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Using Smartphone Technology to Enhance Self-Management Support in Adults with Type 2
Diabetes in Primary Care

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USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Table of Contents

Abstract.....4

Introduction.....5

 Background.....5

 Problem Statement.....7

 Organizational “Gap” Analysis of Project Site.....7

Review of the Literature.....8

 Strength of the Evidence.....9

 Use of Smartphones.....10

 Text Messaging.....11

 Barriers and Facilitators of Self Management.....11

 Lifestyle Modifications.....12

Theoretical Framework/Evidence Based Practice Model.....13

Goals, Objectives and Expected Outcomes.....15

Methods.....15

 Project Site and population.....16

 Procedure.....18

 Measurement Instruments.....20

 Data Collection and Analysis.....21

Ethical Consideration/Protection of Human Subjects.....21

Results.....22

 Discussion.....27

 Facilitators and Barriers.....28

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Future/Recommendations.....29

Cost-Benefit Analysis/Budget.....30

Conclusion.....30

References.....32

Appendices.....36

Appendix A: Search Flow Chart.....36

Appendix B: The Chronic Care Model.....37

Appendix C: Pre-Implementation Survey.....38

Appendix D: Post-Implementation Survey.....39

Appendix E: Consent Form.....40

Appendix F: Enrollment Eligibility Questionnaire.....41

Appendix G: De-Identifier Codes.....42

Appendix H: Thanks You Note.....43

Appendix I: Budget.....44

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Abstract

Background: Self-care is a crucial component in the management of Type 2 Diabetes Mellitus (T2DM). The literature shows that frequent feedback on blood sugar recordings together with reminders can lead to improvements in patient's glucose control and diabetic self-care. The Chronic Care Model developed by Wagner emphasizes the importance of patient participation in the management of their chronic diseases.

Purpose: To explore the possibility of using smartphone technology to help adults with T2DM better manage this chronic disease in a primary care clinic in New England.

Methods: A smartphone application (App) OnTrack Diabetes (OnTrack) and text messaging were used to enhance communication between the patient and the provider. After receiving facility and IRB waivers, participants were recruited and trained on the downloaded App. Data was generated through text messages, the App and DNP student journaling, which was evaluated for patient and provider satisfaction with the App.

Results: This project lasted about five months with five out of the seven participants recruited actually completing the project. Many (60%) of the participants found the App useful, 80% followed through with the instructions in the text messages and 60% intend to continue to use the App. Three out of five providers liked the App and intend to continue to use it. Most (80%) of the participants noticed a decrease in blood sugar, hemoglobin A1C and weight.

Conclusion: This project confirms that an App and text messaging may be a useful tool for primary care providers to enhance self management in patients with T2DM and that frequent communication with the patient in between face to face office visits keeps them engaged and more compliant with diabetes management.

Keywords: *Type 2 Diabetes, self-management, text messaging, smartphone application.*

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Introduction

Type 2 Diabetes Mellitus is difficult to treat, causes pain and suffering to the patient, increased medical expenses as well as lost productivity. It can lead to early death according to the Centers for Disease Control and Prevention (CDC, 2017). While some mild cases of diabetes are caused by poor lifestyle and can be reversed by aggressive lifestyle modifications like diet changes and weight loss, the majority of cases of diabetes are chronic. Despite the technological improvements in managing the disease and the wide variety of diabetic medications available today, a lot of patients still have uncontrolled diabetes. This DNP Project emphasized self-care utilizing a smartphone application in diabetes self-care to make people with diabetes more aware of daily changes in their diet, blood sugar and activity levels which will hopefully result in better management of this chronic disease.

Background

According to the American Diabetes Association's (ADA) Economic Costs of Diabetes report, diabetes has now become the costliest chronic illness in the United States (ADA, 2018). The report states that more than 30 million Americans have been diagnosed with diabetes and this number is estimated to increase by about 700,000 new cases a year. Healthcare costs for patients with diabetes are 2.3 times higher than in those without diabetes.

The latest ADA report on the cost of diabetes estimates that one in every seven healthcare dollar is spent to treat diabetes and its complications (ADA, 2018). The updated data in March 2018, shows that the total costs of diagnosed diabetes including cost from complications in the United States in 2017 increased by 26% to \$327 billion from \$245 billion in 2012 (ADA, 2018). The direct medical cost was \$237 billion, while reduced productivity due to diabetes was \$90 billion. These costs do not include the burden of pain, complications from

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

undiagnosed diabetes, cost of unpaid caregivers, and decreased quality of life. Diabetes is listed as the seventh leading cause of death in the United States in 2015, but it is believed that its contribution to death may be underreported considering its enormous possible complications (CDC, 2017).

With providers being asked to do more and more, there is not enough time to engage and track patients between visits. On average, patients with diabetes are seen two to four times a year, which translates into every three to six months (Martin, 2016). This long interval between visits therefore increases the patient's risk of developing complications (like cardiovascular or chronic kidney disease) if their blood sugar is uncontrolled. According to Waki et al., (2016), individuals whose blood sugar is not well controlled could see a reduction of their A1C because of frequent testing, reminders and interactions with their provider.

Given the fact that there is no cure for diabetes, self-management education and adherence to the treatment plan are considered the key components for the clinical management of diabetes (Norris et. al., 2001). Providers need to reach out to all patients with diabetes between office visits so that patients can be motivated to adhere to the treatment plan (Kim et al., 2016).

Smartphones have revolutionized the way people communicate with each other and the world around them. Owners of smartphones typically carry the device with them wherever they go (Eonta et al., 2011). Smartphones have become an integral component of daily life for many people in the United States. According to the Pew Research Center (2018), 95% of Americans have a cellular phone with 92% of adults between 18- to 29-year-old reporting ownership of a smartphone. Due to the fact that these devices are already integrated in the patient's daily life, the use of smartphone application and text messaging in the management of diabetes makes it a

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

very effective option which can help in reducing the progression of diabetes and its complications and also improve quality of care.

