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M-Health and Smartphone Technologies and Their Impact on Patient Care and Empowerment

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16.1 Introduction

Technology has advanced rapidly over the past decade and it has transformed the lifestyle of most individuals. Healthcare organizations have experienced significant changes after the introduction and integration of technology in various health-care processes. The World Health Organization in its recent statement has clearly highlighted the potential of eHealth and how it has transformed health-care organizations in their daily work. eHealth is defined as the process in which health-care resources and health care are being communicated and transferred by

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the electronic and digital medium. Looking back at the past decade, there have been major advances in both Web-based as well as Internet-based technologies, along with the introduction of smartphones as well as bio-sensor devices. This has led to the development of sophisticated electronic medical records (EMR) systems, as well as various other platforms to triage and help in the management of patient's condition. In addition, such advances have also created a revolution in the way clinicians acquire evidence-based knowledge and information, as they no longer need to turn to traditional modalities of communication, but they could instantly look up pertinent information using just the Internet. Smartphones and their accompanying applications are perhaps the latest advancements in technology.

16.2 Smartphone Technology for Health-Care Professionals

mHealth refers to mobile health and it refers largely to the usage of mobile devices in the practice of medicine (World Health Organization). Over the past few years, numerous studies have been published demonstrating the increased adoption of smartphone and smartphone-related applications by health-care professionals (Garritty and Eman 2006). Smartphones represent a new modality of technology that offers more than the conventional modalities of mobile technology. Smartphones are equipped with immense computing capabilities that allow individuals to access the Internet at their convenience. A smartphone application is a computer program that is specially designed to run on smartphones and tablet computers, usually serving a specific purpose. In fact, the health-care system itself is inherently mobile in nature, encompassing consultations and treatment at a wide variety of locations, including clinics, inpatient wards, outpatient specialist services, emergency departments, operating theatres, intensive care units, and even laboratories. To complete their day-to-day tasks, health-care professionals must be mobile while simultaneously communicating effectively and collaborating with colleagues across disciplines (Abu 2012). Hence, it is not surprising that the smartphone adoption rates

have increased among health-care professionals, who realize the invaluable additions these tools can provide to their daily practices.

Previous systematic reviews have examined 23 surveys on the use of personal digital assistants (PDAs) by health-care professionals across several countries. The key findings include that younger clinicians are more likely to use this technology and family doctors and general practitioners most commonly utilized that PDAs. In particular, large practice- and hospital-based clinicians are more likely to use mobile technology (Abu et al. 2012). Thus, conventional technological modalities are currently being replaced by smartphones, which combine the basic functions of a pager, a cell phone, and a PDA with even more sophisticated capabilities. This major revolution in the medical industry may have begun in 2007 with the release of Apple's iPhone. Since then, the smartphone market has advanced rapidly (Karl 2012). Another pivotal change was the launch of the Apple Application Store in July 2008 (Karl 2012), which enabled users to download smartphone-based applications to add additional capabilities to their smartphones. A recent survey performed by Manhattan Research in 2009 (Abu et al. 2012) showed that approximately 64% of the clinicians in the USA have used smartphones, compared with 30% in 2001. Other research statistics reflect the tremendous increase in the number of smartphone applications being downloaded, from 300 million in 2009 to over 5 billion in 2010 (Mobile Future 2010). Based on the latest statistics released, it showed that as compared to 2013, almost twice the percentage of consumers have at least a health- or fitness-related application in their smartphone (PWC 2015).

With these technological advances, clinicians are no longer confined to using individual workstations or computers on wheels (Abu et al. 2012) when accessing hospital information systems, electronic health and medical records, laboratory results, and/or the latest evidence-based information to help them with clinical management. With the increased adoption of smartphones, clinicians have easier and better access to patient information, which should improve clinical care (Abu et al. 2012). Additionally, new software applications are increasingly tailored to the needs of clinicians, particularly resources for evidence-based information. In addition to clinicians, patients can benefit from this

technology to monitor their own conditions. Previous studies have demonstrated the efficacy of smartphone use in disease prevention and self-monitoring as well as in the management of chronic diseases (Marshall 2008). Previous studies (Abu et al. 2012) have examined differences in the utilization of health-care applications among health-care professionals. Despite the variety of applications used, those for the diagnosis of diseases and medical calculations are the most commonly used by practicing health professionals and in studies in medicine and nursing. In this chapter, we provide an overview of mHealth and smartphone technology and how it has affected how health-care professionals practice. We provide an overview of medical applications that have been developed for patient care and explained how they have empowered patients in terms of self-management of their own conditions. We also provide an overview of psychiatric applications that have been developed and explain how they have managed to empower patients in terms of their own care. We then discuss how we could tap onto mHealth and smartphone technology, and how it could be effectively used to empower patients and transform patient care using selected examples based on our recent work. We conclude the chapter with a discussion of the limitations of mHealth.

