

Project Title

Dapper (Diabetes Application Project)

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Abstract

In a two-phase approach, we aim to improve the compliance, disease knowledge, and successful management of those suffering from the Type II Diabetes Mellitus. Phase I of the study involved focus group interviews to obtain better insight into the life of patients with diabetes and the factors influencing their management of the disease. Phase II, which is currently ongoing, involves aggregating the factors that patients find helpful and those that limit their ability to successfully treat their diabetes and infusing these variables into an entertaining and educational computer based game. The purpose of the game is to assist with diabetes management, educate patients on their disease and uniquely provide direct access to their physician which is a feature not seen in other blood glucose logging applications.

Introduction

With nearly 2 million new cases diagnosed annually, type II diabetes is a costly public health issue that challenges our capacity to respond at the patient level in a comprehensive and system wide manner [1]. The benefits of understanding barriers presented above that prevent patients with type II diabetes from being fully compliant should be carefully considered when designing games to improve patient outcomes.

The purpose of this study is to first identify the behaviors, beliefs, and language involved in the treatment of patients with diabetes. We hope to learn more about the daily habits of patients and their successes and struggles with the purpose of eventually designing a software application that diabetic patients can use to help manage their diabetes. The second part of this study is to design a software application that diabetic patients can use to help manage their diabetes, based on the information gleaned from the first part of our study. With the emerging popularity of computer and mobile-based health and fitness applications, it is obvious that healthcare systems and physicians need to embrace this technology to help improve the management of their patients.

Methods

Phase I: Patients were recruited in two ways. The nurses who worked in the physicians' office identified patients with type II diabetes and invited them to participate in the study, from which two participants responded. The academic researcher also sent a general request for participation to faculty and staff on campus, from which four participants responded. Criteria for selection included type II diabetics greater than 18 years of age. The questionnaire for inclusion in the focus group also contained a question to gauge the participant's comfort with web/mobile based games and/or applications. Also they were further screened to determine if they were diagnosed with diabetes within the last 12 months or beyond. Participants were patients of primary care physicians in the Peoria area and were recruited from those medical practices.

Participants were required to have experience using web or mobile applications. Participants included patients with type II diabetes from a variety of backgrounds. Though participants were recruited among a wider population, there were a total six participants, five Caucasian females and one African American female. Similar to focus group studies, interviews were conducted in pairs to provide a more active and engaging experience and to investigate the types of exchanges of information among patients. The setting of each interview session was private, with one being conducted at a conference room in the physician's office and the other in a private room at a university where the patients worked.

The results of this qualitative study provided a basis for generating an initial proposed set of guidelines for developing software, including games, which hope to enable greater compliance, better disease knowledge and more successful treatment among patients with type II diabetes.

Phase II: This phase of the research project is currently in process. The variables involved with success and limitation of diabetes management gleaned from Phase I were keys in game design of Dapper, a computer based gaming platform used for helping patients manage their diabetes. The game itself is a customizable avatar based game with several different interactive locations that each patient can experience. Each player is assigned to a pack with a pack leader being a physician who can oversee and send messages to the group. Locations such as a library, clinic, and café are used for educational information, daily quizzes, lab logging, and messaging physicians/pack members. There are also entertainment locations, such as an arcade with gaming and a shopping area where the patients can use points to upgrade and customize their avatar. There are three primary outcome measures in Phase II: Clinical Outcomes, Behavioral Outcomes, and Motivation Outcomes. We hypothesize that patients participating in our game will have improved clinical outcomes: lower HgA1C, BP, and lipids than non-participants. To evaluate this hypothesis we will collect data from EPIC on our participants at 3, 6, and 12-month intervals after starting the game. We also hypothesize that our patients will have improved Behavioral Outcomes: they will have better disease awareness, monitoring than they did at the beginning of the study. To test this hypothesis participants are given a self-evaluation at the start of the study and after 12 months. Our final hypothesis is that Motivational Outcomes can affect other outcomes. To test this hypothesis we will pull data about engagement with the game at 3, 6, and 12 months (including time played, number of friends, trivia proficiency, posting frequency, and daily data entry).