Problem Statement

The risk of inadequate support in adult patients with Type 2 Diabetes in primary care offices puts the patients at increased risk for complications, target organ damage and higher risk of early death compared to healthy people due to the long interval between face-to-face visits with the provider. This quality improvement project was focused on keeping the patient engaged between office visits in the management of their diabetes.

Organizational “Gap” Analysis

This primary care office in New England where this project took place has a total patient panel of about 2000 patients. There are four providers in this practice and 337 patients with diabetes in this practice; of which 49% have uncontrolled diabetes. Despite the huge variety of medications and technological tools available to treat diabetes, many patients with uncontrolled diabetes suffer from complications like chronic kidney disease, hypertension, heart disease, neuropathy, vision loss, and amputations (Cotter, 2014).

The most important gap in practice at this site is the fact that the optimal state of diabetes management is an A1C of 7.0 or less. However, approximately half (49%) of the patients with diabetes in the practice are uncontrolled (with A1C more than 7.0). This indicates a clear need for support for patient education in diabetic self-management skills.

Most providers are expected to see more and more patients a day leading to what is generally called the “15 minutes rule” where one patient is expected to be seen every 15 minutes. Most diabetic visits are generally scheduled for 30 minutes at this site. However, by the time intake is completed by the Medical Assistant (MA), the provider has about 7-10 minutes to

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

review the chart, examine the patient, put a plan in place and also educate the patient. Since the schedules are usually full, the provider is often late and rushing to get to the next patient.

Educating and empowering the patient is usually done at the end of the visit and may be rushed or not done at all. The American Diabetes Association (ADA) emphasizes the importance of educating the patient on diabetes and giving them adequate self-management support (Haas et al., 2012).

Providers need to reach out to all their diabetics, especially those with uncontrolled disease, between office visits to increase adherence to the treatment plan (Kim et al., 2016). Since the providers are expected to see more than 20 patients a day, they are often too busy and have no time to follow up with their patients with diabetes who are not scheduled to be seen that day. Lack of provider time decreases the opportunity for between visit follow-up with patients to provide education and support. This follow-up can be especially important for those struggling to control their diabetes. Due to a lack of adequate education, engagement and empowerment of the patient, the provider often tends to rely more on the medications instead of a combination of medications and lifestyle modifications as recommended by the ADA (ADA, 2016). Since there is no cure for diabetes, emphasis is being placed on self-management support.

Review of the Literature

A comprehensive search of the literature, using key words *Type 2 diabetes mellitus*, *self-management*, *self-care*, *mobile applications* and *smartphone technology* was done in Cochrane, PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL) databases and other websites like Up-to-date, and Medline Plus. The results of these searches were further narrowed down focusing on articles with keywords technology and mobile applications as well as the availability of full text, published in English, and in the past 10 years.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Excluded from the searches were articles on patients who were not adults, those with Type 1 Diabetes, and duplicate articles. All the articles selected focused on the importance of frequent communication and feedback between the patient and the health care provider which kept the patient engaged and focused on the treatment plan leading to a decrease in blood glucose, Hemoglobin A1C levels for people with T2DM.

A search in CINAHL of T2DM resulted in 6327 articles. After the self-management, mobile application, and text messaging filters were applied, N=6.

Using PubMed, T2DM search phrase yielded 15958 articles. These were further narrowed down to 105 articles with some of the filters like journal articles in English with full text on adult human beings published within the last 10 years. These were further screened with filters like self-management support, text messaging and mobile phone application. These were further checked for relevance, and eliminating duplicates for a total of three articles.

The biggest results were from Cochrane. Using T2DM for title, abstract and keyword search resulted 29909 articles. With stepwise application of filters like self-management, then text messaging, then mobile application and finally published between 2010 and 2018, N=232. The final articles were then reviewed for relevance, eliminating duplicates, articles on Type 1 Diabetes and kids, N=14. Other directed searches were done with the Pew Research Institute, Center for Disease Control, the American Diabetes Association for specific information for a total of N=16. (Please see Appendix A for a search flow chart).

Strength and Quality of the Evidence

Using The Johns Hopkins Nursing Evidence-based Practice Rating Scale (JHNEBP), the strength of the evidence can be considered as Level 1 for all the selected studies since they were randomized, controlled trials (Newhouse, Dearholt, Poe, Pugh, & White, 2005). Due to the

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

sample size, the quality of the evidence was considered Category B (Good) for all of them except the Welltang, Holmen, Cole and Kershaw studies which had a sample size of 100 and 151 respectively whose quality can then be described as high (A) (Cole-Lewis & Kershaw, 2010; Holmen et al., 2014; Newhouse, Dearholt, Poe, Pugh, & White, 2005; Zhou et al., 2016).

Use of Smartphones

Even though smartphones have already been adapted to become measurement devices, in this project, they were used as data recording and not data measurement devices (Tran, Tran, & White, 2012). Using smartphone technology to enhance diabetes self-management in primary care can lead to better blood sugar control, lower cholesterol and lower blood pressure leading to a 10% reduction in overall diabetes costs (Fitch, Pyenson, & Iwasaki, 2013).

Smartphones are already integrated into many patients' daily life making the implementation of smartphone applications and tools for the management of diabetes a good option for reducing the progression of diabetes and its complications (Eonta et al., 2011). A study by Watson, Bell, Kvedar, and Grant (2008) showed that patients are often willing to try new technology even if previous attempts were unsuccessful. There is always the hope of finding new technology that might be helpful to patients as they struggle to manage their chronic diseases like T2DM, Asthma, chronic obstructive pulmonary disease (COPD) and/or Congestive Heart Failure (CHF).

According to a study on the use of Mobile Health Intervention for Self-Management and Lifestyle Change for Persons with Type 2 Diabetes, contrary to popular opinion, older participants used the App more than the younger participants (Gatwood et al., 2016; Holmen et al., 2014; Zhou et al, 2016). A review focused on whether telemedicine and smartphone technology in diabetes can influence self-management in young people with diabetes revealed

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

that a large number of smartphone apps are targeted at people with diabetes (Cotter, Durant, Agne, & Cherrington 2014). However, limited numbers of well-designed evaluation studies have been performed. As this review demonstrates, the evidence base for efficacy of most of these applications is minimal and improvement in hard outcomes such as HbA1c and complications development is largely lacking (Cotter, Durant, Agne, & Cherrington 2014).

