Diabetes-Self Management Education through Technology

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The purpose of this project was to evaluate the utilization of a smartphone application for diabetes self-management education (DSME) into a family practice office. Cochrane review of technological options for DSME identified the smartphone as the most effective option.

All patients with diabetes presenting in a family practice office for appointments with the clinical pharmacist or the physician were asked if they would participate in the project if they met the inclusion criteria including the diagnosis of diabetes, owning a smart-phone, and over 18 years old. Exclusion criteria were pregnancy, end-stage kidney disease, or use of an insulin pump. The goal was to enroll at least 10 patients and have them utilize the smartphone application Care4life for education and blood glucose tracking. HbA1c, heart rate, blood pressure, weight, and body mass index were collected at the initiation of the trial in addition to a demographic survey. A survey was obtained at the end of the trial.

Ten patients were enrolled in the project; 50% women. One patient discontinued participation after enrollment. Six patients returned their surveys. The feedback was primarily positive with individuals liking the text messaging reminders and ability to track their matrix (blood pressure, blood glucose, weight, medication adherence, exercise).

Continued utilization of the smartphone application within the practice is likely for those patients who enjoy the technology as a reminder. Further opportunities for implementation would be in a hospital setting where patients face a delay post discharge for an appointment with a diabetes educator. Additionally, due to the complexity of the disease this application could be used to educate caregivers.

Keywords Diabetes, HbA1c, Smartphone, Application, Glycosylated Hemoglobin

Introduction

Diabetes self-management education (DSME) is one of the key components of the American Diabetes Association's recommendations of treatment for diabetics (American Diabetes Association [ADA], 2017). DSME typically encompasses teaching about the disease state, risk factors, and carbohydrate counting, medications, exercise, and risk reduction. The goal of this project was to implement and evaluate DSME through use of a smartphone application.

Background and Significance

Eighty-six million people were diagnoses with pre-diabetes in 2012 affirming the prediction diabetes will continue to increase in prevalence (ADA, 2015). Currently one in three individuals will develop diabetes in their lifetime (ADA, 2015). Being diagnosed with diabetes increases an individual's risk of developing heart disease, kidney failure, loss of vision, stroke and amputation of limbs.

While diabetes is a national health issue, Arizona has a higher than average prevalence of diabetes with 13.5% of the population affected (ADA, 2014). Within Arizona, the Pima Indians have an extremely high prevalence of those diagnosed with diabetes 50% of adults over the age of 35 having diabetes (Schultz et al., 2015). In addition to Arizona having a prevalence of diabetes greater than the national average, the incidence has increased by 300% since 1994 (Montiel, Tummala, Valenzuela, & Ramirez, 2011).

Diabetes is primarily self-managed, thus, knowledge about the disease is critical to minimize complications. Studies show that patients who have received diabetes self-management education have improved knowledge, self-care, quality of life as well as better glycemic control (ADA, 2015). Patients who receive diabetes education are also more

physically active, engage in more preventative healthcare activities, and have fewer hospitalizations (Montiel et al., 2011).

The ADA recommends that patients receive DSME at diagnosis for diabetes mellitus, and as needed (ADA, 2015). This is traditionally provided one on one or in a group setting by a diabetes educator. There is currently a shortage of diabetes educators, which makes it difficult for people with diabetes to receive adequate education. In recent years there have been numerous articles published on using technology for DSME. There are multiple types of technology utilized: Short Message Service (SMS) text messaging, smart phone applications, computer based interventions, and telemedicine programs (Pal et al., 2013).

Diabetes self-management training has been shown to be the most beneficial to those who have the highest HbA1c's (Pillay et al., 2015). Pillay et al. (2015) did a review to evaluate the effectiveness of behavioral programs for adults with type 2 diabetes. Their review indicated that interventions that consisted of more than 10 hours of education and also included follow up engagement were the most effective.