Results

Phase I: This section provides a summary of the three major themes that developed from this study: Compliance Factors, Variables that Enable Compliance, and Variables that Enable Digital Interventions. Each is detailed in this section.

I. Compliance factors

The three major compliance factors are monitoring, nutrition, and exercise.

Monitoring. Although all the participants recognized the need for daily monitoring of their blood sugars, compliance with monitoring varied significantly. Participants 1, 2, 5, and 6 tested once every day in the morning. Of the two participants on insulin, participant 6 tested regularly throughout the day and recorded the results, while participant 4 only tested once per day. Though she should be testing more frequently, she cited that “I don’t test my blood twice a day, because them little strips are expensive. So I try and test it 2-3 times a week”. Participants 5 and 6 had upgraded meters that stored their readings; however, neither knew how to access those readings.

Exercise. Participants saw improvements in their glucose levels from increased exercise. Two participants (1 and 5) remarked that they were surprised at how quickly exercise improved their sugar levels. Participant 5 stated that “...that was the one of the biggest surprises to me, when I first was diagnosed and starting monitoring my blood sugar, was the immediate impact exercise has on your blood sugar. I really had no idea.” This is a somewhat unique finding, as several studies have confirmed the benefit of exercise in long term glucose control, however, exercise in the short term does not have as robust evidence. There are however, studies that have demonstrated increased insulin sensitivity, responsiveness and glycemic control even in short term aerobic exercise of 7 days [2,3,4]. Participants faced several challenges when it came to exercise, including finding adequate time, paying for gym and/or class memberships, and finding instructors that understood their specific needs. Participants participated in several forms of exercise, including swimming, walking, water aerobics, boot camp and fitness classes. Participant 4 and 6 engaged in intense exercise two to three times a week, one engaged in exercise occasionally, and three rarely exercised. Participants prefer variety and were more inclined to exercise with a friend. Participant 4 stated that “I need some incentives” to exercise (such as in-game rewards) and to motivate her more. Participants 4 and 6 found it difficult to find fitness instructors who knew how to engage older participants with diabetes.

Nutrition. Though participants found many challenges with nutrition, they typically complied with a carbohydrate/fat controlled diet. All participants acknowledged a two to three month adjustment period to adapt to a compliant diet. While participant 2 and 3 felt challenged by constantly thinking about food that was acceptable to eat, noting that “you have to constantly think about what you’re putting in your mouth”, others felt it was a non-issue.

Since foods from scratch are a healthier alternative to processed foods, participants found it difficult to find time to prepare healthy meals on busy days during the workweek and on weekends that were often spent caring for others. In particular, participant 1 noted that “I always have so much other stuff going on, so it’s hard for me to really go about what I’m going to eat.”

Participants were acutely aware that their nutrition has a direct and immediate impact on how they feel. Participants who had their diabetes under control found that non-adherence to a low-carbohydrate diet even during one meal can make them feel physically ill. All participants except participant 2 knew immediately if their blood sugar was high or low based on how they felt, with participant 1 noting that “if it’s high, if it’s over 150, I feel funny. But then, if it’s too low, I feel weak.” These participants also knew that there are safe ways to satisfy their cravings for simple sugars and carbohydrate rich snacks, like eating a small dessert immediately after a high-protein meal.

Carbohydrate counting has shown benefit in patients with type II diabetes, not only in maintaining glycemic control but avoiding hypoglycemia in those that use insulin. This skill was one that most participants were able to learn quickly upon diagnosis. Eating at restaurants remains challenging, and participants 1, 3, 4, and 5 review menus online for carbohydrate and fat limited options prior to going to restaurants. They supported restaurants that had menus online as well as “heart healthy” meals that were appropriate for their needs, as well as restaurants that promoted moderation. The majority of the participants read labels, and participant 6 used an app from Weight Watchers to help them identify foods that meet their dietary needs. Participants noted that grocery stores are full of unhealthy choices, and participants find it tedious to search for healthy foods and for a variety of such foods. Participant 1 wanted tips on quick/fast foods, since it is difficult to prepare meals late after a long day at work. It takes significant time and energy to do so in a compliant way, and this contributes to the management of the disease being tiring.