Text Messaging

Evidence in the literature to suggests the use of smartphone application and text messaging as a useful focus for this project. According to Cole-Lewis & Kershaw (2010), a systematic review of studies on the use of text messaging as a way of effecting behavior change in disease prevention and management found this method to be equally helpful in diabetes management. Their review showed that text messaging led to better diabetic outcomes, which were reflected in an improved Hemoglobin A1C (A1C) no matter the age of the patient. These studies were based on the fact that the optimal state of diabetes management is an A1C of 7.0 or less. They considered the gap in practice as uncontrolled diabetes with A1C more than seven (7) due to less support for patient self-management.

Barriers and Facilitators to Self-Management

Highlighted in the systematic review are barriers to self-management support such as lack of time for health care workers to provide continuous education on nutrition counseling and physical activity; high cost of lifestyle modifications and limited access to health care providers (Cole-Lewis & Kershaw (2010). A pilot study (DialBetics) to assess the safety, usability, and impact of remote health-data monitoring on patient hemoglobin A1C (HbA1C) outcomes and the effect of home blood pressure monitoring as a way of managing the complications related to diabetes showed positive results. In this study, patients reported that their participation did not

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

require too much time away from their daily routine (Waki et al., 2014). More than half of the participants (58%) stated that they were able to easily incorporate using the system into their daily routine (Waki et al., 2014). This supports a project at this primary care practice as the patients were more likely to participate until the end of the project because of the convenience of using their smartphones.

Lifestyle Modifications

Some of the studies like the Allen and Arsand also used a mobile application like “Few Touch” technology to measure other aspects of self-management like physical activity, diet and medication adherence. These studies all showed positive outcomes due to frequent reminders (Allen, Jacelon, & Chipkin, 2009; Arsand et al, 2010). With frequent reminders from their primary care provider the patients exercised more frequently, made better meal choices, and were more compliant with their medications. The result was an improvement in the patients’ blood sugar. Some of the challenges to lifestyle modifications for patients with diabetes are the costs; especially healthy diet (Cole-Lewis & Kershaw (2010). These patients tend to eat what they can afford even when they know it will negatively affect their diabetes. Through frequent reminders, improvements in other components of diabetic self-management can help compensate for poor diet.

Most of the studies were done for about three months and therefore considered very short for any meaningful lifestyle change (Waki et al., 2014). Even if the patient were able to make the changes, it might not have been adequately reflected in the A1C. Considering that diabetes is increasingly becoming a global disease, global studies were selected from Norway, Japan, China, South Korea, and United States of America. They all showed potential in the use

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

of smartphone Apps and text messaging to support patients with T2DM better manage their disease since this is usually a lifetime condition.

During the DialBetics study, patients had only two weeks to get familiar with the DialBetics software (Waki et al., 2014). Even though they had been smartphone users, most patients required a little more time to get used to this software considering the comprehensive nature of the application software. There should have been more time allocated to adequately train the patient on the software to enhance cooperation. This study also opened the door for the use of newer technologies in chronic disease self-management support.

Summary

It is clear from the literature reviewed that the idea of using a smartphone application to enhance self-management support for patients with T2DM although not well studied, has a lot of promise. As an evolving component of patient care, the greatest challenges are that most of the applications are developed by software professionals and there are few evidence-based best practice guidelines presented in their implementation. Most of them have not been certified by any regulatory body like the Food and Drug Administration (FDA) and are therefore somewhat experimental (Tran, Tran, & White, 2012). The implementation of smartphone application and text messaging can enhance communication and rapport between the patient and the provider. This can increase the patient's knowledge and skills of diabetic self-management, to improved outcomes in the components of diabetic self-care and ultimately improved glucose control.

Theoretical Framework/Evidence Based Practice Model

The theoretical framework for this project is The Chronic Care Model (Wagner, 1998). The essential components of The Chronic Care Model (CCM) are the community, the health system, self-management support, delivery system design, decision support, and clinical

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

information system. The main purpose of this model is to assist the care team to deliver chronic disease management that is equitable, inclusive and accessible. To be able to use this model/tool effectively to deliver good quality care, the care team must be able to recognize the diverse nature of the needs of the individual.

This requires the formation of collaborative partnerships between the stakeholders like the patients and health organizations all aimed at supporting the patient to meet care needs (Cefalu, 2014; Wagner, 1998). The health system component ensures that programs include measurable goals, which was one of the objectives of this project. Through self-management support, the model emphasizes the importance of the central role the patient has to play in the management of their chronic disease like T2DM.

This DNP project sought to highlight the pivotal role the patient has to play by educating and equipping them with the knowledge and tools necessary to help them better manage their T2DM. Decision support facilitates the integration of evidence-based guidelines into the daily clinical practice as implemented in this quality improvement project. The delivery system design of this model required focus on teamwork to enhance delivery of chronic care.

The diabetes team consisted of the DNP student, project mentor, MA and receptionist who helped with the implementation of this project. The text messages and smartphone application were used to generate relevant patient data that was used to improve patient care. This project used effective self-management support strategies and tools like smartphone technology to help patients better manage their diabetes. The team used productive interactions with the informed, activated patient to improve outcomes. (See Appendix B; Wagner's Chronic Model).

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Goals/ Objectives/ Outcomes

The goal of this project was to explore the feasibility of implementing smartphone technology to enhance self-management support for patients with Type 2 Diabetes at a primary care office in New England. The table below outlines the project goals and outcomes.