The importance of adherence to medications and lifestyle interventions is a component of DSME. Asante (2013) conducted a review to evaluate the success of telenursing, electronic pill caps, and other devices in promoting adherence to medications. Telenursing consisted in either phone calls or SMS text messages to provide messages about diet, exercise, medications and frequency of self-monitoring. Both the phone calls and the text messages were effective at reducing the patient's HbA1c's. The electronic monitoring pill caps were only effective while they were in use, and when they were removed the patient resumed previous behavior (Asante, 2013). The costs of establishing a technology based diabetes self-management education program are not included in the majority of studies. However there is data that suggests it is cost

effective based on the interventions recommended by the ADA (Fitzner, Heckinger, Tulas, Specker, & McKoy, 2014).

Saffari and colleagues (2014) suggested that SMS text messaging has been shown to be an effective method of providing DSME and lowering the level of HbA1c in type 2 diabetic patients. In this systematic review, there was some evidence that a multimodal approach of using both SMS texting in addition to online education is superior to only using one modality. Additionally smartphone applications have increasing popularity for management of patients with type 2 diabetes. Frazetta, Willet and Fairchild (2012) performed a systematic review of trials that evaluated the efficacy of smart phone applications at lowering the HbA1c levels of patient's with type-2 diabetes. There was variability in the scope of what the applications did from glucose monitoring, exercise and diet tracking, to a teaching intervention (Franzetta et al., 2012). Similarly tablets have been used to assist with diabetic teaching. A recent pilot study evaluated the use of an iPad for journaling activities and found it comparable to using a written journal (Hunt & Sanderson, 2014).

A recurrent theme in a recent review of the literature is that the success of the use of technology is dependent on the preferences of the patient. Older patients report preference of nurse education to that of a computer (Fitzner & Moss, 2013). Additionally, among patients over 65 there is only a 13% increase in smart phone use, while overall, 46% of Americans own a smart phone (Franzetta et al., 2012). Applications on smartphones range from basic to complex, , costs range from no cost to $6.99 (Tran, Tran, & White, 2012). While all of these factors will play into whether a particular technology is suited to a patient, the majority of the trials have shown positive outcomes from using technology to assist with management of diabetes.

A Cochrane review evaluated the effectiveness of computer based self-management education. This review demonstrated that patients who engaged in computer based DSME had lower HbA1c. The most effective subgroup of computer based DSME was the one that utilized the cellular phone (Pal et al., 2013).

Review of the literature lead to the development of the clinical question: " (P) In patients with type-2 diabetes under the age of 65, (I) how does cell phone based diabetes self-management education compare to (C) office visits (O) for reduction of HbA1c (T) over three months?"

Search Strategy

An extensive search was performed in Public Medline (PubMed), Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Cochran Library. In CINAHL, phrases used were *diabetes mellitus type 2, AND diabetes self-management education, AND technology, cell phone, mobile application, or smart phone.* Limits were set to the past ten years and journal articles producing 15 articles as a result (Appendix A). PubMed was the second database searched using the MESH terms *diabetes mellitus OR diabetes mellitus, Type 2* and *education or health education or patient education or self care* and *Hemoglobin A, Glycosylated or Blood* Glucose. Limits of 10 years, clinical trial, or review were placed on the search resulting in 49 articles (Appendix B). A key phrase search was performed using phrases *diabetes mellitus type 2, AND diabetes self-management education, AND technology, cell phone, mobile application, or smart phone.* Again limits of ten years, clinical trial or review were place and resulted in 19 articles. A final search was performed of the Cochrane Library using the term *diabetes self-management education,* which yielded 10 results (Appendix C). Attempts to combine search terms in Cochrane resulted in zero yield.

The extensive search produced a total of ten studies that met inclusion criteria, of being either a randomized clinical trial (RCT) or systematic review, using a cellular phone for communicating with patient, patients having diabetes mellitus, and a measurement of glycemic control. The evidence from these studies, including four systematic reviews and six clinical trials is represented in Appendix A.

