Diabetes and mHealth: Using SmartPhones, Apps, and Other Technologies

Can we create "smarter" diabetic patients through electronic self-management of disease?

BY CHRISTOPHER HOOD, JR., DPM

It seems like everyone nowadays has a smartphone, and that is not far from the truth. Latest reports have roughly three-quarters of Americans (∼220 million) with smartphones demonstrating ownership in persons aged 50-64 years old and 65+ years old at 74% and 42% respectively.[1] Dependent upon them, people use their phones for a variety of everyday tasks: directions, organizing their calendar, checking the weather, updating to-do lists, using social media platforms, and so on. An emerging use of smartphones has been the concept of mHealth (also referred to as eHealth), the idea of using mobile or electronic devices in the healthcare space to support and improve patient care.

The cornerstones of mHealth include: monitoring and surveillance, delivery of information, and knowledge or information exchange. Techniques used to implement mHealth include patient-doctor communication through portals, web-based education modules, promotion of healthcare practices, monitoring disease status, patient coaching techniques, and even attempting to modify habits through active participation in one's own care by app and device engagement; all in an attempt to complement the traditional healthcare system. The public has taken to this with almost one-third of American smartphone owners having a health app on their phone as of a 2014 report.[2]

mHealth and Diabetic Self-Management

With close to 30 million persons in the United States diagnosed with diabetes mellitus (DM) and potentially one in three adults with pre-diabetes, this group would be one to target with mHealth technologies.[3] There are many advantages of integration of mHealth, especially how it relates to DM.

Peoples' constant attachment to their phones, often keeping it close by if not on their person at all times, allows instant access to health-related content. Through the use of smartphones and applications (apps), it has been hypothesized that patients with chronic diseases such as DM could use these apps to increase patient adherence to treatment regimens and self-management of their disease, which in turn may achieve better health outcomes, increase patient quality of life, and decrease healthcare costs.[4-6] The American Association of Diabetes Educators and the American Diabetes Association define the following behaviors as the skills re-

quired for diabetes self-management and what these apps hope to correct: healthy eating, being active, monitoring, taking medication, risk reduction, problem solving, and healthy coping.[7] By having all this information in one place, an app, we can create smarter, more proactive, and healthier patients. Physicians see the benefit in this. A *New England Jour-*

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nal of Medicine 2015 survey revealed that biometric devices and apps were felt to be the best technology to achieve patient engagement through patient support and patient-provider interaction by monitoring metrics tracked by the app and app predictive analytics to alert physicians to perform intervention when necessary.[8]

In the Apple and Google Appstores there are many programs one can download to assist in mHealth as it pertains to DM (+1000 reported apps), whether diabetes-specific, food calorie/carbohydrate counters, educational applications, or exercise and activity-related.[6] Most of the di-

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abetes-specific apps offer features like data collection and logging either through direct entry or sensor use: e.g., medications, blood glucose levels (BGLs), activity, weight and body mass index, meals/carbohydrate counting), graphing (e.g., tracking BGLs, activity/"steps") with analysis over user-chosen date ranges, reminders (e.g., doctors appointments, to take a medication, to check blood sugar), doctor-patient communication (e.g., portals, text messaging), health-related challenges, educational information (e.g., medication information, exercise routines, health recipes, and motivational feedback as just some of the examples of integration.[2,5,9]

When put all together, apps can be a positive force for change. For example, an active user entering in items like BSL, foods consumed (i.e., what and when), and activity level can start to see correlations between what to eat or do and how this effects BSL, with the goal of positive changes in habits by the user. Another important feature is the ability to share the data, whether with your doctor or family members. Through this, physicians and family members can also hold the patient accountable. With nearly half of DM patients having poor sugar control, providers who have direct digital communication to their patients can monitor and address issues in real time without an office visit.[10]

Studies have shown that smartphone logging of BGL with primary care physicians able to monitor and give feedback has enhanced glycemic control (e.g., reduced BGL, reduced HbA1c, reduced blood lipids) and reduced patient hospitalization.[4,6] A different example of feedback includes communication between children with diabetes entering their BSL so parents can monitor while the kids are at school. Currently, most monitoring between patient and physician appears to be through the specific app being used (i.e., both on the app or an apps peripheral software interface such as a website portal), but a future goal could include integration of the app to a physician's electronic health record.[2]

Peripheral Integration

To make something as simple as monitoring BSL easier, some apps have peripheral integration to the smartphone. The Accu-Check® (Roche Diabetes Care, Inc., Roche Holding AG, Basel, Switzerland) Aviva Connect BGL monitor sends results directly to your phone using Bluetooth, while the iHealth® Align BGL monitor (iHealth Labs Inc., Mountain View, CA) inserts directly into the headphone port on the phone, using the smartphone screen as its display. While most of these apps are free or of minimal cost, some do have higher prices or annual subscription costs. Insurers seeing

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mHealth technologies as a way to reduce complications and medical costs sometimes offer free or discounted rates for these apps.[11]