II. Variables that impact compliance

Several variables were found to enable or impede self-management of each participant’s diabetes. These variables included education, insurance, support, motivation, and emotional barriers.

Education. Participants differed in the amount of education they received about their disease. Participants received various amounts of education for managing their diabetes. They learned from their physicians, books, courses, information found on-line, magazines (not necessarily diabetes related), and follow-up mailings. Participants 1, 3, 4, 5, and 6 received education about blood sugar, exercise, nutrition, and overall management of the disease. Those that attended classes in-person found these highly informative, but insurance coverage on these classes varied among participants. Participant 2 specifically mentioned that she only recently learned about the importance of frequent eye exams and she was unaware of the need for visiting a podiatrist to examine her feet until participant 1 informed her of her own experiences.

In general, participants found that their best sources of information were classes at a diabetes clinic, their doctor, online resources, and talking with other patients with type II diabetes. Participants learned about managing their disease from their doctor, a diabetes clinic, online resources, talking with others with diabetes, reading magazines, and getting emails from insurance companies. Participants 1, 3, 4, and 6 attended classes at a local

hospital clinic that provided very detailed information about caring for themselves in order to reduce complications. Participant 4 noted that the class taught her that she “can eat whatever you want, within moderation” and to “get back to basics and stay away from processed foods.” Participants found these classes informative, including presentations, hands-on demonstrations, and one-on-one group sessions where participants could interact privately with presenters on different topics.

Participants thought they were adequately equipped to manage their disease and all six participants stated that they had sufficient knowledge to manage their disease. However, based on observational data and by their own responses, all six participants were willing to and did learn something about managing their diabetes from the other participant in their group. This sharing of information was central to several discussions and demonstrated the willingness for patients to share information among themselves.

Insurance. Participants were constrained in managing their disease and to follow-up care due to inadequate insurance benefits. Several participants spoke of being unable to comply with guidelines due to lack of support from their insurance companies. For example, Patient 4 noted that “I want to have [my eyes] checked every year, but [my company insurance] doesn’t pay for it every year.” Participants 3, 4, and 5 noted that individual insurance providers did not pay for additional diabetes education classes, strips for monitoring, and check ups with eye doctors.

Participant 4 found it helpful to receive reminders to schedule doctor visits from her insurance company. Participants varied in the amount and type of follow-up visits with their doctor, podiatrist, optometrist, and nutritionist. Five participants (1, 3, 4, 5, and 6) understood the importance of follow-up visits and wanted to comply with recommended guidelines; however, they were limited to follow-up care due to limitations from their insurance companies.

Support system. Participants 3, 4, and 6 had immediate family or friend support and had their diabetes under control. Participants 1, 3, 5, and 6 had close family members who were also diagnosed with type II diabetes, and there was mutual support and accountability between them. Participant 1 had a support group at work for sharing their experiences managing their diabetes. These five participants had their diabetes under control. The participant without a strong support network, participant 2, acknowledged that her diabetes was not under control and, though she was well aware of the risks, was not motivated to make necessary life-style changes to manage her care.

From observational data, participants willingly shared information about managing their disease with the other participants. During each session, participants warmed up very quickly to the other participant attending their session. Patients exchanged information about nutrition, exercise, and follow-up care with nutritionists and doctors. Each participant was actively engaged in these exchanges and highly inquisitive about the other participant’s experiences. Participant 3 referred to the Food Plate that had been altered for those with type II diabetes, and follows that method along with moderation. They shared small tips, like cooking foods from scratch and food substitutions for reducing sugars and increasing fiber.

