Chatbots for Diabetes Self-Management: Diabetes coaching at scale

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Table of Contents

Introduction

Diabetes affects 29 million people in the United states each year and costs $245 billion to treat. Successful diabetes management requires that patients create new habits around medication adherence and glucose monitoring, dramatically change their diets, and exercise more. Because these changes are so difficult for people to make, fewer than 50% of patients adhere to treatment therapies,[1] contributing to the nearly 75,000 diabetes deaths per year.[2]

Standard approaches to improving diabetes health outcomes involve Diabetes Self-Management Education and Support (DSME) aimed at helping patients change behaviors and monitor their disease progression. DSME programs can be temporarily effective; however, their effects are small and diminish over time.[3] Furthermore, because they are often highly individualized interactions between a patient and a care provider, they are difficult to standardize, costly to implement, and difficult to scale.

Internet-based and mobile health (mHealth) technologies have the potential to supplement or replace standard DSME approaches. However, existing solutions focus on only a few needs of a diabetic patient, such as nutrition guidance or glucose monitoring,[4] without considering the entirety of patient needs or how these needs are interrelated.

Chatbots are a new and quickly developing technology that harness the potential of mHealth while overcoming the shortcomings of existing solutions. Chatbots rely on artificial intelligence (AI) to create conversational, interactive experiences through a user's SMS platform (i.e., text messaging, Facebook messenger, etc.). Users can interact with a chatbot as they would with a friend or family member, without requiring a downloaded mobile application. An evidence-based behavior change chatbot could transform diabetes care by delivering personalized yet standardized interventions that address the range of patients' needs at scale.

Diabetes Self-Management Landscape

Traditional Approaches

The American Diabetes Association includes DSME as a core component of diabetes care. DSME provides individualized education and support to patients with the goal of preventing complications, slowing disease progression, and improving health outcomes. DSME addresses both lifestyle and psychosocial issues and helps patients manage monitoring and medication regimens.

Depending on specific patient needs, DSME can help patients lose weight, change their diet, increase physical activity, quit smoking, and build habits around monitoring blood glucose, taking medication, and checking for signs of complications.

DSME is typically delivered through one-on-one or group-based counseling with a nurse, dietician, or certified diabetes coach. Programs last for an average of 6 months with around 18 hours of contact between the patient and the care provider.[5] Programs may also include phone support, text communications, or educational tools.

Programs are very focused on goals that are set collaboratively between the patient and the care team. The National Standards stipulate that programs are individualized, so patients are encouraged to come up with their own goals. National Standards also include monitoring patient progress, so clinical outcomes are tracked closely.[6]

There may be some benefits from lifestyle interventions delivered through DSME programs; however, in practice, many lifestyle interventions place undue emphasis on health outcomes (like weight loss) and have limited clinical benefit. Positive impacts are inconsistent across the different types of interventions,[7] and when effects are found, they are small and become smaller over time.[8] Furthermore, interventions typically do not impact diabetes risk outcomes or mortality at all.[9]

Diabetes is often associated with comorbidities or difficult lifestyle circumstances, such as financial hardship, food insecurity, or lack of social support, increasing the difficulty of self-management. The specific needs of individual diabetic patients are wide-ranging and highly variable. Traditional diabetes management programs have addressed these diverse needs by providing highly individualized care programs that require intensive one-on-one interactions between patients and providers or well-coordinated care provider teams. These interactions allow for personalized care, but at a cost: researchers and health providers are unable to identify the specific elements of interventions that really work.[10] As a result, DSME programs are difficult to standardize and scale, costly, and inaccessible to patients who need support, which may explain why only 5-7% of eligible patients participate in them.[11,12]

Digital Approaches

Mobile health (mHealth) and internet tools have become increasingly popular alternatives, or additions, to traditional DSME programs. mHealth in particular has great potential to expand care delivery as smartphones are ubiquitous and can integrate data from a patient's numerous connected devices (e.g. glucometer or Fitbit).

