant
Beating the Blues £49.99	Computerised CBT: 8 50 min sessions; Endorsed by NHS
myCompass (Black Dog Institute). $0	Interactive mood tracking/management with reports on patterns and behaviour over time. Diary; Others' experiences stories; Access to reading material

APPENDIX 2: IDENTIFIED FUNCTIONALITIES FOR AN SA DEPRESSION MOBILE APP

The following table lists the required functionalities identified for a proposed South African mHealth app to treat or manage depression. Sources for these functionalities are literature (α), existing apps (β) and interviews with experts (γ). Functionality marked with δ is not recommended for initial designs.

MHCU interface

- Security: pin
- Profile creation
  - governmental patient ID (optional)
  - medical history (form field)
  - Psychosocial history and information
  - Privacy settings (who gets to use data. Information about data collection)
  - Customisable settings (reminders, themes, potentially choosing from an extended list of features)
- Doctor dashboard
  - Finding doctors and nearby facilities by accessing their public profiles
  - automated alerts to seek help based on EMA trends and the last time health services were accessed
  - List of doctors that are linked to profile and how much information they receive
  - health care facility visits

Supervisory specialist interface

- Security: user ID and password
- profile creation
  - verification tool/authentication to create profile
  - registering tool to add CHWs
  - public profile for MHCUs
  - restricted profile for clinic interface, CHWs,
- patient dashboard
  - "at a glance" - alerts for patient trends, any warnings
  - notifications from clinic/CHWs about patients, alerts if a patient has not received care for a set period of time.
  - individual patient selection
    - data from patient device
      - journal reading, commenting
      - graphical representation of EMA data
    - communication
      - IM communication with patients δ

        - record of facility visits (satisfaction ratings?)
        - receives requests from providers that the MHCU attend a clinic - notification goes away when a clinic visit is registered
    - Communication:
        - IM communication with CHW
        - asynchronous outgoing: requests for appointments/visits from CHW, requests from health practitioners to access information, refer patient notes, etc.
        - record of therapeutic sessions, notes (audio-recordings?) from sessions (satisfaction ratings?)
    - "Add a doctor" – the MHCU enters the doctors ID code, adding the doctor to the dashboard and authorising the sharing of information.
    - "remove a doctor" (sends notification to doctor)
- Personal tools:
    - Monthly standardised test, based on an existing screening tool β
    - Manual-input EMA: mood and physical attribute variables α β
    - Automated EMA: wearable tech, phone environment, corresponding to manual-input data. α β (P) δ
    - Journal: time-stamped free text entry β γ (***PSLGT***)
        - tagging of key words/themes – tracking of theme recurrence, search by theme.
        - prompt fields (e.g. positive events, contact with friends –***PSLGT***))
        - Voice entry δ
    - Activities and resources
        - CBT-based activities. personalised modules α β
        - educational articles, podcasts, videos, allowing for exporting and sharing (can have modules aimed for sharing with friends/family for reducing stigma)
    - suicide plan β
        - reminders of positive things from journal
        - "to do" of self-identified help solutions.[v]
        - emergency contacts (possibility to contact them through app)
        - suicide help-line δ
    - Graphical representation and trend monitoring
    - Export/share function for all/any activities
- My medication β γ (***PSLGT***)
    - medication history
    - List of current medication with start/stop dates of treatment
    - medication reminders, with photograph of meds, number of tablets, which one to take when
        - note when medication is/isn't taken to track adherence
    - medication information
    - Monitoring - link to tracking- see side effects, response to treatment δ
    - potential to link up with pharmacy information systems at a future date δ
- other communication tools
    - support group/community feature β δ
    - anonymous support from trained lay workers β δ
    - Community IM tool with formal support group within health care structure (with CHWs/supervisors as moderators)
- tech support: IM, web-based, call-line, built in manual