Motivation. Motivational triggers did not necessarily lead to action. Two participants expressed a variety of reasons why they were or were not motivated to comply with guidelines. Participant 2 simply lacked motivation altogether, and although she was aware that she should be engaging more actively in controlling her disease, she simply was not interested in putting forth the effort. She noted that “you kind of get tired of thinking about it.” She knows that she has never “had a regular (blood sugar) read since 200....Mine is not under control whatsoever.” More than once, she stated that the only way she could comply with a diabetic diet (limiting caloric/saturated fat intake and maintaining controlled carbohydrate intake from primarily whole grains, fruits, vegetables, legumes, and low-fat dairy) was to hire a nutritionist; however, since she had recently been laid off, she did not anticipate that happening anytime soon. Participant 5 also expressed that the condition was “just not fair” and she had trouble with the mental challenge of dealing with the condition.

Motivational triggers that had been internalized seemed to lead to more compliance. Each participant expressed that they were motivated to keep their diabetes under control for a variety of reasons, including staying healthy for the sake of their children and the desire to avoid becoming dependent on insulin. Participant 4 and 6 had friends or family members who had lost their eyesight or limbs, which brought home the reality of consequences of not managing their diabetes. Participant 6 loathed the thought of being a burden on someone else. Several participants expressed directly or indirectly a feeling of shame during the interview process and/or when visiting the doctor when they had not been following an exercise or diet regimen. Participant 1 expressed how she perceived that the doctor “yelled at her” for not complying, later explaining that her doctor really didn’t yell, but that is how she perceived it. Participant 2 noted that the doctor “makes you feel bad” for non-compliance.

Emotional Barriers. Emotional and psychological struggles emerged during the discussions. Three participants, 3, 4, and 6, recognized that altering their lifestyles was necessary for them to feel good. Overall, they believe that reaching compliance is difficult, particularly as it pertains to exercise and diet.

No participant described management as easy. Rather each found it difficult due to the many challenges they face due to work, finances, health complications, and other responsibilities. Participants recognized that the first two to three months were critical in adapting to their new lifestyle. Even after adjusting, they found their lifestyle demotivating in certain situations, like ordering meals at a restaurant. Participant 5 stated that it was overall “hard to comply” and that it is “mentally difficult and tiring” to constantly be aware of the impact of daily decisions. As noted earlier, it was clear that several participants felt shame in the fact that they were not compliant.

III. Variables for digital interventions

Each of the participants enjoy playing casual games either online or on mobile devices. All participants have recently played casual games on a smartphone or a desktop. The youngest of the participants, participant 2, also had a console (Nintendo Wii). Participants 1 and 2 acknowledged that they had little time to play games. Participant 1

mentioned that there was still a moral stigma of laziness attached to playing games too frequently, while participants 3 and 4 acknowledged their frequent playing of mobile games, specifically Candy Crush. All indicated that they had limited time to play games, but enjoyed doing so.

Participants were unaware of diabetes management software or use it infrequently. Two participants were unaware that applications to help manage diabetes existed. Only one participant, participant 1, acknowledged using a software application daily for approximately 18 months. Even then, only glucose tracking and nutritional software were used. Participants found drawbacks to the software, including unappealing food recommendations, a lack of variety in food choices, and a lack of motivation to use the software consistently. Participant 3 stated a desire to have a mobile app that not only allowed the user to enter data for blood sugar and meal choices, but also sent an analysis of the results to the user with recommendations on how to improve.

Phase II: Phase II of our study focused on game design and implementation of the game, Dapper. Taking the lessons learned from Phase I the team sought to design a game that would provide education to our patients, give them the ability to log data, a support network of friends, family, and a physician while also providing some entertainment. The Bradley students were responsible for aesthetics of the game and the technical design of the game. Both residents were responsible for populating the game with evidence based information regarding; exercise, nutrition, problem solving as well as creating daily quizzes. As above, results are pending for Phase II, as this portion of the study is currently underway. First data collection and result evaluation of clinical and motivational outcomes will occur at the end of May 2015 with subsequent result monitoring at 6 and 12 months of total game play.