Project Goals	Outcomes
Introduced a new diabetes self-management protocol (an App and Text Messaging) in the practice.	At least 80% of the participants utilized the App and text messaging throughout the duration of the project. This information came from the pre and post implementation surveys.
Increased patient knowledge of diabetes and skills of diabetes self-care through the use of an App (OnTrack) together with frequent text messaging with the care team.	About 100% of the participants through the post implementation survey and student journaling reported increased knowledge of diabetes and self-management education.
Enhanced communication and improved relationship between the patients and the provider through frequent feedback with supportive text messages.	After five and half months, the participants received up to eight times more frequent feedback from the provider during the course of the project compared to the traditional once every three to six months.

(See Appendices C & D for details of pre and post implementation surveys).

Methods

This was a quality improvement project which utilized evidence-based practice in the use of smartphone technology to enhance self-management in Type 2 Diabetes patients at a single primary care practice in New England. To be eligible to participate in this project, the patient had to be diagnosed with Type 2 Diabetes, own a smartphone, be 18 or older, have an

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

A1C of more than seven, and sign an informed consent form. (See Appendix E for details of Consent Form). Excluded were patients with Type 1 Diabetes or had Type 2 Diabetes with an A1C of less than seven. Since the patients all belonged to the practice, there was no need for a flyer to be placed in the waiting or exam rooms. Instead the provider and MA talked to patients who met the criteria to encourage them to participate.

Project Site and Population

The site of this quality improvement project was a primary care practice in New England. The practice has four adult primary care providers. There were a total of about 1800-2000 patients in the practice. Of this total, about 337 had been diagnosed with diabetes. About 178 (53%) were well controlled (with an A1C <7). and 159 (47%) have uncontrolled diabetes. There were 159 patients with uncontrolled diabetes identified by running a report using the “diabetes” filter. The final count was established after the patients were manually separated into two groups (Type 1 or 2). The participants for the project were recruited from the group with Type 2 Diabetes.

The App that was used for this project is OnTrack Diabetes App (Vertical Health LLC, 2017) in combination with text messages from the provider. OnTrack is very simple and easy to use even by those with low literacy level. It is similar to those used in the literature review, and it is free. The App was used in this project by the patient to track/log their blood sugar per testing schedule that had been ordered by their primary care provider (PCP). The DNP student reviewed the blood sugar data every week and red flag cases got feedback immediately.

The main features of OnTrack include helping the patient with most of the components of diabetes self-care like tracking the blood glucose, Hemoglobin A1C, diet, weight, blood pressure, etc. It is customizable; giving the patient the flexibility to add or edit categories that

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

they want to focus on at any given time. This App can also generate detailed reports of the components of self-care (like the blood sugar, blood pressure, weight) and graphs to share with their healthcare provider. Another important aspect of this App is its ability to record your data in either United States or in International Units. It also enables the patient to choose how often they want to summarize their tracking log (daily, weekly or monthly). These summaries were very handy to the provider and guided the customization of the patient's plan of care based on trends and lifestyle (Vertical Health LLC, 2017).

The manager and the other three providers in the practice offered support and permission to implement this quality improvement project. There are three MAs and a receptionist in the practice. The panel used for this project is predominantly Caucasian (especially those of Italian heritage) and the remainder is a mix of Latinos and African Americans and a few Asians. The age range of the patients was between 30- 80 years old with an average age of 59 years. The majority of the patients were between 40-66 years old.

The Implementation began in September 2018 and was broken down into three main phases (pre-intervention, intervention and post-intervention). A reasonable amount of time was spent in September to educate the MA and receptionist on the rationale of the project and what is expected of them. Additional time was spent with the MA to explain the functionality of the App, and her role in the project implementation. The owner, who is also a provider, had already been briefed during the site acquisition process. The other two providers also were educated on the rationale and objectives of the project. It should be noted that between the time of project approval and its implementation, there were affiliation and electronic medical records changes that impacted its implementation.

Procedure

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Phase 1: Pre-intervention. This phase started on September 6, 2018 with a practice wide manual chart review to identify patients with Type 2 diabetes with an A1C of more than seven. The expectation was to have about 10 to 20 participants for this project. The participant selection process was challenging due to the transition of the practice and electronic medical records that took place over the summer and were still ongoing. Out of 34 patients with Type 2 Diabetes with an A1C of more than seven in June, 2018, only 10 were available for selection. The charts for the other 24 were still in the old electronic medical records database which was no longer accessible to the student. Of the 10, three now had an A1C less than seven, one could not participate because she had a phone that was provided by the state and she could not download any app on it. The other patient was dealing with an imminent loss in the family and could not participate at this time. So, a total of only five patients qualified to participate in the project. However, in December two additional patients who met criteria were recruited for a total of seven participants for this quality improvement project.

Those patients who had appointments scheduled in September were contacted in person by the DNP student or the MA while they were in the office. The project was introduced to them and consent obtained for those who qualified. The remainder of the patients was contacted by phone to establish their willingness to participate in the project. Those who agreed to participate were mailed the eligibility questionnaire. (See Appendix F). The Eligibility Questionnaire was filled out according to instructions stipulated on the form. Qualified patients signed a consent form in the office at an appointment or the form was mailed to the patient for signature with a stamped return envelope. Most of the patients completed and signed the forms at the office. Even those who received the forms in the mail personally came to the office to drop them off. Recruitment remained open until the end of December, 2018. All forms collected were stored in

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

a locked drawer even though everyone who worked in the office had to comply with the HIPAA policy. All the participants who had completed the three forms were offered a \$20 gift card reward if they participated until the end of the project.

Phase 2: Intervention. This phase started in early October and lasted about 12 weeks. Upon receipt of completed pre-intervention survey, a link was handed to the patient with a follow up call on how to download the App. All seven participants came to the office to setup the App on their phones. After setup of the App, patients had to re-demonstrate understanding. A very simplified user guide for the App was also provided to the patients to take home just in case they forgot the process. Patient personal information was de-identified using the coder. (See Appendix G for sample codes that were used). This was to protect patients' personal information since these forms will be shared with non-employees of the practice like the project mentor.