<u>CHW (Clinical Healthcare Worker) interface</u>

- security features: user ID and password
- Profile creation
    - verification tool/authentication instructions to access profile created by supervisor
        - asynchronous/one-way: request for access to patient data suggestions for activities, sending them in for an appointment.
    - consultation tools
        - patient notes
        - *diagnostic tools*
        - activity recommendations for patient
    - referral tool γ (***MRR***, ***PSRT***)
        - suggest a referral of a patient to another specialist/doctor
        - remove a patient from a CHW patient dashboard
        - refer a patient to a CHW patient dashboard
        - refer a patient to a clinic
    - archiving of patients after referral
- CHW dashboard
    - tool to "add" CHWs
    - tool to "archive" CHWs (requires approval from clinic administrators)
    - manage CHW patient dashboards
        - remove a patient from a CHW patient dashboard
        - refer a patient to a CHW patient dashboard
    - access to log books - monitoring of CHW activities
        - potential graphic display of hours spent active, etc.
    - managing CHW training activities
    - access to CHW journal, EMA, etc. (on request?)
    - send instructions to CHWs ("to-do list")
    - IM Communication: α γ (***PSRT***, ***SSR***)
        - one-on-one communication CHWs
        - community forum with all CHWs in the team
- Professional tools
    - statistics for supervising area
    - "find a colleague".
    - IM communication with colleagues
    - to do list (can link to contacts), receives instructions
    - eLearning platform (connection to health news?) α
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor/colleague

<u>Primary care clinic admin interface</u>

- Security: user ID and password
- clinic profile creation
    - verification tool/authentication to create profile
    - public profile: contact details, services offered, catchment area, opening hours, etc.
- patient dashboard
    - logs patient access to facilities (QR code?)
    - recording of time/date, doctor seen, patient notes, prescriptions δ
    - limited access to MHCU's doctor dashboard (which doctors they are seeing)
    - scheduling δ
    - referral tool γ (***MRR***)
        - "send" a patient to a specialist - requires permission of specialist and patient. sending of patient file requires extra permission.
        - "send" a patient profile to a CHW - requires permission of patient. sending of patient file requires extra permission.
        - Refer patient to a secondary or tertiary institution
    - noting death of patient, request archiving of MHCU profile.
    - communication
        - asynchronous/one-way: request for access to patient data suggestions for activities, sending them in for an appointment.
    - Medication δ
        - Monitoring adherence
        - Monitoring prescription practice
        - Sending notifications for prescription collection

- public profile: public details for patients
- restricted profile: details for specialists, clinic

- Patient dashboard
  - "at a glance" - alerts for patient trends, any warnings
  - notifications from clinic/supervisor to communicate with patients
  - individual patient selection
    - data from patient device
      - journal reading, commenting
      - graphical representation of EMA data
    - communication
      - IM communication with patients
      - asynchronous: request for access to patient data, recommendation of articles, activities
    - consultation tools
      - log book and electronic note-taking tool
      - diagnostic tools γ (***ISP***)
      - survey tool for additional epidemiological data collection on demand.
    - referral tool – to supervisor or clinic γ (***MRR***)
  - Personal tools (own journal; EMA; debriefing tools)
- Professional tools
  - compile log book from individual patients
  - to do list: receives instructions from supervisors and clinic
  - training activities eLearning α
  - IM Communication: α γ (***PSRT***, ***SSR***)
    - one-on-one communication with supervisor
    - community forum with other CHWs in team as well as supervisor
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor/colleague

System administrator

- security: enter ID and codes (secure password)
- management of permissions
- removing identifiers from profiles
- compilation of master indices
- monitoring for rogue users/bad data
- monitoring IM content for inappropriate content
- updating system, optimising interoperability
- following up/archiving inactive profiles

- service co-ordination dashboard
  - master index of specialists, CHWs, other mental health providers in catchment area
  - details of other programmes. facilities, private sector practitioners NGOs
  - master index of patients in the catchment area
    - limited access to patient information
  - limited access to view (?edit?) supervisors' CHW dashboard (which supervisors are overseeing which CHWs)
    - access to log books of CHWs
  - limited access to view (?edit?) CHWs' and supervisors' patient dashboards (which care providers are overseeing which patients
  - alerts when patients are referred.
  - verification tool to authorise supervisors and CHWs, adding them to service provider dashboard
  - send instructions to CHWs
  - send instructions to supervisors
  - "map" function to locate CHWs, patients
- statistics
  - aggregated, anonymised data for catchment area
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor

Epidemiology terminal

- Security – strong password
- anonymised MHCU EMA statistics α γ (***PSRT***,***SSR***,)
  - incidence, trends, risk, outcomes, co-morbidities, distribution.
  - Health service usage
  - medication use, outcomes of medication
- usage statistics
  - each login (time, location, amount of data)
  - amount of communication
  - CHW performance –fidelity of CHW programmes
  - distribution of services, penetration
- ongoing evaluation of intervention α
  - completeness of data sets, completion of activities
  - continuity of care
  - outcome variables, efficacy
- master index of services: clinics, practitioners, CHWs