The residents also recruited patients for the study. An orientation session for our participants was provided so they could get login information and have a walk-through of the game. For the first cohort of patients, we had 6 participants that attended the on-boarding session and were enlisted in the study. This cohort started in February. Each participant filed out an initial self-evaluation questionnaire. Self-assessment questionnaires focusing on diet, exercise, blood sugar testing, medication compliance, smoking, and foot care were distributed to the 6 randomized/de-identified participants in the study prior to game usage and will be reassessed at 12 months of game use. Clinical outcomes will be gauged at 3, 6 and 12 months by IT specialists to evaluate patient's EPIC data (lab testing, BP, weight) and also in game matrix data. Engagement and motivational outcomes will be evaluated by reviewing participant game play frequency, data entry, trivia proficiency, and posting frequency.

Conclusions

Phase I:

Presently, there are no specific frameworks or guidelines for creating software or games specifically for improving self-care for patients with type II diabetes. After completing Phase I, we were able to create an initial framework to follow to enhance motivation and compliance for patients with type II diabetes. We made the following deductions

regarding the creation of Dapper from Phase I and implemented these ideals into the design of the game.

Create casual games for desktop and/or mobile devices. The patients in this study all played casual games on either their desktop or mobile devices. Only casual games fit into their many other responsibilities. Each also indicated that they would be interested in playing such games, if they were available on the market.

Include various forms of knowledge in bite-sized, hidden manner. Each participant believed she had sufficient knowledge to manage her disease, yet during the session each learned how to improve her self-care regimen. By including small, varying chunks of information throughout a game, important facts can be shared without overwhelming or boring the player.

Assume unequal knowledge about diabetes across the sets of players. Based on observations, participants were not equally knowledgeable about how to control their diabetes. With some having more instruction in the form of classes and hands-on group activities, and others receiving minimal instruction from their doctors, games that convey similar base knowledge to players will increase patient knowledge. It is important that patients receive continued education, and any software implementation should ensure that such patients have access to such education throughout their journey.

Build games not just for the patient, but for those who support patients as well. Patients with spousal, family, peer, and group support have a higher compliance rate. Including design features that provide education to support players as well as strengthen communication between patients and their supporters may lead to higher compliance.

Include individualized care. Because the characteristics of these diseases are specific to each patient, personal health management is especially meaningful. This includes consideration of ways to interpret in-game metrics with respect to self-care measures and provide occasional recommendations for improving their self-care regimen.

Provide simple input techniques for the players to enter health related information. The interface must be as simplistic as possible, including options to enter data through texts, email, or an in-game panel. These are potential enhancements that are being considered going forward in future builds of the Dapper.

Provide features for exchanging information. Participants effectively shared and learned from each other. Capitalizing on this natural phenomenon as in many other games seems logical.

Offer in-game rewards for sharing information, motivating, and supporting other players. Managing diabetes can be tough and tiring. Create a natural in-game support system as part of gameplay may improve self-esteem and self-efficacy, reduce the feelings of shame, and increase intrinsic motivation.

Phase II:

Phase II is currently underway. Participants are playing and our first data collection is due at the end of May 2015. However, there are already some conclusions we can draw. First, we understand that our cohort size is too small. In order to expand our numbers we are currently redoing our IRB to include all of the offices in UnityPoint Peoria so we can expand our recruiting and hopefully get a larger cohort for the next phase. We have also determined some enhancements within the game that we think would improve patient participation including changing to a mobile platform, providing a way to track data

entered and print results in real time for patients/physicians to review, and improving the ease in which participants can communicate within the game.

Future research includes conducting a quantitative study with a broader set of diabetic patients to determine if these needs can be generalized and if other needs exist. Long-term research requires validating these guidelines by incorporating them into games (in whole or in part) and testing for efficacy with patients.

References

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