

# Medical smartphone applications

A new and innovative way to manage health conditions from the palm of your hand

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## ABSTRACT

Smartphones have a variety of unique features including text-message communication, camera, sensors, and health applications (apps), which can be used to assist in monitoring an individual's health, diet, and exercise, as well as support goal-focused strategies personalized to user needs. Mental health and diabetes management apps are two prominent examples that have been shown to be effective in improving specific health outcomes. Mental health apps provide day-to-day patient care by teaching users how to reduce stress, focusing on strategies to enhance mental well-being. Apps such as *Kokoro*, *Headspace*, and *PRISM* have been demonstrated to reduce symptoms of depression and anxiety, and psycho-education apps have been demonstrated to reduce symptoms and to enhance concentration during specific tasks. Many diabetes apps are accessible by patients and physicians, and include tracking features for nutrition, fitness, and hemoglobin A1c levels. Specialized apps with text-messaging services and personalized support have been associated with improvements in blood pressure and blood glucose control. Social forums also provide patients privacy and the freedom to discuss their conditions with comfort. Health apps are easily accessible and available at low or no cost, and can be an effective tool for educating patients with chronic disease, supporting collaborative self-management, extending the impact of healthcare providers, and include response anonymity. There remain significant challenges including the protection of private health information and the development of regulatory frameworks to evaluate app quality, effectiveness, and absence of harm. Overall, the implementation of smartphone apps in healthcare systems may decrease demand in clinics, reduce healthcare costs, and lead to an improvement in patient health.

## INTRODUCTION

Over one billion smartphones have been shipped worldwide to date and are expected to continuously increase in number.<sup>1</sup> Since the introduction of smartphones, there has been continuous innovation allowing users to access a variety of functions, such as mobile health (mHealth) applications (apps) that provide consumers with disease information and monitor an individual's health, diet, and exercise. Smartphones have many features (camera, CPU, sensors, etc.) that work concordantly with various apps to attain goal-focused strategies that are personalized to a user's needs (weight loss, ways to decrease stress, etc.). The functional complexity and ubiq-

uitous nature of smartphones combine to create the potential for the integration of mHealth apps into our health system.

Changes in population demographics, including the rise in senior populations, will result in an increased burden of chronic diseases and disorders, such as mental health, COPD, congestive heart failure, diabetes, hypertension, and HIV/AIDS. Health budgets cannot double to meet the anticipated increase in demand, so transformative health system innovation is required. In addition, accessibility to healthcare can be limited by geography and economics, which may cause individuals to avoid seeking medical attention when needed. As the world continues to be connected via increased access to the Internet, apps become extremely accessible to anyone. Many health apps are currently available at a low or no cost, enabling users to track progress of health plans, manage symptoms, seek support among other users, and bridge the communication gap between patients and healthcare providers.

Although there are thousands of health-related apps available for download, there is very little evidence available that demonstrates their efficacy. To date, the best evidence exists for mental health and diabetes management apps due to their high user rate and demonstrated effectiveness.

## MENTAL HEALTH MANAGEMENT

It is estimated that one in five adults will experience issues associated with mental health in any given year,<sup>2</sup> yet only 41% of those individuals seek medical treatment.<sup>3</sup> Mental disorders, such as depression, anxiety, and bipolar disorder, are an increasing challenge felt worldwide and their prevalence has been rising at an alarmingly fast rate.<sup>4</sup> Their presence poses significant economic, personal, and societal costs and are often more difficult to treat than physical illnesses.<sup>5</sup> Given the broad spectrum of mental illness and the limited number of available psychiatrists accepting new patients, it is often a challenge for psychiatrists to diagnose accurately, schedule regular meetings with all patients, and to frequently access patient progress in order to tailor treatment options. Traditional psychotherapy and pharmacological interventions have been the standard care of practice for many years. However, certain therapies and their durations may not be readily accessible or affordable to certain patients needing routine clinical care.<sup>6</sup>

One affordable and convenient adjunct to present day treatment options are free, novel smartphone apps. Mental health apps provide day-to-day patient care by teaching users how to reduce stress and manage symptoms, focusing on strategies to enhance mental well-being. These mental health services support various elements of mental healthcare, such as rapid/open access, personalized treatment, convenience, establishing feelings of personal safety, preven-

tion options, and behavioural supports for those who would like to refrain from taking pharmaceuticals.<sup>7</sup> Apps like *Kokoro*, *Headspace*, and *PRISM* (Personalized Intervention for Stabilizing Mood), have been demonstrated to reduce symptoms of depression and anxiety in a variety of clinical trials.<sup>8-10</sup> Psycho-education apps, which provide patients and their families the education, information, and skills to co-manage their mental illnesses, have been demonstrated to reduce depressive symptoms over a six-week period and have also enhanced concentration during specific tasks.<sup>11</sup> In addition, they can serve as an adjunct to psychotherapy and pharmacotherapy in individuals classified as “treatment-resistant”, patients that do not experience changes with their regular treatment.<sup>12</sup>

To protect private patient health information, most apps have the option for patients to remain anonymous. The current stigma associated with mental health may result in many individuals that are hesitant to seek medical attention. The ability to remain anonymous enables patients to freely seek help at their own convenience as well as maintains patient anonymity for privacy purposes. With this in mind, patients are more likely to disclose symptoms related to mental well being as it may be stressful to talk to healthcare professionals with the fear of being judged.

