Review Series – Connected Health

QJM

Mobile phone health apps for diabetes management: Current evidence and future developments

S. GOYAL[1,2] and J.A. CAFAZZO[1,2,3]

From the [1]Centre for Global eHealth Innovation, Techna Institute, University Health Network, [2]Institute of Biomaterials and Biomedical Engineering, Faculty of Medicine, University of Toronto and [3]Institute of Health Policy, Management and Evaluation, Faculty of Medicine, University of Toronto, 27 King's College Circle, Toronto, Ontario, M5S 1A1

Address correspondence to Shivani Goyal, Centre for Global eHealth Innovation, R. Fraser Elliott Building, 4th Floor, Toronto General Hospital, 190 Elizabeth Street, Toronto, Ontario, M5G 2C4. email: shivani@humanfactors.ca

Summary

Can an app help manage diabetes? We discuss how the advent of mobile health apps in connecting patients to providers is creating new opportunities for the management of diabetes. Although there are promising outcomes, there is still much to be learned about how such technology could be fully exploited.

With hundreds of millions diagnosed with diabetes worldwide, the ubiquitous mobile phone allows for access into a population that is often difficult to reach and engage.[1] Poor self-management skills, lack of personalized education and clinical inertia are leading to serious complications, resulting in exhaustive use of resources and reduced quality of life. Recent evidence suggests that mobile health (mHealth) applications (apps) may be used to effectively deliver health services and self-management tools while overcoming certain barriers to provider access. A significant potential lies in the ability to communicate with individuals in real-time, be able to capture data, and provide decision support. mHealth apps may be targeted for patient use, the care provider, or both, promoting communication, sharing of information and decision-making.

Although there is a growing body of research supporting the use of specific mHealth applications for diabetes self-management, the availability of hundreds of such apps makes it difficult to identify those with clinical relevance. Recent reviews of apps conclude that impact of mHealth on clinical outcomes compared to usual care remains uncertain.[2] Nonetheless, there continues to be opportunities for mHealth to supplement traditional care, especially between healthcare care provider visits, where patients can be provided with *in-situ* feedback and personalized education.

Insulin-dependent diabetes

Younger, and less experienced patients with type 1 diabetes (T1DM) struggle with the complex guidance involved, and ultimately fail to reach target A1c values.[3] In addition to monitoring glycemic variability, the psychological stress related to fear of hypoglycemia, future complications and impact on general wellbeing, results in a significant burden of care for both the patient and their family caregivers.

The paper tools currently available to patients permit them to log blood glucose, carbohydrates and insulin doses, but remain suboptimal largely

due to (i) a high probability of erroneous manual data entry; (ii) inability to capture enough data need for healthcare care provider clinical decision-making; and (iii) lack of real-time feedback and behaviour change motivation enabling patients to improve their ability to self-care.[3]

For insulin requiring patients, the means to transfer blood glucose data wirelessly to a mobile phone can reduce errors and frustration associated with manual data entry, simplifying the daily task and potentially impacting adherence to self-monitoring. However, Chomutare *et al.* reveals that all of the apps commercially available required manual data entry, and only 62% of those found in the literature used wireless data transfer.[4] Although wireless medical devices are becoming more readily available, proprietary restrictions and regulatory issues are hindering the use of them in the commercial market. A similar discrepancy is seen with the integration of personal health records in research-based apps compared to those commercially available. While personal health records (PHRs) allow for secure and portable storage of personal health information as well as secure sharing between informal and formal caregivers, majority of apps found on the market only allow for Excel data export.

Although personalized feedback is a key construct of most self-care behavioural frameworks, only 20% of the apps assessed had an educational component, of which only 1/5 delivered personal feedback. Without embedded behaviour change strategies, mobile apps risk being simply an electronic form of existing paper-based tools, failing to empower patients with actionable self-care knowledge. Others apps have explored the use of automated algorithms and external incentives to influence behaviour change. In a recent pilot conducted by *Cafazzo et al.,* the use of a mobile app *bant,* led to a 49.6% increase in the frequency of blood glucose measurements at the end of a 12-week period. In additional to enabling users to wirelessly transfer blood glucose readings, review trends, receive automated feedback and share information through Microsoft HealthVault, the app rewarded positive behaviour with points which users could then redeem for iTunes rewards. These results further emphasize that mHealth apps can effectively engage patients, influence their behaviour positively, and potentially impact health outcomes.[5]

T2DM diabetes and lifestyle management

The self-management of non-insulin requiring type 2 diabetes (T2DM) deemphasizes frequent blood glucose (BG) monitoring and focuses on the modification of lifestyle behaviours. Supporting these patients requires a multifaceted solution embedded with behaviour change mechanisms, where the patient is involved in their own care and is receiving regular feedback from their health care providers.

Although telemedicine delivered through web and mobile phone systems overcomes geographical barriers, providing frequent follow-up and feedback to diabetes patients remains both challenging and costly.[4] *Quinn et al.* evaluated the effectiveness of the WellDoc system, a patient-coaching and provider clinical decision support system.[6] The multimodal tool enables patients to wirelessly upload BG readings and other diabetes-related information, and receive real-time feedback either via the health care provider (HCP), caregiver or WellDoc research team. In a 1-year cluster-randomized clinical trial, the intervention group's A1c decreased by 1.9% compared to the usual care group that decreased by 0.7%. Although third party feedback systems can reduce A1c, the involvement of the HCP is critical, and the reimbursement of this additional resource is of major concern. This solution's dependency on the HCP or coach will be difficult to scale, and does not fully explore the advanced capability of personal devices and mobile applications to promote more autonomous patient self-management.

The gap between research and the marketplace

Most apps commercially available are not evidence based and tend not to differentiate between T1DM and T2DM. Of the 137 apps identified, the top features were manual data recording, insulin and medication tracking, followed by data export and communication.[4] By focusing on the simple logging of blood glucose readings, the significant and fundamental differences between this self-management of these conditions remain ignored.

Although the role of self-monitoring of blood glucose (SMBG) among T2DM patients on oral medications remains controversial, there is still some consensus that these patients could benefit from monitoring blood glucose when viewed in the context of their lifestyle behaviours.[7] Although there exist individual apps that allow users to objectively track physical activity, nutrition, weight and medications, few offer an integrated behavioural self-management tool targeted towards non-insulin requiring type 2 diabetes.[4]

Although electronic versions of less efficient paper-based tools are trending, and telemedicine

systems with health coaches are gaining momentum, the full potential of mHealth remains unrealized. To truly impact diabetes outcomes, the gap between evidence-based guidance and functionality of consumer apps needs to be addressed. Whether it is for patients with T1DM who need to adjust insulin doses according to carbohydrate intake, or for patients with T2DM who are struggling to reduce sedentary behaviours and improve their lifestyle, mobile applications can potentially address existing gaps in self-care while empowering patients with the ability to effectively manage their chronic condition.

The consumer uptake of diabetes-related mobile apps indicate that these patients can be reached increasingly through these electronic tools. However, fully harnessing the capabilities of smartphones to deliver real-time feedback, diabetes education and secure data sharing remains largely underexplored. Even more compelling is the possibility of positively shaping behaviours, and guiding patients with chronic illnesses towards optimal mental, emotional and physical health and wellbeing.

Conflict of interest: None declared.

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