16.3 Overview of Medical Applications and Their Impact on Patient Care and Empowerment

mHealth- and smartphone-based technologies have been successfully deployed for usage in medical care in several aspects, such as in terms of chronic disease management, as well as patient's monitoring. There are smartphone-based applications that are potentially useful for patients who are undergoing rehabilitation as well. Some of the existing smartphone-based applications could also aid in medical diagnosis and have also been approved by the US Food and Drug Administration. In addition, smartphones and their applications have also been effective in reaching out to those who are in need of medical care in developing countries. We proceed to explore more with regard to these existing

applications and explain how they have managed to successfully empower patients in their own medical care.

With regard to the utilization of medical applications for the management of chronic diseases, Ozdalga (2012) has identified an application, named as Diabeo for chronic disease self-management (Charpentier 2011). This particular application collates not only information regarding self-measured blood sugars levels but also carbohydrate counts as well as the levels of physical activity. Hence, in essence, the application facilitates and empowers individuals to take control and be aware of their chronic disease health status. Researchers have studied the application over a 6-month period in France, and a cumulative total of 180 patients have since completed the evaluation of the application. It is of significance that individuals who used such an application tended to have a lower HBA1c as compared to those individuals who have no access to the application. In addition, smartphone applications have been used as patient monitoring tools, to empower caregivers with information about their loved ones. iWander is an android-based application that has been designed to help monitor the movement of geriatric patients with Alzheimer's dementia using the Global Positioning sensors within the smartphone.

One of the core advantages of the utilization of technology is the provision of accessible care, in spite of the physical locality of the patient. Technology serves to mitigate the geographical barriers and distance. Worryingham (2007) has previously described how they have utilized just a Bluetooth device with a single-lead electrocardiography (EEG) and how this has enabled patients, who have just recently suffered from a coronary artery event or having just recently underwent an angioplasty, to continue with their rehabilitation program in the comfort of their home settings. This particular form of innovation empowers patient to continue to participate in their rehabilitation program, for sustained clinical outcomes after their recent discharge from a major operation. mHealth and smartphone have also been used to improve patient's care and to reduce health-care costs incurred for certain investigations. Bsoul (2011) demonstrated the utility of the smartphone in assisting clinicians with medical diagnosis. The diagnosis of sleep apnea is now made possible remotely simply by using a smartphone coupled to a single-lead EEG. Other researchers

(Oresko 2010; Huang 2012) have highlighted how the smartphone could be used as an ECG recording device or even a Doppler device to measure blood flow.

mHealth has made health-care provision accessible for individuals in developing countries as well. mHealth and its accompanying smartphone applications have helped health-care workers in rural areas of Thailand in their treatment of malaria (Meankaew 2010). Health-care workers in Kenya have also benefitted from mHealth as it has allowed them to collate data and other information which they have obtained during home visitations.

In 2013, the World Health Organization has identified several conditions that are deemed to be prevalent globally. These conditions include iron deficiency anemia, hearing loss, migraine, poor vision, asthma, diabetes mellitus, osteoarthritis, as well as depressive disorder. The World Health Organization has identified that to date; there are several commercial applications that have been developed to cater for these highly prevalent conditions (Perez 2013).

16.4 Overview of Psychiatry Applications and Their Impact on Patient Care and Empowerment

As we are domain-experts in the field of psychiatry, it will be helpful for us to determine whether mHealth is capable of outreaching to this target population, in terms of meeting their clinical needs as well as patient empowerment. As there are no objective clinical signs in psychiatry, reaching out to this population would also be more challenging. We provide an overview of some of the applications that have been commercially developed in psychiatry and how they have helped in terms of patient care and empowerment. We then highlight some of the limitations and explain how we have managed to overcome these limitations, with the objective of producing more evidence-based applications for patient care and empowerment in psychiatry.

The conventional text-messaging service has been evaluated to be useful for patients with schizophrenia (Granholm 2011). In a previous pilot study, participants received text messages daily. If they responded, they will be given advice regarding the management of their symptoms via their mobile devices. Eighty-six percent of the participants responded and among those who have responded, they reported a reduction in the sense of self-distress. In addition, they also reported that they find themselves more compliant with their prescribed medications. Aside to text messaging, there has been further evaluation of smartphone-based applications to empower individuals in dealing with their psychotic symptoms. Palmer-Claus (2012) examined the effectiveness of self-reporting psychotic symptoms using a smartphone-based software application and found that five items scored by participants on their smartphone correlated well with validated toolkits. Thus, this implies that patients when empowered can self-monitor their own symptoms. In addition, the implementation of such a technology has also enabled patients to identify specific relapse triggers as well. The identification of psychosocial triggers is pertinent as they are factors that might trigger a relapse and might also result in poor compliance and response to the standard medications prescribed. Further studies have looked into the feasibility and the effectiveness of integrating a smartphone-based self-reported questionnaire into the daily lives of individuals living with schizophrenia. Clearly, patients feel empowered and it has a benefit for clinicians as well, as clinicians are able to better their understanding of the daily symptoms experienced by their patients.