During the month of September and October, additional time was spent for one on one session to educate the patients on the App. Follow up phone calls were also made to reinforce their knowledge on how to use the App and answer any questions the patient had. Five of the participants for the project were enrolled between October 1-16, and the other two in December, 2018.

By the second week of October the patients were expected to send in their first set of blood sugar recordings through the App to a designated secured email address monitored by the DNP student or the MA. These are the blood sugar recordings that the patient had saved in the App (OnTrack) for that week. Sending it directly through the App ensured the data was received in a timely fashion and reviewed by the student for any red flags like blood sugar >350 or <100. These were to receive immediate feedback and addressed by the DNP student in collaboration with the PCP. However, during the course of the project, no red flag incident happened. When

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

data was not received from a participant, a follow up text message or phone call was initiated within 48-72 hours excluding weekends. Reminder phone calls were made to all the participants during the first 4 weeks and intermittently throughout the whole project. There was more communication with the patient than anticipated.

Phase 3: Post-Intervention. This phase lasted about four weeks during which time the post implementation survey was administered (See Appendix D for details). After the post intervention survey form was received, the patient was thanked (See Appendix I) for their participation and a \$20 Wal-Mart reward gift card was given to them (See Appendix J). The project ended with a review of the project results with the practice stake holders.

Measurement Instrument(s)

In order to measure the outcomes of this DNP project, pre and post intervention surveys were administered to the patients. These have been adapted from the American Association of Diabetes Educators D-SMART version 2.0 and the American Diabetes Association Clinical Practice Recommendations for 2014 (Cefalu, 2014). These were ideal for this project because they are consistent with the theoretical framework of this project (CCM) with emphasis on the central role the patient has to play in the management of their chronic disease. These surveys facilitated the collection of patient data (both qualitative and quantitative) relating to general knowledge of diabetes, self-management knowledge and skills as well as communication with the provider and compliance. The only disadvantage was that they solely depended on patient reported data. It would have been ideal to correlate the patient reported data with an A1C level which is more objective, but that would be considered as research and therefore is outside the scope of this quality improvement project.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Data Collection and Analysis

Apart from gathering data from the surveys, the DNP student also had individual discussions with patients throughout the length of the intervention. They shared more details about their impressions of the intervention verbally than in the survey. Most of the qualitative data was gathered through observation and DNP student journaling.

Descriptive statistics were used to show how many patients enrolled and completed the project as well as details about the demographics of the participants. Qualitative feedback was also solicited from the providers and other members of the care team to assess its usefulness and the likelihood of them using this intervention after the project is completed. The overall impression of the project from both the patients and the care team were examined for themes to assess patient and provider's willingness to continue to use the App in diabetes management.

Ethical Consideration/Protection of Human Subjects

The University of Massachusetts, Amherst Institutional Review Board (IRB) after review decided that there was no need for Human Subject Protection in the implementation of this quality improvement project at this practice location (Department of Health and Human Services, 2009).

To protect the privacy of patient's health information, the project was implemented with strict adherence to the Health Insurance Patient Portability Act (HIPPA) of 1996. Additionally, the DNP student and practice personnel followed the Standards of Care for practice in a primary care office. All data that was collected from the participants for the evaluation of this project was presented in aggregate form and will exclude any potential patient identifiers. The risk to the patients for participating in this project was not any different from the risk they take when

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

surfing the internet, shopping, using an app, receiving or sending text messages on their smartphones. There was very minimal risk to the patients who participated in this project.

Every effort was made to maintain the accuracy of the data that was collected and kept in a format that was easily retrievable at the same time ensuring patient confidentiality. To ensure security and confidentiality, patient data was de-identified and stored on a password protected folder and computer in a locked drawer in the office. These were only accessible to the DNP student). Each participant was issued a unique identification number that was used throughout the project. These codes were stored in the locked folder mentioned above.

Results

The implementation of this quality improvement project lasted for five and half months from September, 2018 to February, 2019. A total of seven patients participated in this project, six were men (86%) and one female (14%). There were four Whites, two Hispanics and one Asian. By the end of the project, two patients dropped out; one because he was hospitalized for an extended time and the other for unknown reasons with three quarters of the project implemented. The final count was four males and one female made up of three Whites, two Hispanics and one Asian. The age range of the participants was from 36 to 69 with a mean of 57 years with a standard deviation of ± 14 years.

Patients sent the logs to the provider weekly and received feedback every two weeks for a total of about eight times during the duration of the intervention phase of the project. The number of times a patient got feedback also depended on the time they enrolled in the project. This was a significant improvement from the current practice of communicating with the patients once every three to four months during a face to face office visit. The patients received text messages on prompts and reinforcement of the components of diabetic self-care. For example,

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

“This week please check your feet every day for any new or abnormal spots or wounds”; with the nice weather this week, please go for a walk at least once a day”. These texts were sometimes individualized to the patient and other times everyone received the same text message.

The smartphone devices used for this project were Android and Iphone (See table 1).

Table 1.

Type of smartphone used by participants

	Frequency	Percent
Android	4	80.0
Iphone	1	20.0
Total	5	100.0

Table 2. below shows the ethnicities of the participants of this project. It should be noted however that the two patients that dropped out of the project were both White males.

Table 2.

Frequency table showing the ethnic groups represented in the sample.

	Frequency	Percent	Valid Percent	Cumulative Percent
White	2	40.0	40.0	40.0
Hispanic	2	40.0	40.0	80.0
Asian	1	20.0	20.0	100.0
Total	5	100.0	100.0	

A positive outcome from the project was the fact that about eighty percent of the patients actually reported making an effort and actually following the instructions in the text messages which were meant to enhance the components of diabetic self-management. (See Table 3 for details).

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Table 3.

Followed instruction in text messages received

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	4	80.0	100.0	100.0
No	1	20.0		
Total	5	100.0		

Even though they were not one hundred percent compliant throughout the text period, this was significant progress for some of them compared to the time before the implementation of this project. Apart from finding the App useful, sixty percent of the participants stated their intent to continue to use it in managing their diabetes after the project was completed (See Table 4).