Summary of Evidence Synthesis

The ten studies retained from the extensive search were level I and II evidence. The six clinical trials were randomized clinical trials, although due to the nature of the trials blinding was not possible. All of the articles included in the four systematic review papers were randomized controlled trials providing a high level of evidence.

All four of the systematic reviews demonstrated that there was a reduction in HbA1c when a cell phone was utilized in the role of providing patient education to those with diabetes mellitus. Four out of the six RCTs demonstrated a greater reduction in HbA1c in the intervention group compared to the control group. One of the trials had a strong trial effect, and the other group HbA1c was not able to be measured at the end of the study. The results of improvement in health related quality of life was more heterogonous. Various methods were employed to measure health related quality of life and results were mixed.

In patients with diabetes mellitus, type 2 using a cell phone based method of self-management education is effective at lowering HbA1c. When education was accessed by cell phone there were better outcomes than if it was necessary to utilize a computer. One of the common themes in study design was to utilize a software program for monitoring parameters and communicate that to a provider. The provider then provided input via SMS text messaging. The other method was for the software to provide recommendations for change. Both methods were

successful at reducing HbA1c in the target population compared to the usual treatment. This indicates that there is a basis for utilizing cell phone technology to educate patients with diabetes mellitus, type 2 . (Appendix B). A smart phone based application that allows for provider monitoring and feedback will lower patient's HbA1c

Purpose and Rational

Diabetes is a health condition that impacts millions of Americans and places a significant burden on the healthcare system. Diabetes self-management education (DSME) has been shown to reduce the levels of HbA1c. Technology based DSME provides a patient- centered, cost effective alternative to individual and group based education.

EBP Model to Guide Implementation of Evidence

The Model for Evidence-Based Practice Change developed and revised by Rosswurm and Larrabee is the model selected to guide the process of change (Melnyk & Fineout-Overholt, 2015). This model consists of six logical steps: assess the need for change, locate the best evidence, critically analyze the evidence, design practice change, implement and evaluate change in practice, and integrate and maintain change in practice. This model was chosen because the steps of implementation are compatible with implementing change into a private medical practice. The diagram of the model is located in Appendix C. These are the steps that were taken to evaluate a system of DSME using cell phones and SMS text messaging feedback to patients with diabetes.

Methods

Prior to implementation of the project all methods were reviewed and deemed ethical by the Institutional Review Board at Arizona State University. The methods include enrolling

patients with diabetes in a convenience sample from a large family practice office in Chandler, AZ. The practice contains six physicians, a nurse practitioner, and a physician assistant. A clinical pharmacist visits the site for a half day weekly to work with medication optimization for patients who have diabetes. Inclusion criteria were being diagnosed with diabetes, owning a smart-phone, and being over of 18 years old. Exclusion criteria were end stage renal disease (ESRD), use of insulin pump, and pregnancy. Speaking English was also an unstated requirement as the DNP student is English speaking and no translators were available. The smartphone application is available in Spanish as well.

Patients, who that met inclusion criteria, were recruited to participate in the project during their visit by the clinical pharmacist or physician. If patients indicated interest the DNP student further explained the project, and obtained written consent. Patients completed an initial survey (Appendix G) and downloaded the free Care4life application to their phone at the visit. The DNP student demonstrated how to input data, where to set reminders, and the educational training provided by the smartphone application. The participant was asked to input daily activities including exercise, fasting blood glucose levels, and medication adherence. Patients received automatically generated daily text message reminders to check blood glucose and take medications. They had the ability to use educational videos and modules in the smartphone application to increase their knowledge. The smartphone application has educational videos related to; hypoglycemia, the impact of alcohol and smoking on blood glucose, the benefits of exercise, setting exercise goals, and taking small steps to increase exercise. As well as videos on medication such as; sick day management, diabetes pills, insulin injections, starting insulin, insulin and exercise, insulin storage, insulin myths and possible side effects. There are eleven different videos on nutrition and carb counting, and on weight management regarding setting a

weight goal. At the end of 2 weeks time, the participants completed a qualitative survey regarding their satisfaction with the program (Appendix D). The data was analyzed using descriptive statistics using SPSS 23.