Aside to psychosis, there have been studies demonstrating the efficacy and potential of smartphone technology for individuals who are suffering from bipolar disorder. Smartphones and wearable devices could be used for recognizing the depressive and manic states of patients and thus empowering individuals to identify their changes in state. The pilot study has demonstrated that the recognition accuracy is as high as 76% (Grunerbl 2014). Faurholt (2014) piloted daily electronic monitoring smartphone software called MONARCA on 17 patients for duration of 3 months. In that 3-month period, patients were required to complete both the Hamilton Depressive Rating Scale as well as the Young Mania Rating Scale once every 2 weeks. The results gathered show that patients felt empowered and were receptive toward such an

intervention. In addition, their self-monitored depressive scores correlated with the objective measures such as their levels of physical and social activity, thus indicative of the severity and improvements in their core depressive symptoms. Similarly for depressive disorders and anxiety-related disorders, trials have demonstrated their efficacy in screening individuals with symptoms, as well as helping in the reduction of underlying anxiety symptoms through an increase in coping skills via techniques taught in the smartphone applications.

16.5 How to Harness the Potential of mHealth in Empowering Patients

One of the concerns about the current developments in mHealth and smartphone applications are issues relating to confidentiality and privacy issues, as well as limitations with regard to the existing evidence base of these applications on the application store. Zhang et al. (2015) have previously proposed several strategies to mitigate these concerns, which include that of: (a) Encouraging more peer review of health care-related applications, (b) utilization of a systematic self-certification model to rate existing applications to determine their information quality and evidence base, and (c) enabling and empowering psychiatrist and health-care professionals to be content developers of smartphone applications. Zhang et al. (2014a, 2014b) have highlighted how this could be done using cost-effective methodologies such as online application builders as well as cloud-based blogging sites to create responsive Web-based applications.

We wish to elaborate more about how we have made use of these techniques in the creation of theory-driven applications and how they have empowered our patients. We discuss this in the form of case studies and describe the respective innovations that we have created.

Case Study 1: Increasing mental health awareness among the general population/Empowering public with mental health knowledge—The Royal College of Psychiatrists (UK) Mental Health Application

Zhang and Ho (2015) have previously described how psychiatrists could be involved in the creation of evidence-based smartphone applications at the

individual level, making use of the methodologies described previously by Zhang et al. (2014a, 2014b). The Royal College of Psychiatrists Mental Health application is one such example. The application contains and provides an online handheld version of the key facts information for patients. In addition, the application also has integrated video podcasts and animations to help the general public in understanding common mental health-related disorders such as depression and anxiety disorders. The application also features audio podcast of the experiences of individuals who have had experience of the various disorders. The smartphone application is an initiative of the Royal College of Psychiatrists' Patient Education and Engagement Board and its main aim is to empower the general public with readily accessible mental health information, readily on the go. Of course, the secondary aim is to help to dispel the stigma with regard to mental health disorders among the general population. It has been reported that the application was launched during the 2014 college congress and that there were approximately 346 unique downloads of the application.

Case Study 2: Empowering Individuals at risk of addictive disorders with information to seek help

Zhang et al. (2016) in their recent article have highlighted the challenges in psychiatry, in particular in addiction psychiatry. Based on the Singapore Mental Health Study, the duration of untreated addiction disorders, such as that of alcohol abuse is as much as 13 years. With the changing trends overseas, it is expected that there are more at-risk individuals who might not be seeking help early. Zhang et al. (2016) mentioned that these factors include that of the normalization of general public's perspective toward common drugs of abuse, especially so after the legalization of Cannabis overseas as well as the usage of drugs like ketamine as a rapid antidepressant. Stigma and the failure of the primary physician to pick up substance-related abuse might be a causative factor accounting for the long duration of untreated illness.

mHealth and smartphone technologies thus could help to play an integral role in the empowerment of individuals about how best to seek help once they recognize that they have a particular disorder. Zhang (2016) has addressed the limitations of the methodologies proposed previously with regard to the usage of Web-based application builders and

have advocated for the usage of cross-platform techniques in the programming of new applications. Zhang et al. (2016) have advocated and highlighted that there remains a need for evidence-based psycho-educational drug applications that could empower the public with core knowledge about drugs. Of importance, Zhang et al. (2016) has recommended that the conceptualized application should mimic how prior mass media interventions have helped in terms of the dissemination of health-related information. Hence, in their conceptualized application, “Say No to Drugs” smartphone application, they have included relevant videos, aside from information to better empower patients and the general public in the acquisition of core knowledge about the harmful effects of common drugs.