Today's apps claim to assist in managing different components of diabetes care with features such as the ability to track glucose, insulin, medication, diet, and/or exercise.[13] For example, MySugr, which has nearly 900,000 downloads, combines data from multiple devices and allows for meal tracking so users can view trends and share data with their physicians. Other less common features in diabetes apps include reminders for refills, data logs that can be uploaded to care providers, medication information,[14] and calendar-based alarms to remind patients to take medications.[15]

The majority of existing apps focus on only a few needs of a diabetic patient (e.g., nutrition guidance or glucose monitoring),[16] and few focus on addressing the behavioral or psychological barriers to successful disease management. Consequently, there is little evidence that these apps improve health outcomes[17] or are a cost-effective approach to delivering DSME.[18]

Behavioral Shortcomings

Both traditional and mHealth solutions fail to take into account behavioral perspectives that could greatly improve patient self-management. National Standards include behavioral goals as an important component for DSME programs,[19] but 'behavioral goals' are not clearly defined. Furthermore, the examples cited to support this component of DSME do not take into account behavioral science evidence around creating new routines and habits or overcoming psychological barriers.

mHealth solutions also lack a behavioral science foundation to their design and instead are overly focused on tracking and trend reporting as mechanisms for behavior change.[20] For example, the MySugr app is centered on tracking and viewing data trends. Users can track glucose, insulin, carbs, and exercise, and will estimate HbA1c values if users log their blood glucose values three times a day for seven days.

MySugr Dashboard

Tracking features are typically evaluated favorably and patients believe that viewing this data improves health.[21] However, these ratings and beliefs about efficacy should not be confused for true drivers of behavior change. While some forms of self-monitoring, such as recording diet and exercise, can be effective in certain cases,[22] emerging evidence suggests that showing a patient trends in their clinical values is not effective at changing behavior.[23]

This overreliance on presenting data back to patients may also have unintended consequences. Patients with low numeracy or cognitive bandwidth may become overburdened by this data feedback and disengage from the app altogether. Patients may misinterpret normal fluctuations in their data as meaningful trends and erroneously associate these changes with whatever behaviors are salient in the moment. This tendency would make it more difficult to learn how and why specific behaviors impact health.

A more effective solution is one that incorporates evidence from behavioral science around how to change and sustain behaviors along with the individualized care of traditional DSME programs, while taking advantage of the scalability of mHealth.

Chatbots for Diabetes Self-Management

Chatbot technology has enormous potential for transforming DSME and changing patient behaviors. Artificial intelligence (AI), natural language processing (NLP), and machine learning (ML) allow chatbots to have conversational interactions with the user, interpret meaning from the user's responses (such as emotional valence or time preferences), and learn from prior interactions with the user.

From the user's perspective, the bot is seen as an expert in a particular domain, with a personality and human-like characteristics. Over time, as the user interacts with the bot in a social manner, the user becomes attached to the bot in much the same way they would with a friend or family member. This social relationship creates accountability and commitment between the bot and the user. The bot is responsible for the user's needs and the user is therefore compelled to meet the bot's expectations.

Interacting with a chatbot can feel like interacting a human, except that a chatbot is much smarter than a human. Behind the scenes, a chatbot app can integrate data from any connected device, triggering an interaction in response to flags in the user's data. The chatbot can provide continuous and reliable support to the user in an experience that is customized to each patient but standardized based on predetermined parameters.

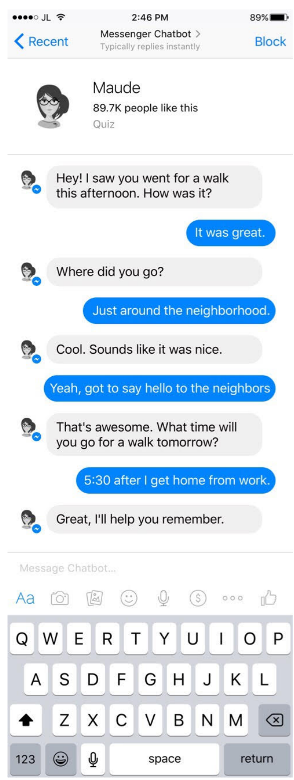
As evidence of their unique value, chatbot apps are rapidly emerging to address health problems. For example, Emile offers to help users sleep better and exercise. Emile promises to "never give up on you." X2AI provides mental health care, like cognitive behavioral therapy, in places where people would not otherwise have access. These products are in their early phases of development, but their use cases are expanding rapidly.