Wayne, et al. (2015) studied smartphone health coach software in a Type 2 DM population of lower socio-economic class, demonstrating a clinically significant reduction in HbA1c values at three months which remained steady at the six-month endpoint compared to the control group that took until six months to achieve a similar HbA1c level.[12] The software intervention group also showed significant decreases in weight and waist circumference while the control group did not. More recently, Sweet, et al. (2017) showed through a combined digital app and personal health coaching approach that they were able to achieve a 7.5% reduction in patient weight, improved BSL, reduced cholesterol, and participant-reported improvements in self-care, diet and exercise, and improved psycho-social status (i.e., reduced feeling of depression and isolation).[13]

Mixed Results

While all this sounds good, the results are mixed.[2] Across many

chronic disease states studied, the literature shows "potential" positive effects of mHealth utilization and implementation. Hamine, et al. (2015) performed a large systematic review to evaluate the effectiveness of mHealth in adherence (coined mAdherence) to chronic disease management in DM, cardiovascular disease, and chronic lung diseases from 1980 to 2014.[5] Of the 27 randomized control trials (RCTs) measuring mAdherence, 14 pertained to DM resulting, 7 (50%) studies having a significant effect, 5 having no significant effect, and 2 having mixed results. Twenty-six RCTs evaluated mAdherence on clini-cal outcomes (e.g., blood glucose, HbA1c, 2-hour post-prandal blood glucose) with 11 (42%) having a significant effect, 9 having no significant effect, and 6 having mixed results. Overall significant effect was at 56% (n = 15) on adherence and 40% (n = 16) on clinical outcomes when looking at all three aforementioned chronic diseases.

There are multiple other points to consider regarding drawbacks of mHealth integration. These programs are only effective if patients have access to smartphones, the Internet, and/or a means to understand the app. In lower socio-economic areas, studies have shown not having access to a smartphone or the Internet to be a significant barrier.[5] Moreover, if the population is not trained on the app, or the app is too complicated, then implementation for self-health benefit is not possible.[5,8]

Choosing the Right Apps

Another common issue of smartphone and app use is trying to get patients to the right one for their situation. This includes both patients with multiple chronic diseases where each disease may benefit from mon-

itoring, and apps not being all-en-compassing for a single disease state. For example, while there are many apps to pick from, none meets all the needs of a diabetic.[4] The Internet provides a plethora of information reviewing apps and making recommendations based on the users' goals in using the app. These goals range from BSL monitoring, weight control, calorie counting, reminders, or community support. As stated, the issue can become more complex when patients have multiple chronic diseases (e.g., cardiovascular disease, hypertension, lung disease), needing a different app for each in addition to their DM one.

When considering how this relates to podiatry, patients can use these apps to help monitor and track various metrics. One thing we harp on with patients is to be active and to exercise. Common ways to track activity level can be through apps or other technologies (i.e., digital pedometers, either app-based or wearable such as a Fitbit®) to monitor steps and count calories burned. Furthermore, a new technology of smart insoles with feedback to monitor pedal pressure and prevent ulcer formation has been developed by Orpyx® Medical Technologies, Inc. (Calgary, Canada).[14] Currently, plantar foot pressures are evaluated passively but through the use of their technology, the SurroSense Rx® insoles actively monitor plantar pressures and send real-time feedback when pressures in particular areas are too high.

Other Technologies

The goal of the alert to patients is to adjust behavior, whether checking their feet or shoes for an issue (e.g., callus, pre-ulcer lesion, foreign body), get off their feet altogether, or go see their podiatrist right away for a more thorough evaluation. Other technologies include the F-Scan plantar pressure analysis system (in-shoe sensor for pressure monitoring) and the F-Mat (pressure sensing mat) by Tekscan (Tekscan, Inc., Boston, MA), as well as the Remote Temperature Monitoring System (Podimetrics, Inc., Somerville, MA).

A recent study on the Podimetrics Mat looked at its temperature-sensing capabilities to predict diabetic pedal ulcerations through daily sensing with feedback wirelessly to a monitoring service.[15] In the studied cohort, the mat was able to detect 97% of non-traumatic diabetic foot ulcerations approximately 5 weeks before patient presentation to the clinic with 86% of patients averaging three home mat scans per week.

Adherence is a concern in technology implementation, but using such technologies allows monitoring of both compliance and non-compliance, with patients being called when there was a noted absence in scanning regularity. The same can be done when patients are not achieving certain goals like daily step counts, calories burned, or out-of-range BSLs.

In the end, there is still much work to be done in the mHealth space in trying to achieve positive outcomes in patients with chronic diseases such as DM. While many of the published studies and retrospective reviews demonstrate mixed positive outcomes, mHealth is a promising way to promote compliance to treatment and for patients to take an active, responsible role in their care. As apps continue to evolve, adapting to be more inclusive, more user-friendly, and engaging (i.e., between the app and patient or between the patient and physician), mHealth modalities will continue to improve and grow.

With diabetes being a commonly cited disease researched in mHealth with multiple apps available, podiatrists (as well as primary care, endocrine, and diabetology physicians) have the platform to help their patients. This can be accomplished through dual-sided recommendation—to not only encourage patients to use these smartphone apps or wearable technologies, but also encourage physicians to integrate their use into practice. The greater knowledge one has with these programs and applications, the better one can relay and educate/teach their patients. If

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we physicians take an active part in promotion of this technology, we may be able to both improve our patients' experience with DM through education, adherence, and a healthier lifestyle. What's more, an increase in users will in turn generate more data that will help developers to continue to update and improve these programs, pushing mHealth into the future. **PM**

Resources

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