Results

A total of ten participants enrolled in the project. One participant called and cancelled the next day, three others were lost to follow up leaving a total of 6 returned surveys. Participants were 50% men, 50% IPhone verses Android owners, with an average age of 63.8(±10.7) years. The mean BMI was 33.6 (±7.2,) kg/m^2 and the mean length of time having diabetes was 13.5 (±4.7) years. At the initiation of the project the average HbA1c was 7.6 ± 0.9% (Appendix H). Trends were that those completing the project were slightly older, had diabetes slightly longer, and had a higher HbA1c than those who did not complete the project.

Results from the follow up survey were 67% of the participants would recommend the program to a friend (Appendix E). The text messaging reminder component of the application was found useful by 67% of the participants, and 83% of the participants found the application easy to use. Again, 83% of the participants found the educational information contained in the application easy to use. The primary components of the application that were utilized were the text messaging reminders, tracking features for blood glucose, blood pressure, weight and exercise. Positive aspects of utilizing the application were that it was easy to use, that the tracking aspects were useful and that the text messaging reminders were helpful. One participant reported that they did not receive reminders on weekends, and that could be improved. The two individuals who would not recommend the application to a friend did not like the text messaging aspect and thought it could be improved.

Discussion

This study was conducted on small convenience sample of participants and therefore may not be generalizable to the population as a whole. Challenges faced in obtaining a larger sample size can partially be attributed to the necessity of having the DNP student obtain a biomedical consent for each of the participants. The original design was for the practice to implement utilization of the smartphone application for all patients who have diabetes with an HbA1c above 7.0 and recheck it in 3 months. The necessity of having the DNP student there to obtain consent limited the number of participants who could be enrolled. Another general trend that was observed was that patients who had a smartphone tended to have an HbA1c below 7.0 and those who did not have a smartphone had an HbA1c above 7.0%.

Those who participated indicated that the smartphone application was easy to use and had useful features including the educational components and the recording of health matrix such as blood glucose and weight. Three of the participants indicated verbally that they planned on continuing to use the self-management aspects of the application. Two of these individuals reported having concerns related to memory and found that the text-messaging component was extremely helpful. This suggests that this is a reliable and efficacious way to educated adults about diabetes management and provide a tool for assisting in self-management.

The study of smartphone applications for providing self-management education and management tools has applicability to future research in multiple areas. A study that evaluate HbA1c at 3 months after installation of the application and utilization of the management tools would be valuable. It would also be interesting to design a study to evaluate the correlation between having a smartphone and HbA1c. It would also be of value to identify if that correlation could possibly be associated with age, income or other factors. Another area of research would

be to evaluate the application as a tool for educating family and caregivers of individuals with diabetes. A final area of study would be in patients being discharged from the hospital with a diabetes related diagnosis. Patients may be discharged without seeing the diabetes educator if it is on a weekend, or only obtain one hour of education if it is a weekday. This application has the potential to bridge the gap for those transitioning from hospital care to home, where they are facing delays in outpatient follow-up.

Conclusion

There is a nationwide shortage of diabetes educators, and challenges with insurance paying for DSME. Poorly controlled diabetes negatively impacts an individual's health and quality of life. DSME through cell phones has been shown to improve HbA1c's. Lower HbA1c's correlate with better long-term outcomes in patients. Implementation of a program using a smart phone application is a cost effective way to provide both education and self-management activities for patients with diabetes. Utilization of the application was well received by participants and has the potential to increase self-management skills due to the ease of use. If the self-management behaviors continue there is the potential for long-term health benefits and reduction of burden to health care system.

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