Human-like interaction and social contract

Chatbots are unlike other technology solutions because they are personified. They feel like people so we treat them like people. A chatbot has a name, the interactions are conversational and responsive, and the experience exists within the same platforms where users interact with friends and family.

Even when we know we're interacting with a computer, we often *anthropomorphize*, or assign human characteristics to robots.[24] We apply the same mental models to these human-like interactions that we apply to humans: we create social contracts, we feel trust and empathy, and we feel social pressure to not disappoint. Therefore, we can rely on a robot, or chatbot, the same way we rely on people. We assume they have expectations of us, just as a friend, family member, or therapist might.

With traditional DSME programs, the more interactions between a patient and a care provider, the more effective the intervention.[25] This is likely because increased interactions leads to stronger social relationships, which provides social accountability for the patient's behaviors. Social interactions are also salient and meaningful to us, so they may have a greater influence on our behavior compared to non-social experiences. Chatbots show great promise for delivering DSME at scale because they can recreate the human element of these interactions that is likely so powerful for patients.

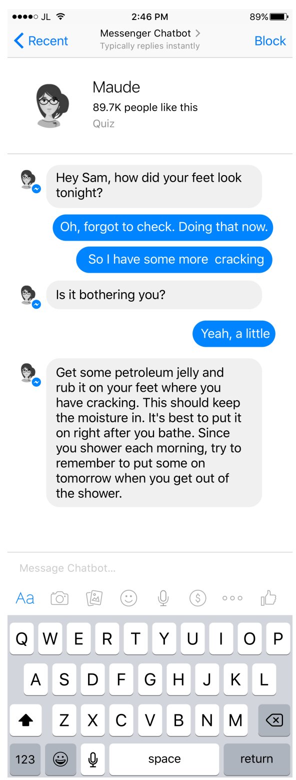


Social accountability, provided by a chatbot

Behavior hacking and continuous learning

Because a chatbot engages in conversational interactions with a user, there is an opportunity to collect rich data from users. For example, a chatbot could ask all users a set of behavioral diagnostic questions periodically over time, which would then inform the type of behavioral interventions the chatbot would deliver to the user. Users who report having fewer daily habits could be exposed to interactions with the chatbot that are focused on building new habits, whereas users with more negative affective responses could be exposed to interventions focused on mindfulness or other emotion regulation strategies.

In a downloaded app, a user's experience is constrained to a set of predetermined interactions or the content that is included in the app. With a chatbot, the user can also initiate interactions across a wider range of topics. For example, a user could ask the chatbot about specific symptoms as they are occurring. The bot would use natural language processing to interpret the user's unprompted question and provide an appropriate response.



Conversational alert and symptom feedback, from a chatbot

A chatbot app has the potential to learn from the user and change the user's experience based on previous interactions and the user's behavior. A chatbot app could also learn from all of the users and recognize patterns, identify types of users who respond particularly well to certain types of prompts or interventions, and eventually automatically and precisely funnel users to the most effective journey or behavioral intervention for them.

Chatbots are for everyone

Chatbots on mobile devices work within existing messaging platforms like iMessage or WhatsApp, and do not require the user to download anything new. Users simply install the chatbot by providing their phone number or sending a text message. Users do not need to learn how to use a new app or build new routines around the new app, since the interaction with the chatbot exists within platforms where they are already regularly engaged, such as text messaging.

Messaging-based apps also have substantially slower drop-off compared to standard apps, leading to continued use and greater long-term retention. The interactions do not need to be predefined, resulting in more engaging and varied experiences, and a higher likelihood of health improvements.[26] Chatbot apps do not require users to have smartphones, either, which means they are more accessible to low-income and elderly populations who are less likely to have smartphones but have other mobile devices.

Conclusion

Diabetes impacts a large number of Americans each year. Medical and behavioral treatments are effective but only when patients successfully and permanently change their behaviors.

Mobile technology offers enormous opportunity for integrating into patients' everyday lives in ways that enable long-term behavior change. However, the existing smartphone apps have limited functionality and are not suitable for a large segment of the population. Chatbots, implementing artificial intelligence through SMS platforms, offer enormous potential to take advantage of the benefits of both mobile technology and the power of human interactions to offer a scalable, cost-effective, and powerful diabetes behavior change intervention.

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