Table 4.

Frequency table trying to find out if patients will continue to use the App after project completion?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	3	60.0	60.0	60.0
No	2	40.0	40.0	100.0
Total	5	100.0	100.0	

All the participants (100%) stated that the project was worthwhile for various reasons. All of them appreciated the frequent communication and feedback they got from the provider. Three of them were very excited about the features of the App like the graphs and summaries of their blood sugar log, weight, blood pressure or A1C. Due in part to their participation in this project, 80% of the patients saw an improvement in their blood sugar, reflected in a decrease in

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

A1C (between 0.9 to 2.3 points) and weight loss of about 20lbs in one case. Even the patient that was hospitalized reported significant improvement in blood sugar from 200-300s down to 130-140s before the hospitalization.

As illustrated in table 5 below all the participants tested their blood sugar more during the project than they did before the intervention. This increase can be attributed to the frequent reminders that were done during the implementation of the project.

Table 5

Number of times a day patient checked blood sugar before and after intervention

Participant	Before	After
1	.00	2.00
2	1.00	2.00
3	.00	2.00
4	2.00	3.00
5	.00	2.00
Total N	5	5

Some of the participants reported an increase in number of days they exercised during the course of the project to be considered as an effect from the intervention in this project. See table 6 below. From the table below it can be noted that four out of five patients saw an increase of one to four days of exercise which can be attributed to frequent reminders.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Table 6.

Number of days a week patient exercised before and after intervention

	Before	After
1	.00	4.00
2	.00	.00
3	.00	1.00
4	1.00	1.00
5	.00	4.00
Total N	5	5

The other components of diabetic self-management like: having a meal plan, cheating on their diet as well as having support at home, did not witness any significant improvement due to the intervention used in this project.

Student Journaling

One aspect of the project some patients found helpful was the ability to focus on one component of self-management at a time. That was a large contrast from a regular office visit where they are told to implement the components together. They felt overwhelmed and often did just one or sometimes none.

Due to the frequent reminders, two patients confided that they were less likely to disengage from their diabetes care between office visits. Unlike being engaged for only two to three weeks before and after an office visit, they remained focused during the duration of the project. This non-adherent period sometimes lasts for about two months during which they neglected their diabetes treatment. Most of the patients stated that this project has changed the way they look at their smartphone. The phones reminded them of diabetes when texting to friends and family.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Discussion

The results outlined above showed improvement in patient knowledge in diabetes self-management, increased blood sugar monitoring, and more exercise due to frequent reminders. Some of the patients were able to learn a new App, and intend to continue to use it to manage their diabetes. A patient-centered collaborative partnership was created between the diabetes care team and the primary care practice. Another component of the Wagner model that was applied in the project was teamwork to enhance chronic care delivery. To be able to play their pivotal role, the patient had to be informed and motivated for optimal management to occur. The CCM also recommends more integration of technology, which has been proven to work in chronic disease management including T2 DM and is the basis of this project.

The ultimate goal of this project was to integrate the use of an App and text messaging into routine diabetic care. Data from the pre and post implementation patient surveys showed that the use of text messages in combination with an App did improve diabetic self-management at this practice. The frequent contacts created a rapport between the patient and provider that has not been seen here before. This enhanced adherence to the treatment plan led to more exercise, and blood sugar monitoring. Diabetes is best managed through a combination of self-management and medication enhanced by technology.

Due to personnel changes at this practice at the end of the project, it was not possible to present the findings during an all staff meeting as originally planned. The project was summarized and presented on an individual basis. Three out of five providers (including the project mentor) liked the App and intend to continue to use it.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Facilitators and Barriers

One of the facilitators was the fact that most of the participating patients already had the device (smartphone). The management of the practice had verbalized interest in this project because it might improve quality of care for their patients as well as their Quality Measures. It therefore offered support through facility space and equipment as well as employee time donation towards the project.

There was no privacy or confidentiality breach of patient data. There were no language barrier issues or need for an interpreter since all the participants were fluent in English. The greatest facilitator was the input and encouragement from instructor/advisor, and project mentor on some of the barriers listed above. Their valuable suggestions provided a different approach to the barriers.

One of the barriers to the implementation of this project was the short time frame for implementation. Even though the implementation phase was extended from three months to five months, this was not enough time for patients to get used to this App to effect significant lifestyle changes in the management of their diabetes. Even though this project added extra work for the members of the care team, they remained excited till the end.

Another challenge of the project was the adherence issue. Most of these patients have uncontrolled diabetes partly because of non-compliance to the treatment plan. However, frequent contact and feedback kept them motivated. They necessitated more follow up calls and encouragement than anticipated. There were privacy and confidentiality issue just like any intervention that involves technology. While smartphones are increasingly integrated into our lives, many users don't take securing their phones seriously. A 2016 Pew Research Center survey found that 28% of U.S. smartphone owners said they do not use a screen lock or

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

other features to secure their phone. Participants were reminded of the risks they were taking by not securing their phones (Pew Research, 2016). Some of them did establish a password for the phones.

Apart from the challenge of generating a reasonable sample, one of the participants had a difficult time using the App because of co-morbid Attention Deficit Hyperactive Disorder (ADHD). Another participant had an acute change in condition and was hospitalized for an extended period and his routine was disrupted. Even though most of the patients had difficulties sending the log when due, they have expressed gratitude with the frequent communication and reminders. Some of them instead of sending the log through the phone, preferred to bring it in to the office for review.

Despite the challenges, the greatest positive outcome from this project is that it created greater rapport between the provider and patients. The patients loved the frequent communication and therefore remained engaged. There is therefore great potential to integrate an App and text messages in diabetic routine care as it enhances communication and keeps the patient engaged considering this is a chronic condition.