#### DIABETES MANAGEMENT

Diabetes is estimated to affect 9.3% of Canadians, and for many people the responsibility, dedication, and attention required to live with this disease can be overwhelming.<sup>13</sup> Diabetes applications with a focus on lifestyle, access to personal health records, text messaging, and wound care have improved diabetes management.

Diabetes is heavily influenced by lifestyle choices and management of these, including nutrition and exercise, can be supported by medical apps.<sup>14</sup> A recent study compiled the top nutrition and fitness tracking apps available for smartphone users and assessed them by their food databases, logging options, and interoperability with other devices and apps.<sup>15</sup> Some apps included additional features such as daily reminders and online communities to engage patients socially.

Personal Health Record (PHR) services are available on select apps, giving patients the option to manage and maintain their health records by themselves.<sup>16</sup> These apps are synchronized with the hospital Electronic Medical Record (EMR) system and allow patients to monitor Hemoglobin A1c (HbA1c: glycosylated hemoglobin level), Low-Density Lipoprotein (LDL) and Blood Urea Nitrogen (BUN) levels. PHR services provide patients with a sense of responsibility and a substantial body of data for physicians and clinical researchers to integrate and analyze.<sup>17</sup>

Text-messaging services have also been studied as a way to provide important psychological and motivational support. Participants in *txt4health*, a large-scale, public health-focused text message program targeting type 2 diabetes, reported that 67.1% of users gave the app a satisfaction rating 8 on a 10-point scale. In addition, 88.8% of users found the app made them knowledgeable about their risk for type 2 diabetes and made them conscious of their diet and physical activity.<sup>18</sup> In an alternate study, a nurse-facilitated, mobile

phone-based clinical decision support system-enabled intervention in primary care was associated with improvements in blood pressure and blood glucose control.<sup>19</sup> In a comparable study, patients in the *TEXT ME* intervention for smoking program received four messages per week for six months that provided advice, motivation and support, resulting in investigators reporting significantly lower LDL-cholesterol, systolic blood pressure, and body mass index in patients.<sup>20</sup> These findings suggest that a similar program for diabetics could lead to improvements in health.

Diabetic wound care is a common problem that requires frequent hospital visits for inspection and cleaning. Researchers at Worcester Polytechnic Institute created *Sugar*, an app to assess chronic diabetic foot ulcers.<sup>21</sup> The patient takes a picture of the wound, which is analyzed by a series of image processing steps. Image and colour segmentation are performed to measure wound area boundaries and healing progress, respectively. *Sugar* tracks the progress of the wound, reducing the number of hospital visits previously required. This unique feature gives patients a sense of responsibility and an active role in their wound care.

#### CHALLENGES AND BARRIERS INFLUENCING APP INTEGRATION INTO THE HEALTH SYSTEM

Smartphone affordability, operation and security, and app performance and effectiveness are challenges influencing app integration into the health system. Lower socioeconomic groups may struggle to afford smartphones, while senior populations may have difficulties operating app features. Online security and protection of private health information remains a concern.<sup>22</sup> Mobile malware capable of accessing user information or making remote transactions (i.e. financial transactions) and on-line attacks are becoming more frequent.<sup>1</sup> Medical apps must be required to ensure that transmitted data is strongly encrypted and anonymous, and regulatory frameworks are needed to certify app performance and security.<sup>23</sup>

Another challenge is whether the advice provided by apps is grounded in legitimate medical knowledge and demonstrates effectiveness and absence of harm. Websites such as *PsychologyToday.com* and *PsychiatryAdvisor.com*, have provided a short list of quality assured apps that have been developed by board-certified clinicians.<sup>24</sup> As previously stated, early-adopted apps focused on tracking information.<sup>25</sup> Initiatives such as the Mobile Applications Rating Scale (MARS) assess the quality of health apps and promise to provide patients and healthcare providers with the highest quality tools.<sup>26</sup> Services like *txt4health* and apps like *Sugar* will continue to be developed and adopted by healthcare systems going forward.<sup>18,21</sup> In addition, governments and healthcare systems need to develop a system to regulate and establish a set of standards against which an app can be measured voluntarily.

#### CONCLUSION

The impact of the changing demographics in our society demand more than incremental changes in our health system; transformative innovations are required. Failure to act may lead to increased demand for doctors, increased wait times, delayed diag-

nosis, and a health system with unsustainable costs. Smartphone apps provide patients and healthcare providers with an efficient and effective tool to communicate and manage symptoms and treatments. In addition, patients may feel more comfortable tracking progress and receiving support from the comfort of their homes as opposed to coming into a hectic and stressful clinic environment. All of these benefits may potentially lead towards decreased demand in clinics, a reduction in healthcare costs, and improved health. Research needs to continue to assess innovative opportunities that fully leverage the strength of this unique platform to deliver effective patient care in our health system.

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