As reviewed previously, most of the current smartphone applications seemed to be more focused on being an adjunctive tool for patients who are in the recovery process. Aside to the provision of psycho-education materials, one of the key interventions in addiction psychiatry pertains to the concept of harm minimization. Given the inherent effectiveness of harm minimization for a variety of addictive disorders, such a theory could be used to conceptualize and develop applications that could help at-risk individuals. Zhang et al. (2016) have described how they made use of this theory in the field of alcohol addiction as well as gambling addiction, using new cross-platform application development strategies. Their conceptualization of the alcohol tracker application serves to address the limitations raised in previous content analysis of alcohol related applications. Of note, the most recent content analysis of alcohol-related applications have highlighted that they lack evidence base and their methodology of tracking alcohol consumption could be counter-intuitive, in that it encourages individuals to challenge their limits. Their conceptualized alcohol tracker application encourages individuals to log down the absolute number of drinks they have had and this will be tracked across the span of one week. According to the National Institute of Clinical Excellence (NICE) UK guidelines, in the event that they exceed their recommended units per week, they will be prompted with a notification immediately. Aside to the provision of tracking tools to empower individuals to track their own condition, their conceptualized application also has information about alcohol abuse and dependence and its related medical complications. More importantly, they have empowered individuals through the

integration of a national helpline for them to seek help for their problem. In a sample cohort of 100 Canadians, the authors have further demonstrated that both the notification as well as the information within the application has been deemed to be useful. Clearly, the theory underlying their conceptualization is that of harm minimization, through the usage of live notifications as well as provision of resources for individuals to seek help.

Zhang et al. (2016) have also described how they have successfully applied the concept of harm minimization for problem gambling in Singapore. They have managed to do so by harnessing the potential of the global positioning sensors within the smartphone device. Based on the author's conceptualization, on the surface, the application just seemed to be providing psycho-educational information to individuals, ranging from the signs and symptoms of gambling to that of how best to seek help. However, in reality, the global positioning sensor is being harnessed upon to continuously track the locality of the patient. Hence, once the at-risk gambler is within the proximity of a gambling locality, they will be prompted with a notification. The notification feature will enable the at-risk gambler to seek help by contacting his loved ones via a telephone call or via email. Hence, not only are the individuals being empowered to deal with their underlying condition, their network of loved ones are also being empowered to assist them in making a change in their lives.

Case Study 3: Empowering individuals with psychiatric disorders to better understand their treatment regiment

Healthcare professionals routinely refer to clinical practice guidelines to guide them in their management of various medical and psychiatric conditions. However, one of the major limitations with these guidelines is that they are not kept updated and relevant with the emerging changes in the research literature and evidence base. In addition, the traditional guidelines routinely serve only to empower the clinicians with making evidence-based changes in terms of their management of the patients. With the rapid advancement in technology, patients to date are more cognizant of the latest updates in medical information and would want to be better informed about their treatment plans. Zhang et al. (2016) described an innovation that serves to mitigate the above issues. The authors describe

how they have implemented an innovative server feature that facilitate the rapid updating of guidelines so that clinicians could make use of latest evidence based guidelines in the treatment of various psychiatric disorders. Patients, on the other hand, are empowered to know more about their treatment plans, as they could have access to simplified version of these clinical guidelines as well. Hence, they are empowered to know what stage of the treatment plan they are currently in at the moment. In addition, patients could also use the application to take validated questionnaires, such as the GAD-7 and the PHQ-9 and their scores would be tracked chronologically across time. Hence, this would enable patients to track the severity of their depressive symptoms across time as well.

16.6 Conclusion

Despite the inherent benefits of mHealth for patient empowerment as previously described, it is also essential for health-care professional to recognize the inherent limitations of mHealth technology. It is easier to harness and tap onto mHealth technologies in developed countries, but even in developed countries, it is important to bear in mind that there might be disadvantaged individuals who might not be able to have access to a smartphone and hence, would not have access to the smartphone applications. Such an innovation would be difficult to implement in a low to middle income country and hence limits the effectiveness of mHealth-based interventions. In addition, clinicians and health-care professionals need to recognize the constant need to keep their smartphone applications updated with the latest evidence. Also, alongside the limitations highlighted previously, clinicians and health-care workers need to be critical and more cognizant that most of the current health-care applications are not developed in conjunction with a medical specialist and hence, their evidence base might be lacking. Keeping this in mind, clinicians need to be careful when they are recommending health-care applications to their patients.

Given these limitations, not only should health-care professionals be more actively involved in the conceptualization of health care-related mHealth interventions, but at the managerial level, there ought to be more supervision as well as project management.

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