Suggestions and Future Recommendations

Future projects should include all patients with diabetes whether Type 1 or Type 2; whether controlled or uncontrolled due to the fact that anyone with diabetes can always learn something that can help them better manage this disease. Secondly, the patient should be trained for at least two to three months on how to use the App. This project needs to be implemented in a larger and more diverse sample and for at least six to twelve months to determine its generalisability in routine diabetes management. This intervention could be more focused on only one of the components of self-management like glucose monitoring only or text message

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

reminders for physical activity, diet, weight, and blood pressure. Some of the questions in the questionnaires could have been phrased differently in order to get clearer or more precise answers /data. The number of questions in the questionnaires could be reduced to a few as well.

Cost-Benefit Analysis/Budget

The following people donated time to this project: project manager (DNP student), project mentor and practice manager and her staff. No additional costs were incurred in renting space and training the participants since initial and follow up meetings were held in the clinical areas of the practice, or the project mentor's office. Training for the application was done one on one by the DNP student during the intake process. Follow up telephone calls for questions, clarifications were done by the DNP student. During the duration of the project, most of the communication was done through the App, text messaging and phone calls, which did not incur any additional costs. The staff did not need extra time or overtime pay for this project since the forms and surveys were completed during routine office hours. At the end of the project, the patient was thanked for their participation and a \$20 Wal-Mart gift card was provided by the DNP student to the patients and \$30 for the office staff. This project certainly helped reduce the risks of complications from diabetes for some of these patients. Another great benefit was the lifestyle changes that the patients made which are really essential in preventing complications from uncontrolled diabetes. Hopefully these changes will become permanent.

Conclusion

Type 2 Diabetes is a chronic, complex, and expensive disease and its management requires continuous medical care that involves more than just controlling blood sugar. Due to the pivotal role the patient has to play, this project was implemented using a patient centered theoretical frame work like Wagner's chronic care model. The literature emphasizes the need

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

for continuous patient self-management support which translates to a compliant patient thereby preventing or reducing some of the complications from Type 2 Diabetes. This can be best achieved by using all available tools to enhance communication and interaction between the patient and the provider between office visits. The ultimate goal of this project was met in using technology to close the gap in care at this primary care practice; although this tool still needs further testing and fine tuning.

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

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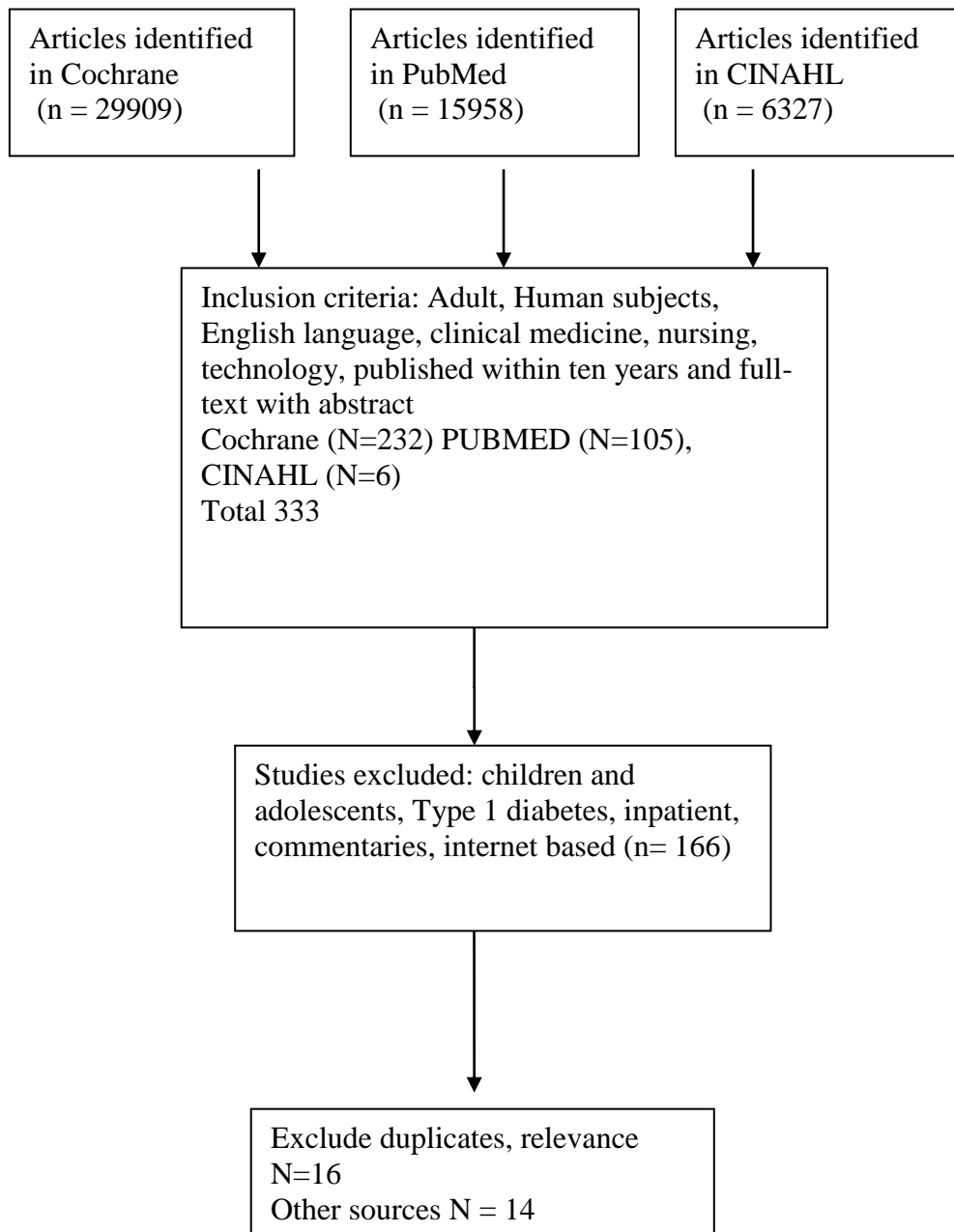
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USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendices

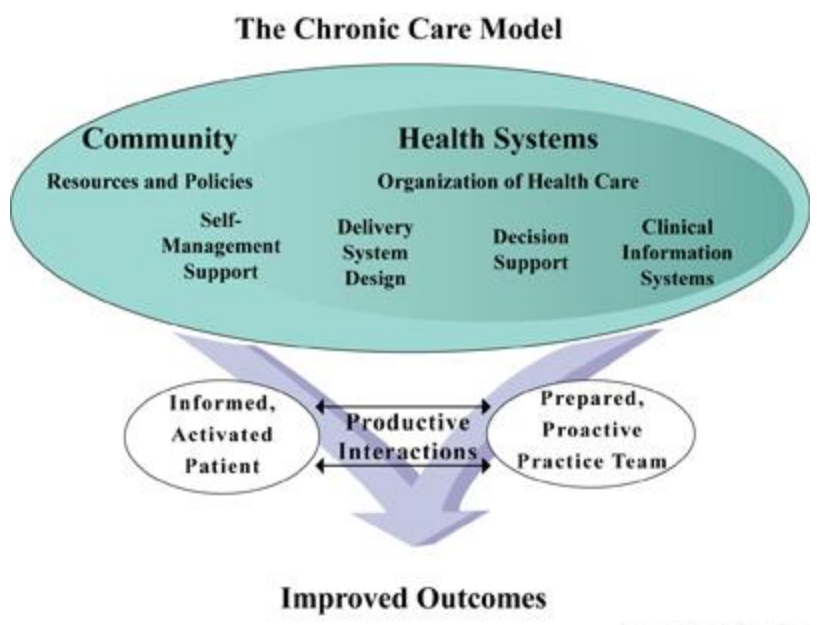
Appendix A. Article Search Flow chart for Review of Literature.

Summary of Search strategy



USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix B. The Chronic Care Model



Developed by The MacColl Institute
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Appendix C. Pre-Implementation Survey

Question	Participant				
	80066	80061	80062	80063	80065
1. Have you ever received information on how to manage your diabetes (Yes/No)	Yes	No	Yes	Yes	Yes
2. On a scale of 1-5, how confident are you with managing diabetes (0 not confident at all and 5 being very confident)	5	5	4	5	4
3. How many times a day do you check your blood sugar?	0	1	Never	2	Never
4. Do you have a schedule to check your blood sugar?	Yes	Yes	No	Yes	No
5. Do you follow a meal plan or diet for your diabetes?	No	No	No	No	Yes
6. How often do you cheat on your diet?	Daily	Daily	Daily	Weekly	Weekly
7. How many days per week do you exercise?	0	None	None	1	Never
8. Do you have family support for managing your diabetes?	Yes	No	No	Yes	Yes

Adopted from American Association of Diabetic Educators Patient Self-Assessment Tools (D-SMART) Version 2.0 (This tool is within the public domain and its use is permitted by fair use policy).

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix D. Post-Implementation Survey

Please answer the following questions relating to your experience with this project over the past 5 months.

Question	Participant				
	80066	80061	80062	80063	80065
1. Have you ever received information on how to manage your diabetes (Yes/No)	Yes	Yes	Yes	Yes	Yes
2. On a scale of 1-5, how confident are you with managing diabetes (0 not confident at all and 5 being very confident)	5	5	5	5	5
3. How many times a day do you check your blood sugar?	2	2	2	3	2
4. Do you have a schedule to check your blood sugar?	Yes	Yes	Yes	Yes	Yes
5. Do you follow a meal plan or diet for your diabetes?	Yes	No	Yes	No	Yes
6. How often do you cheat on your diet?	Monthly	Daily	Weekly	Weekly	Weekly
7. How many days per week did you exercise?	4+	0	1	1	4
8. Did you have family support with managing your diabetes?	Yes	No	No	Yes	Yes

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix E. Patient Consent Form

I authorize Peter Ameck (project manager) to send text message information about my diabetes care to my cell phone number. I understand that I will not be able to respond to these text messages and the messages will only contain general diabetic self-management information. The text messages will be sent from a Medical Associates cell phone number. I understand that no private or personal information will be sent. By agreeing to participate, I understand that I will be receiving messages every two weeks or sooner if need be. I understand that text message charges from my cell phone provider may apply.

I further agree to download and use OnTrack Diabetes App to track and send generic data concerning my diabetes to the project manager. This App will be free of charge to me.

By signing below I am the legal owner of the cell phone number listed. I also understand that this consent can be terminated anytime only in writing.

Patient ID Code _____

Signature: _____

Date: _____

(Modeled from consent template on Umass Amherst IRB website).

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix F. Enrollment Eligibility Questionnaire

Question	Participant				
	80066	80061	80062	80063	80065
Gender	Male	Male	Male	Male	Female
Ethnicity	Asian	White	White	Hispanic	Hispanic
Do you have a Cell Phone?	Yes	Yes	Yes	Yes	Yes
What type of phone?	Android	Android	Apple	Android	Android
Can you receive text messages?	Yes	Yes	Yes	Yes	Yes
Are your text messages free?	Yes	Yes	Yes	Yes	Yes
Are you comfortable receiving text messages about your diabetes?	Yes	Yes	Yes	Yes	Yes

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix G. Patient De-identifier Codes (Sample)

Patient Name	Patient Number	Patient ID Code
Jane O'Moon	1	80060
Jane Sky	2	80061
	3	80062
	4	80063
	5	80064
	6	80065
XXXXXXXXX	7	80066

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix H. Thank You Note

Patient name-----

Thank you for participating in this project aimed at trying to find new ways to help patients better manage their diabetes.

Please find included your \$20 Wal-Mart Gift Card.

Sincerely,

Student name and signature----- Date-----

USING SMARTPHONE TECHNOLOGY IN TYPE 2 DIABETES

Appendix I. Budget

Item	Cost Estimate
Project Manager (DNP student)	Donated
Data collector/manager	Donated
App Training (DNP Student)	Donated
App	Free
Gift Card to participants	\$160 (bought by student)
Office	
materials/supplies/printing	\$40
Total	\$200
